Human-wildlife interactions in the Western Terai of Nepal. An analysis of factors influencing conflicts between sympatric tigers (Panthera tigris tigris) and leopards (Panthera pardus fusca) and local communities around Bardia National Park, Nepal

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5

Defining the risks of attacks by predators around protected areas

"Defining the risks of attacks by predators around protected areas – the case of Bardia National Park, Nepal".
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Abstract

The present study focused on defining the probability of attacks by predators on livestock in the buffer zone of Bardia National Park, Nepal. Semi-structured interviews were used to explore the patterns and factors affecting livestock losses in four administrative sectors of the park's buffer zone. For this purpose, we developed models to investigate (i) overall probability of livestock loss, (ii) economic damage, and (iii) the attitude of respondents towards wildlife. We observed a higher probability of attacks on livestock by leopards (85%) compared to tigers (8%). Among the four sectors of the buffer zone, the Northern sector experienced the highest loss of livestock (50%). Livestock loss was significantly related to the number of livestock owned, the ethnic group of the respondents, and distance to the national park boundary. Variables contributing to economic damage were study sector, the number of livestock owned, and distance to the national park boundary. The attitude of respondents towards wildlife conservation depended on knowledge about the species (tiger/leopard), educational level, self-sufficiency, and the probability of livestock getting killed by leopards. Higher educational status, male gender and greater self-sufficiency of respondents resulted in a higher positive response rate (80%) for supporting conservation. The higher level of religious tolerance towards tigers and access to conservation benefits by people living in the buffer zone also has a positive role in conservation. Because there are no religious tolerance towards leopards and they are the most damaging predator's strategies should ideally focus on the conservation of leopards in a human-dominated landscape.

Keywords

economic loss, human attitudes towards conservation, leopard, livestock loss, tiger.

5.1 Introduction

Worldwide, large carnivore populations have declined for a variety of reasons, but mostly due to human interventions (Woodroffe & Ginsberg, 1998; Karanth & Chellam, 2009). Poaching for traditional medicine and furs, habitat destruction and depletion of their natural prey are major threats (Smith et al., 1998; Treves & Karanth, 2003).

Several studies reported increased conflicts between people and large carnivores in areas where large carnivore populations have started to increase (Saberwal et al., 1994; Treves & Karanth, 2003; Inskip & Zimmermann, 2009; Seidensticker, 2010; Silwal et al., 2017). This kind of interactions where the needs and behaviour of wildlife has a negative impact on humans or *vice versa* is called human-wildlife conflict (Madden, 2004). However, the use of term human-wildlife conflict is misleading because, in reality, it is a conflict between conservation and other human interests (Peterson et al., 2010; Redpath et al., 2015; Fisher, 2016).

Predatory attacks on livestock are presently one of the most critical challenges faced by livestock owners living near protected areas, with tigers and leopards annually killing 118 livestock in Bardia and 123 livestock in Chitwan National Park (Lamichhane et al., 2018). In spite of these losses, people living around protected areas in Asia have always been relatively tolerant towards wildlife (Dinerstein et al., 2007; Karanth & Nepal, 2012) compared to indigenous people from other regions of the world. Whereas sometimes cultural values and beliefs support wildlife conservation, livestock depredation events often lead to retaliatory killing, as is the case with lions in Africa (Bauer & Iongh, 2005). Trophy hunting also had an adverse effect on the population density of lions (Croes et al., 2011).

As the successful recovery of both leopard and tiger population depends a great deal on their capacity to co-exist with humans, adequate implementation of conflict mitigation measures is key to any protected area in which tiger and leopard are managed in the vicinity of the human population (Treves et al., 2006; Woodroffe et al., 2007; Carter et al., 2012).

In view of this, the aim of our study was (1) to identify the probability of livestock loss due to attacks by predators and due to other factors, such as disease and flooding, in different sectors of the buffer zone of Bardia; (2) to quantify the economic damage to resident communities due to predatory

attacks; and (3) to assess the attitude of residents towards the conservation of tigers, leopards and other wildlife, and the factors underlying this attitude.

5.1.1 Study Area

Bardia National Park (henceforth Bardia, IUCN, Category II) established in 1976, is located in South-western Nepal (N: 28.2630 to 28.6711; E: 80.1360 to 81.7645) (Figure 5.1). It is the largest national park in the plains (Terai) of Nepal with a surface area of 968 km^2 (DNPWC, 2018). It is one of the prime habitats for tiger and leopard in Nepal (Walston et al., 2010). The buffer zone of Bardia was established in 1996 with an area of 327 km^2. In 2010 an additional 180 km^2 of the Surkhet district was included in the buffer zone which mainly consists of hilly terrain. Buffer zone regulations have provisioned 30 to 50% of the revenue generated by the protected area to be invested in measures that should minimize damages caused by wildlife (Baral & Heinen, 2007).

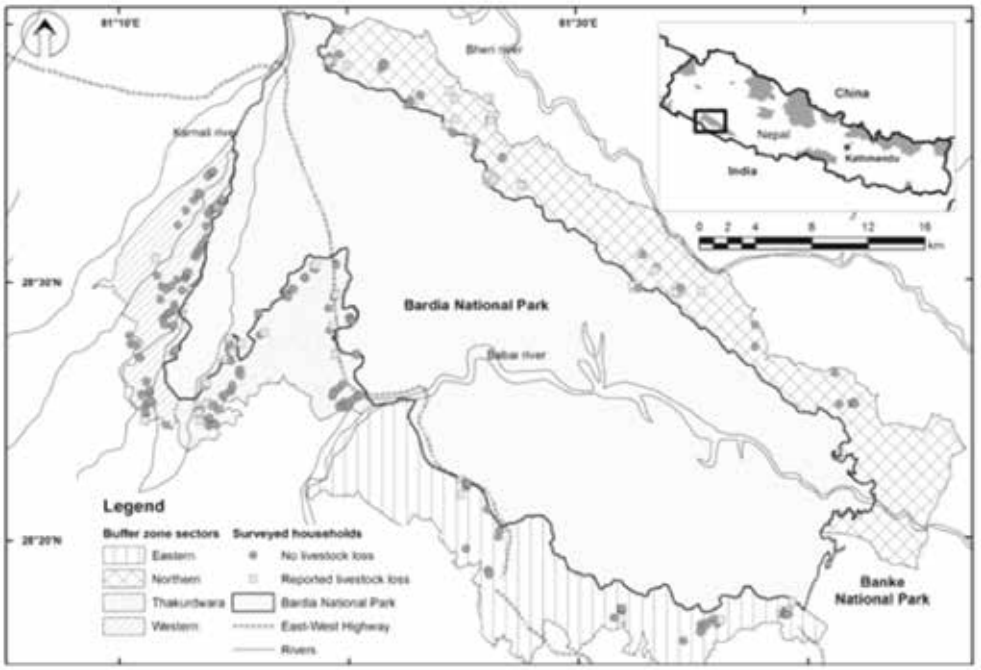

Figure 5.1
Bardia National Park and its buffer zone showing the study sectors, surveyed households and cases of reported livestock loss.

The rapid expansion of human settlements, habitat degradation, and poaching has caused tiger numbers to plummet to 18 individuals inside the park in 2009. In recent years however, the Bardia tiger population has rapidly increased to 50 individuals in 2013 and density of prey is 92.6/km^2 (Dhakal et al., 2014). Leopard number has not been recently assessed in Bardia, but Wegge et al. (2009) estimated 5 individuals/100 km^2.

The park has three distinct seasons: winter (late-September to mid-February), summer (mid-February to mid-June) and monsoon (mid-June to September). Temperature could rise to a maximum of 45°C and annual rainfall is 1500 mm (Dinerstein, 1979; DNPWC, 2018). Flooding that took place in 2014 contributed to a significant amount of damage to human and livestock (Bhattarai et al., 2016). However, loss of wildlife was not documented.

Indigenous Tharu people and migrants from the hills (Pahade) inhabit the buffer zone of the park (Bhattarai et al., 2016). The majority of households are involved in subsistence farming supplemented by the use of forest and grassland for grazing livestock (Thapa Karki, 2013). Paddy and maize are grown mainly in the monsoon, whereas wheat, mustard, and lentils are cultivated in winter for domestic consumption (Studsrød & Wegge, 1995). Livestock kept by villagers mainly include cow, buffalo, oxen, sheep, goats, pigs and chickens which are primarily kept for their milk, eggs, meat, manure and draft power (Thapa Karki, 2013).

5.2 Methods

5.2.1 Data collection

We used a semi-structured questionnaire (Supplementary material 5.1) survey (adapted from Sogbohossou et al., 2011 and Bhattarai & Fischer, 2014) of 297 households which were opportunistically selected in each of our four study sectors, taking into account the size and the total number of households in each sector (Table 5.1). The questionnaire was reviewed and we received ethical approval from the Institute of Environmental Science, Leiden University. Between May and August 2015 the heads of each selected household were interviewed taking verbal consent before starting the interview. Interviews were conducted in the Nepali language by native Nepali and Tharu language speaking assistants, who also worked as tourist guides in Bardia. They were trained and instructed on the structure and purpose of the questionnaire before the interview, and during the course of the survey regular as-

sessments were performed to limit any bias which could have resulted from their positive attitude to conservation as professional nature guides.

Table 5.1
The number of households interviewed per sector and village development committee.

Sector	Old Village Development Committees *	New Local body#	Number of households	Households interviewed
Thakurdwara (TK)	Bagnaha, Thakurdwara, Suryapatuwa, Neulapur, Shivapur	Madhuban Municipality, Thakurbaba Municipality.	5265	87
Eastern (ES)	Chisapani, Basgadhi, Motipur, Dhadhawar, Magaragadhi	Basgadhi Municipality, Warbardia Municipality.	4414	53
Western (WS)	Manau, Pashupatinagar, Gola, Patabhar	Geruwa Rural Municipality.	5099	80
Northern (NS)	Bheriganga, Taranga, Lekhparajul,	Bheriganga Municipality, Barahtal Rural Municipality.	1856	77
Total			16634	297

*Thapa & Chapman, (2010).
New local bodies have been formed by the Ministry of Federal Affairs and Local Development, Government of Nepal (MoFALD, 2017).

The surveyed communities were divided into four sectors based on their location inside the park management sectors and taking into account relative densities of livestock and natural prey in these sectors, as contributing factors to the probability of predatory attacks on livestock: The Thakurdwara sector (TK) and Western sector (WS) which were characterized by relatively high densities of both natural prey and livestock, and the Eastern sector (ES) and Northern sector (NS) with relatively low densities of natural prey and high densities of livestock.

5.2.2 Data analyses and statistics

Three logistic models were created to estimate (i) the overall probability of loss of livestock and poultry (including loss due to wildlife attacks and other factors such as disease, natural calamities); (ii) probability of loss due to wildlife; and (iii) the probability of loss due to leopards.

To analyze the economic damage, i.e. the costs of livestock losses due to predatory attacks and other factors, we developed a linear model for economic loss.

We also created logistic models for attitude (which was either positive [1] or negative [0]) towards (i) wildlife in general; (ii) wildlife conservation in general; (iii) wildlife conservation when family members had in some way experienced a negative impact from wildlife; and (iv) wildlife conservation in case of livestock losses due to predatory attacks. All our models were created in R (R Core Team, 2018). The model's likelihood ratio test (LRT) was used to compare all models with and without independent variables (Bolker et al., 2009). All variables are listed in Supplementary Table 5.1.

5.3 Results

Respondents were 16 to 76 years old (40 on average), 254 of whom were male and 43 female. In terms of educational status, 14% of the respondents were illiterate and 86% literate (24% – basic education, 18% – primary level, 23% – lower secondary, 14% – secondary level, and 8% - higher secondary or university level education). 52% of the respondents were able to sustain for 9-12 months, whereas 48% sustained for less than 9 months on their own crop production. Respondents were of several cultural backgrounds, with 37% Brahmin or Chhetri, 46% Tharus, 11% *Dalits* and 6% from another ethnic group. Around 85% of the respondents were farmers. The average household size was 5.13 persons. The average number of livestock kept by respondents was as follows: cow/ox-1.56, sheep/goat-4.49, buffalo-0.95, and pig-0.58. The percentage of livestock in different sectors were as follows: Thakurdwara-23%, Western-21%, Eastern-13%, and Northern-43%.

Around 59% of the respondent households were located within 2 km from the park boundary, 36% between 3-4 km, and 4% at more than 5 km from the park boundary. In total, 131 (44%) household heads reported the loss of livestock and poultry either due to predatory attacks (92 cases, 70%) or due to other factors (disease and flooding) (39 cases, 30%). There were 92 cases of deadly attacks on livestock and poultry reported, of which eight (8%) were due to tiger (which was confirmed by official park records), 78 (85%) due to leopard and six (7%) incidents due to other wildlife, viz. fox (*Vulpes vulpes*), jackal (*Canis aureus*), crocodile (*Crocodylus palustris*), python (*Python bivittatus*), eagle (*Aquila spp.*) and jackal (*Canis aureus*). Tigers kills comprised

94% cattle and 6% water buffalo, whereas leopards kills comprised 68% goats, 12% sheep, 14% pig and 6% cattle. Crocodile and fox killed goats whereas other wildlife killed poultry. Predatory attacks took place more often in summer (46%) and winter (35%) than in the monsoon season (19%). 81% of losses occurred inside the village and 19% away from habitation, in forest habitat. Most respondents were able to distinguish a tiger from a leopard based on photographs (c. 90%). They were able to recognize the predators based on pugmarks at the kill site and bite marks on the livestock carcass, which was verified by a park authority representative during compensation claim verifications.

5.3.1 Probability of loss

The probability of livestock loss per household for each study sector, with their respective causes are shown in Table 5.2. The overall probability of livestock loss was positively related to incidences of livestock grazing inside the community forest ($p = 0.004$), ethnic group ($p = 0.04$), the number of pigs owned by the respondent ($p = 0.02$) and study sector ($p = 0.02$). Attacks on livestock by leopards showed a strong relation with study sector ($p < 0.001$) (Supplementary Table 5.2). Incidences of livestock grazing inside the government forest ($p = 0.04$), ethnic group ($p = 0.04$), number of goats and sheep owned ($p = 0.02$) and number of pigs owned ($p = 0.01$) were significantly related to study sector (Supplementary Table 5.2).

Table 5.2
Probabilities of livestock loss per household in each study sector due to tigers, leopards and other causes.

Sector	Loss due to				
	Wildlife	Big cats	Tiger	Leopard	Other causes
Thakurdwara	0.30	0.24	0.02	0.22	0.43
Eastern	0.38	0.38	0.02	0.36	0.43
Western	0.10	0.09	0.06	0.03	0.35
Northern	0.55	0.53	0.01	0.52	0.69
All sectors	0.32	0.30	0.03	0.27	0.47

In all three models, the highest probability of livestock loss was found for the Northern sector (c. 50%), followed by the Eastern sector (c. 30%), and the Thakurdwara sector (c. 20%) (Figure 5.2a).

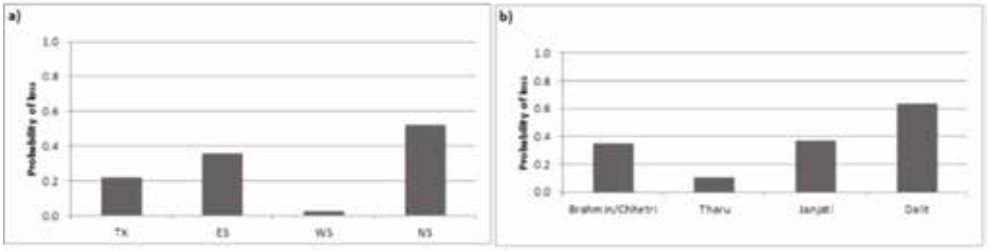

Figure 5.2
Probability of loss due to leopards, a) according to study sector, b) according to ethnic group.

Our results show that in all three models the probability of loss for the Tharu ethnic group was smaller than for other ethnic groups (Figure 5.2b). Around 79% of the predatory attacks took place when the livestock was held inside their corals and 52% occurred during the night.

5.3.2 Economic loss

The total costs of livestock lost due to predatory attacks and other factors amounted to $ 22,927 (1 USD = 105 Nepali Rupees) for the surveyed households, of which $ 14,573 (63.5%) was lost due to predatory attacks and $ 8,353 (36.5%) due to other factors (Table 5.3). The average cost of each livestock species ranged from $30 to $50, depending upon their size.

Table 5.3
Costs (in USD) of overall loss, loss due to predatory attacks and loss due to other factors in each study sector.

Sector	Total Loss	Average per household impacted in general	Loss due to wildlife	Average per household impacted by predatory loss	Loss due to other factors	Average per household impacted by loss due to other factors
Thakurdwara	2995	34	2507	29	488	6
Eastern	2067	39	1676	32	391	7
Western	7446	93	2181	27	5265	66
Northern	10419	135	8210	107	2209	29
All sectors	22927	75	14574	49	8353	27

The linear model suggests that the most important factors contributing to predation-related economic loss were study sector ($p < 0.001$) and distance to the national park ($p = 0.003$) (Table 5.4).

Table 5.4
Linear model results for economic loss due to wildlife; results of the likelihood ratio test are shown.

Economic Loss					
Variables	**Df**	**Deviance**	**AIC**	**LRT**	**Pr**
Sector	3	139.39	407.43	19.8562	0.0001818 ***
Number of cow and ox	1	124.96	396.68	5.1021	0.0238966 *
Number of goat and sheep	1	124.96	396.68	5.1066	0.0238355 *
Number of buffalo	1	120.54	391.82	0.2473	0.6189475
Number of pig	1	121.44	392.82	1.2455	0.2644177
Number of poultry	1	122.88	394.41	2.8374	0.0920938 .
Loss due to wildlife	1	122.92	394.46	2.8805	0.0896566 .
Loss due to others	1	122.52	394.02	2.4443	0.1179525
Distance to National Park	1	128.52	400.47	8.8931	0.0028624 **

5.3.3 Attitude towards wildlife

Of the 270 responses on questions related to 'attitude towards wildlife', 85% was positive. In addition, 93% of the respondents were positive about the conservation of wildlife in general, even when some of their family members had suffered wildlife-related losses in the past. About 80% of the respondents who had suffered livestock losses from predatory attacks themselves in the past, indicated that they are still in support of wildlife protection and conservation (Table 5.5).

Table 5.5
Attitude towards wildlife in percentage of households for each study sector.

Sector	**Positive attitude towards conservation**	**Willingness to**		
		Support for conservation	**Support with family affected**	**Support with livestock lost**
Thakurdwara	0.90	0.95	0.97	0.97
Eastern	0.73	0.93	0.87	0.76
Western	0.99	0.99	0.96	0.96
Northern	0.73	0.84	0.88	0.46
All sectors	0.85	0.93	0.93	0.80

Our logistic model on the attitude towards wildlife showed that of all study sectors, respondents from the Western sector were most positive towards conservation, followed by Thakurdwara, Eastern, and Northern sector respectively ($p = 0.03$). Respondents with a higher level of education were generally more positive towards wildlife in general ($p = 0.004$) and willing to conserve wildlife ($p = 0.02$). Respondents who were generally self-sufficient (i.e. generating crop yields that could sustain their household throughout the year) were more positive about wildlife conservation in general than respondents who were not self-sufficient ($p = 0.03$). With respect to gender, male respondents were more positive about wildlife conservation than females ($p = 0.10$) (Supplementary Table 5.3). Remarkably, respondents who had suffered livestock losses due to tiger attacks had a positive attitude towards wildlife conservation ($p = 0.06$).

The model on attitude towards wildlife conservation shows that self-sufficiency and education level were positively related to a positive attitude ($p = 0.01$ and 0.02), even when family members had suffered livestock losses from predatory attacks. There is an indication that the overall probability of loss affects the attitude towards conservation ($p = 0.06$) (Supplementary Table 5.3).

The attitude of respondents, who had suffered livestock losses themselves, varied between the study sectors. Around 98% of the respondents of the Thakurdwara and Western sectors, 80% in the Eastern sector and 50% from the Northern sector were positive towards wildlife conservation, despite having suffered livestock losses due to predatory attacks themselves (Table 5.5). The positive response increased with educational level (illiterate-60%, primary level-80%; $p < 0.001$). Similarly, the overall probability of livestock loss also showed some effect on positive attitude ($p = 0.03$).

5.4 Discussion

Household surveys provide insight into how people live and interact with wildlife. We found that leopard caused most livestock killing, similar to Acharya et al., (2016) who reported that leopards contributed to 21% wildlife-induced livestock losses in Nepal. Signs of leopards were mostly found towards the fringe of park in Bardia (Studsrød & Wegge, 1995; Tamang & Baral, 2008; Upadhyaya et al., 2018) as reported in Chitwan National Park (Bhattarai & Kindlmann, 2012) and Macharia National Park, Pakistan (Dar

et al., 2009). Loss of livestock was related to their number which is similar to findings of Tamang & Baral (2008) from Bardia, Oli et al. (1994) from the Annapurna conservation area, Nepal and Wang & Macdonald (2006) from Bhutan. Livestock depredation was higher in the corals as reported by Tamang & Baral, (2008).

Tharu people reported minimal losses, although the number of livestock owned by them was comparable to people of other ethnic groups. This may be related to the Tharu's long experience of living with wildlife as an indigenous group and their adaptation through better livestock husbandry practices (Kolipaka et al., 2017). Distance to the park boundary is an important determinant of predatory attacks on livestock and increased at a distance of 5-12 km in Bardia and Waza National Park, Cameroon (Studsrød & Wegge, 1995; Van Bommel et al., 2007).

Households in the Northern sector suffered considerably higher economic damage compared to other sectors, which may be attributed to the poor husbandry techniques. Poorer respondents substantially lost more livestock compared to wealthier respondents who could afford better protection and husbandry techniques (Saberwal et al., 1994). The lives of people from marginalized groups could be heavily impacted by such financial losses (Manral et al., 2016).

Economic loss due to predatory attacks was comparable to losses due to other causes, which in our study area were related primarily to two natural events: an unexpected flood in 2014, which caused a sudden rise in deaths of livestock, and a bird-flu outbreak which led to great losses among poultry. In other areas where human-carnivore conflicts are considered to be a major cause of economic losses, non-wildlife factors, such as disease and theft, were actually contributing a greater deal to overall economic losses (Dar et al., 2009; Tumenta et al., 2013), compared to predation.

The difference in attitude between respondents from the Western study sector (98% had a positive attitude towards wildlife conservation) and respondents from the Northern sector (around 70% were positive), is very likely to be a consequence of the differences in numbers of livestock lost between these two sectors. In addition, respondents from the Northern sector were generally dissatisfied due to the lack of benefits they are gaining from the Buffer zone program. Pant et al. (2016) showed that a positive attitude is also related to human safety. Although people's attitudes towards wildlife can be influenced

by predatory attacks and other wildlife-related financial losses (Røskaft et al., 2007), and that people are more tolerant towards wildlife if they derive benefits from the park (Allendorf et al., 2007; Baral & Heinen, 2007; Romañach et al., 2007; Wegge et al., 2018). Active involvement of local communities in planning, executing and managing small-scale conservation projects, lead to a positive attitude towards conservation (Nepal, 2002).

Despite the differences, we found in attitude towards conservation between the study sectors, overall c. 65% and c. 80% of all our respondents had a positive attitude towards conservation, even when a leopard or tiger, respectively, had killed their livestock. The fact that tigers were 'slightly in favour' by our respondents is a clear reflection of the cultural values of people in this region (Bhattarai & Fischer, 2014; Kolipaka et al., 2015). People from Bardia believe that tigers are the vehicle of the goddess of might and should not be harmed (Bhattarai & Fischer, 2014).

Respondents with a higher level of education and self-sufficiency had a positive attitude towards conservation, which is comparable to other studies (Allendorf et al., 2006; Sarker & Røskaft, 2011; Sogbohossou et al., 2011; Tumenta et al., 2013; Bhattarai & Fischer, 2014). In Bangladesh, wealthy respondents favoured wildlife conservation 7.4 times more than their less wealthy peers (Sarker & Røskaft, 2011). People who have to rely on a single livelihood or few resources are more vulnerable to the impact of depredation (Ogra, 2008; Dickman, 2010). Generally, more educated people are less dependent on natural resources for their sustenance, than their less educated neighbours (Dickman, 2010). Since education can be an important tool in wildlife conservation at the local scale (Nepal & Weber, 1995), conservation authorities in Bardia could use this information to enhance existing indigenous knowledge and technologies in order to reduce risky human-wildlife interactions (Kolipaka et al., 2017). Female respondents had a less positive attitude towards conservation compared to the male respondents, may be linked to the risks women are exposed to due to their involvement in collecting forest resources, making them more vigilant in the vicinity of wildlife than men (Allendorf, 2010; Bhattarai & Fischer, 2014). However, we cannot generalize this because of the low number of female respondents in our study. Carter et al. (2014) also reported that women, less educated persons and people from marginalized groups more often have negative attitudes, specifically towards tigers.

Based on these considerations, we believe our findings could be of great value to Bardia wildlife managers and other conservation authorities in the region. They could help in predicting where interactions with tigers and leopards are likely to lead to problems and to design intervention strategies that could reduce financial losses due to conflicts (Kansky & Knight, 2014). Mitigation measures in and around Bardia should consider the specialized behavioral traits of cat species involved in the conflict. In order to reduce the impact of carnivores on livestock loss we recommend (1) improvements in enclosure and herding practices; (2) reducing the number of livestock kept, by diversifying economy; (3) implementation of a community-based livestock insurance program; and (4) establishing an early warning system.

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Conflict of interest:
None

Ethical standards:
Our research complies with journal's code of conduct for authors contributing articles.

Supplementary material 5.1

Questionnaire used for survey

Name of interviewer: _____

Date: _____ Time: _____

Address: Muncipality/VDC: _____ Ward No: _____ Village: _____

Consumer group: _____

GPS location: _____ N-_____ E-_____ Elevation-_____

Questionnaire for Interview on assessing Human-wildlife conflict

1 Name: _____

2 Age: _____ Gender (Male/Female) (Score 1,2): _____

3 Occupation:

4 Family members: Male _____ Female _____ Children (below 15 years age)-_____

5 Ethnic group (Score 1, 2, 3, 4, 5):

- **a** Bahun/Chhetri _____
- **b** Tharu _____
- **c** Janjati _____
- **d** Dalit _____
- **e** Other (mention) _____

6 Distance from park boundary (GPS location)(Score 1,2, 3,4):

- **a** 0 to 1 km _____
- **b** 1 to 3 km _____
- **c** 3 to 5 km _____
- **d** Above 5 km _____

7 Where were you born? (if different from present address)

_____

8 When did you come to stay(Score 1, 2, 3, 4, 5)

- **a** 0- 5 years _____
- **b** 5-10 years _____
- **c** 10-20 years _____
- **d** 20-30 years _____
- **e** Before 30 years _____

9 Why did you come to live here?

10 Can differentiate between tiger, leopard and other animals (Yes/No) (Score 0, 1). (Take help of photograph)

11 Source of livelihood (Number of months in a year-Score 1, 2, 3, 4, 5)

- **a** Crop _____
- **b** Livestock _____
- **c** Employment _____
- **d** Business _____
- **e** Seasonal labour _____
- **f** Others _____

12 What are the activities of other family members?

13 How long does the interviewee sustain on own crops and livestock (Select ONLY one-Score 1, 2, 3, 4, 5, 6)

- **a** Less than 3 months _____
- **b** 3 months _____
- **c** 3-6 months _____
- **d** 6-9 months _____
- **e** 9-12 months _____
- **f** More than a year _____

14 Livestock holding (Number)(Score-Big cattles-1, Small cattles-2, Poultry-3)

- **a** Cow/Ox _____
- **b** Buffalo _____
- **c** Goat/Sheep _____
- **d** Pig _____
- **e** Poultry _____
- **f** Fishery _____

15 Which source is utilized for livestock rearing (Give preference from 1 to 4 on the basis of priority)

- **a** National Park _____
- **b** Community forest _____
- **c** Government forest _____
- **d** Private land _____

16 Reason for livestock loss last year

- **a** Natural (Number and name of livestock): _____
- **b** Disease (Number and name of livestock): _____
- **c** Theft (Number and name of livestock): _____
- **d** Wildlife attack (Number and name of livestock): _____
- **e** Accident (Number and name of livestock): _____

17 Monetary value of loss (in NPR): _____

18 Number of own livestock lost in a tiger/leopard/other wildlife attack within this year (Name of livestock and number)

Place: _____ Date: _____ Time: _____

- **a** Tiger _____
- **b** Leopard _____
- **c** Other wildlife(name of wildlife) _____

19 Attack on family members or relatives by wildlife within last 20 years (If yes, place, time, date, gender and age of victim, injury or death)

Place: _____ Name of person: _____

Age/Gender: _____ Date: _____ Time _____

a Tiger _____

b Leopard _____

c Other wildlife (name of wildlife) _____

20 Have you seen a tiger or leopard in your area in the last five years (Yes/No) (Score 1, 0)

21 What was the frequency of seeing the tiger or leopard during past 5 years (Score 1 to 5)

22 Opinion towards tiger/leopard/other wildlife (Score 1,0)

a Dislike **b** Like

23 Do you want to conserve wild animals?(Yes/No)(Score 1,0)

24 Support for tiger/leopard conservation even if a family member is affected (Score 1,-1,0-ONE option)

a Agree **b** Disagree **c** Neutral

25 Support for tiger/leopard even if livestock is killed (Score 1,-1,0-ONE option)

a Agree **b** Disagree **c** Neutral

26 Education level (Score 1, 2, 3, 4, 5, 6):

a Illiterate _____

b Literate _____

c Primary _____

d Secondary _____

e Higher secondary/University _____

Supplementary Table 1
Description of the independent variables used in our models.

Variable	Description	Value
Sector	Sector of the buffer zone	Categorical variable
Distance	Distance of the village to the park boundary	Score (1 to 4) 1: nearest (within 2 km); 4: farthest.
Age	Age of the respondent	Continuous variable
Gender	Gender of the respondent	Categorical variable
Ethnic group	Ethnic group to which respondent belongs	Categorical variable
Household size	Number of members in the household	Continuous variable
Cattle owned	Number of cattle owned	Continuous variable
Self sufficiency	For how long does the respondent can sustain form their own land.	Score (1 to 6) 1: sufficient for 3 months; 6: sufficient for more than a year.
Recognize tiger, leopard	Can distinguish a tiger from a leopard (with the help of a photograph) (Yes/ No).	Score (1,0)
Opinion towards wildlife	Whether the respondent had positive or a negative opinion towards wildlife(Yes/ No)	Score (1,0)
Want to Conserve wildlife	Whether the respondent wants to conserve wildlife(Yes/ No)	Score (1,0)
Want to conserve wildlife even when family members are affected	Whether the respondent wants to conserve wildlife even when family members are affected by wildlife(Yes/ No)	Score (1,0)
Want to conserve wildlife even when livestock is killed by wildlife	Whether the respondent wants to conserve wildlife even when livestock is killed by wildlife(Yes/ No)	Score (1,0)
Education	Educational level of the respondent	Score (1 to 6) 1: Illiterate; 6: high school or college level education.
Overall loss	Loss of livestock due to all causes (Yes/No)	Score (1,0)
Loss due to wildlife	Loss of livestock due to wildlife (Yes/ No)	Score (1,0)

Loss due to big wild cats	Loss of livestock due to big cats (tiger and leopard) (Yes/No)	Score (1,0)
Loss due to tigers	Loss of livestock due to tigers (Yes/No)	Score (1,0)
Loss due to leopards	Loss of livestock due to leopards (Yes/No)	Score (1,0)

Supplementary Table 2
Logistic models for the probability of loss; results of the likelihood ratio test are shown.

Overall probability of loss:					
Variables	**Df**	**Deviance**	**AIC**	**LRT**	**Pr(>Chi)**
Sector	3	322.44	348.44	6.4348	0.092271 .
Distance to National Park	1	316.32	346.32	0.3161	0.573938
National Park	1	318.88	348.88	2.8763	0.089895 .
Community Forest	1	324.33	354.33	8.3306	0.003898 **
Government Forest	1	316.76	346.76	0.7543	0.385115
Own Land	1	319.57	349.57	3.5640	0.059046 .
Number of Times seen	1	318.74	348.74	2.7335	0.098267 .
Caste	1	320.04	350.04	4.0363	0.044531 *
Number of goat and sheep	1	318.45	348.45	2.4473	0.117726
Number of cow and ox	1	319.40	349.40	3.4007	0.065170 .
Number of pig	1	321.44	351.44	5.4372	0.019712 *
Number of buffalo	1	316.25	346.25	0.2520	0.615642
Education level	1	317.89	347.89	1.8900	0.169199
Probability of loss due to Wildlife:					
Sector	3	286.67	312.67	10.2903	0.01625 *
Distance to National Park	1	278.94	308.94	2.5578	0.10975
National Park	1	277.04	307.04	0.6553	0.41824
Community Forest	1	277.45	307.45	1.0735	0.30016
Government Forest	1	280.56	310.56	4.1836	0.04082 *
Own Land	1	276.57	306.57	0.1890	0.66376
Number of Times seen	1	277.60	307.60	1.2140	0.27054
Caste	1	280.44	310.44	4.0550	0.04404 *
Number of goat and sheep	1	281.87	311.87	5.4902	0.01912 *

Number of cow and ox	1	277.23	307.23	0.8511	0.35623
Number of pig	1	282.38	312.38	5.9988	0.01432 *
Number of buffalo	1	277.14	307.14	0.7557	0.38468
Education level	1	276.44	306.44	0.0637	0.80068
Probability of loss due to Leopard:					
Sector	3	254.60	280.60	24.3283	2.133e-05 ***
Distance to National Park	1	231.11	261.11	0.8313	0.3618857
National Park	1	231.36	261.36	1.0811	0.2984409
Community Forest	1	230.82	260.82	0.5496	0.4584844
Government Forest	1	232.12	262.12	1.8433	0.1745697
Own Land	1	230.97	260.97	0.6917	0.4055888
Number of Times seen	1	230.59	260.59	0.3102	0.5775518
Caste	1	237.28	267.28	7.0071	0.0081189 **
Number of goat and sheep	1	242.21	272.21	11.9338	0.0005512 ***
Number of cow and ox	1	230.37	260.37	0.0954	0.7574018
Number of pig	1	235.85	265.85	5.5722	0.0182473 *
Number of buffalo	1	230.90	260.90	0.6230	0.4299252
Education level	1	230.68	260.68	0.4063	0.5238361

Supplementary Table 3
Logistic models of attitude towards wildlife; results of likelihood ratio test are shown.

Attitude towards wildlife					
Variables	**Df**	**Deviance**	**AIC**	**LRT**	**Pr(>Chi)**
Sector	3	154.69	200.69	8.7119	0.033378 *
Gender	1	150.40	200.40	4.4167	0.035589 *
Age	1	147.55	197.55	1.5708	0.210096
Recognize between tiger and leopard	1	146.83	196.83	0.8499	0.356570
Self sufficiency	1	146.15	196.15	0.1654	0.684269
Education	1	154.07	204.07	8.0957	0.004437 **
Overall probability of a kill	1	146.60	196.60	0.6179	0.431821
Probability of kill by wildlife	1	146.94	196.94	0.9639	0.326206
Probability of kill by a leopard	1	148.22	198.22	2.2393	0.134545
Probability of human kill by a tiger	1	146.05	196.05	0.0741	0.785529
Probability of human kill by other wildlife	6	152.85	192.85	6.8728	0.332775
Probability of kill by a tiger	1	148.91	198.91	2.9304	0.086928 .
Probability of kill by other wildlife	6	151.63	191.63	5.6499	0.463533
Attitude towards wildlife conservation					
Sector	3	89.982	133.98	4.0069	0.26072
Gender	1	88.755	136.75	2.7792	0.09550 .
Recognize between tiger and leopard	1	86.924	134.92	0.9488	0.33003
Self sufficiency	1	90.539	138.54	4.5636	0.03266 *
Education	1	91.643	139.64	5.6681	0.01728 *
Overall probability of a kill	1	85.976	133.98	0.0003	0.98568
Probability of kill by wildlife	1	87.442	135.44	1.4669	0.22583
Probability of kill by a leopard	1	87.838	135.84	1.8630	0.17228
Probability of human kill by a tiger	1	86.022	134.02	0.0463	0.82971
Probability of human kill by other wildlife	6	87.861	125.86	1.8855	0.92992
Probability of kill by a tiger	1	89.387	137.39	3.4116	0.06474 .
Probability of kill by other wildlife	6	87.880	125.88	1.9048	0.92824

Attitude towards wildlife conservation even if a family member is affected					
Sector	3	102.36	146.35	2.0058	0.57121
Gender	1	101.74	149.74	1.3922	0.23803
Recognize between tiger and leopard	1	101.07	149.07	0.7248	0.39459
Self sufficiency	1	106.89	154.89	6.5439	0.01052 *
Education	1	105.72	153.72	5.3679	0.02051 *
Overall probability of a kill	1	103.83	151.82	3.4752	0.06229 .
Probability of kill by wildlife	1	100.35	148.35	0.0000	1.00000
Probability of kill by a leopard	1	101.94	149.94	1.5861	0.20788
Probability of human kill by a tiger	1	100.54	148.54	0.1861	0.66621
Probability of human kill by other wildlife	6	102.82	140.82	2.4715	0.87165
Probability of kill by a tiger	1	102.08	150.08	1.7271	0.18878
Probability of kill by other wildlife	6	102.97	140.97	2.6255	0.85417
Attitude towards wildlife conservation even if a livestock is killed					
Sector	3	192.30	236.30	50.556	6.081e-11 ***
Gender	1	141.93	189.93	0.181	0.67057
Recognize between tiger and leopard	1	141.99	189.99	0.243	0.62196
Self sufficiency	1	142.45	190.45	0.705	0.40106
Education	1	166.18	214.18	24.429	7.710e-07 ***
Overall probability of a kill	1	146.36	194.36	4.617	0.03165 *
Probability of kill by wildlife	1	141.88	189.88	0.136	0.71200
Probability of kill by a leopard	1	142.24	190.24	0.493	0.48251
Probability of human kill by a tiger	1	141.82	189.82	0.072	0.78800
Probability of human kill by other wildlife	6	148.74	186.74	6.992	0.32160
Probability of kill by a tiger	1	142.77	190.77	1.025	0.31132
Probability of kill by other wildlife	6	142.22	180.22	0.479	0.99809