



Human Dimensions of Wildlife

An International Journal

ISSN: 1087-1209 (Print) 1533-158X (Online) Journal homepage: www.tandfonline.com/journals/uhdw20

Examining human-wildlife conflict and management strategies in Indian protected areas: evidence from Jim Corbett Tiger Reserve

Riyaz Alam & Diptimayee Nayak

To cite this article: Riyaz Alam & Diptimayee Nayak (2025) Examining human-wildlife conflict and management strategies in Indian protected areas: evidence from Jim Corbett Tiger Reserve, *Human Dimensions of Wildlife*, 30:1, 34-51, DOI: [10.1080/10871209.2024.2303364](https://doi.org/10.1080/10871209.2024.2303364)

To link to this article: <https://doi.org/10.1080/10871209.2024.2303364>

 [View supplementary material](#)

 Published online: 11 Jan 2024.

 [Submit your article to this journal](#)

 Article views: 687

 [View related articles](#)

 [View Crossmark data](#)

 Citing articles: 8 [View citing articles](#)

RESEARCH ARTICLE



Examining human-wildlife conflict and management strategies in Indian protected areas: evidence from Jim Corbett Tiger Reserve

Riyaz Alam and Diptimayee Nayak

Department of Humanities and Social Sciences, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand, India

ABSTRACT

The study examines the trends and patterns of human-wildlife conflict and explores stakeholders' perceptions toward management strategies in the Jim Corbett Tiger Reserve, India. The study used a mixed "methods" research approach. Human-wildlife conflict quantitative data was analyzed using a trend line approach. Grounded Theory and thematic analysis were used to analyze local households ($n = 150$), park employees ($n = 20$), and eco-development committees ($n = 10$) interviews content. The results revealed a significant decline in human casualties, cattle depredation, and crop damage, possibly attributed to strategies like awareness programs, electric fencing, and alternative livelihoods. The study found no significant evidence of retaliatory wildlife killing by locals. Although human-wildlife conflict has declined significantly due to existing management strategies, the thematic analysis highlights serious challenges, including inadequate funding, insufficient compensation, and limited local participation in alternative livelihoods. These challenges need to be addressed urgently for the sustainable management of conflict.

KEYWORDS

Eco-development committees; Grounded Theory; human-wildlife conflict; Jim Corbett Tiger Reserve; wildlife management strategies

Introduction

Human-wildlife conflict (HWC) involving human casualties, cattle depredation, crop raiding, and property damage caused by wildlife, as well as retaliatory wildlife killing by local people, poses a serious challenge to global conservation efforts in protected areas (PAs) (Karanth & Kudalkar, 2017; Nyhus, 2016). HWC is driven by a variety of factors, including human population growth and expansion of human settlements in and around PAs (Naha et al., 2019), transformation of forest into agriculture and grazing land (Naha et al., 2019; Tripathy et al., 2021), increasing accessibility to PAs through ecotourism and other developmental activities, and an increase in wildlife populations (Distefano, 2005). Furthermore, cattle grazing, fuelwood harvesting, and fodder gathering, as well as clearing forested land for settlements escalate HWC by degrading habitat and reducing the availability of food and space for wildlife (Naha et al., 2019; Nayak et al., 2012, 2018; Tripathy et al., 2021). The paucity of food and space compels wildlife to invade the adjacent human settlements to meet their nutritional and behavioral needs, causing human casualties, cattle depredation,

CONTACT Diptimayee Nayak  dipti.nayak@hs.iitr.ac.in  Department of Humanities and Social Sciences, Indian Institute of Technology Roorkee, 5th Floor-503, Roorkee, Uttarakhand 247667, India

 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/10871209.2024.2303364>

© 2024 Taylor & Francis Group, LLC

crop raiding, and property damage (Tripathy et al., 2021). If these costs are not mitigated and/or compensated, the affected communities might engage in retaliatory wildlife killing through poisoning, trapping, and shooting (Badola et al., 2021; Nyhus, 2016; Ripple et al., 2014; Tiller et al., 2021).

The existing management response to HWC involves preventive and mitigation strategies (Distefano, 2005). Preventive strategies, such as electric-fencing (Distefano, 2005; Lamichhane et al., 2018; Tiller et al., 2021; Wilson et al., 2015), solar spotlights (Davies et al., 2011), relocation of communities outside the reserve, translocation of problematic wildlife (Distefano, 2005; Gross et al., 2021), and night time watching with deterrents (e.g., fire, bells, firecrackers, radios, and guarding dogs) (Distefano, 2005; Karanth & Kudalkar, 2017; Siljander et al., 2020; Tiller et al., 2021), are some of the tools used to prevent negative human-wildlife interaction. Mitigation strategies may include compensation and insurance schemes (Badola et al., 2021; Distefano, 2005), local development projects (Mathur et al., 2011), and economic diversification through ecotourism and other livelihood opportunities (Alam & Nayak, 2020). Besides, conservation education and awareness programs (Sharma et al., 2020; Siljander et al., 2020), effective patrolling, and sustainable resource utilization (Distefano, 2005) are also popular mitigation strategies targeted at improving tolerance and resilience among the affected communities toward wildlife (Distefano, 2005), which can contribute to the achievement of peaceful human-wildlife co-existence.

There exists vast literature examining various facets of HWC in India, such as direct and indirect costs (Badola et al., 2010, 2021), spatial and temporal patterns (Bargali et al., 2018; Sengupta et al., 2020; Tripathy et al., 2021), compensation records (Karanth & Ranganathan, 2018; Sengupta et al., 2020), determinants (Badola et al., 2021; Chartier et al., 2011), and the socioeconomic, geographic, historical, and environmental factors associated with the use of management strategies by households (Karanth & Kudalkar, 2017). However, the literature exploring stakeholders' perceptions about wildlife management strategies in Indian PAs is scant. Implementing and monitoring preventive and mitigation strategies in Indian PAs relies on the active involvement of park staff, eco-development committees (EDCs), and local households. EDCs are local-based institutions consisting of a forest range officer as a head, a president, and 4–5 members from each EDC village. They primarily aim to foster an alliance between the local people and park management by facilitating the implementation of management strategies (Ministry of Environment, Forest and Climate Change, Government of India, n.d.). Therefore, understanding such stakeholders' views and perceptions is necessary for the development of a holistic framework for the sustainable management of HWC. The objectives of this study are, therefore, to 1) analyze the trends and patterns of HWC between 2015 and 2019; 2) identify the pattern of financial compensation; and 3) explore stakeholders' perceptions about wildlife management strategies in 2020–2021.

Sequential Explanatory Design Framework

Sequential Explanatory Design (SED), a systematic framework for a mixed “methods” research (Creswell et al., 2011), was used in the study. The framework consists of two sequential phases. The first phase involves the quantitative data collection through surveys or experiments, and analysis using statistical techniques to examine patterns, relationships, and statistical significance (Creswell et al., 2011). The quantitative data measures the

pervasiveness of “known” social phenomena. The second phase involves the qualitative data collection through personal interviews, focus groups, or observations, which is used to explore themes, patterns, and explanations that complement the findings of quantitative data (Creswell et al., 2011). Besides, qualitative data provides a deeper understanding, and offers critical insights into complex social phenomena that may not be fully captured by the quantitative data. The qualitative data is analyzed and interpreted using various analytical techniques, including Grounded Theory and thematic analysis. After completing both the phases, SED requires the integration of the findings of quantitative and qualitative data analysis.

Methods

The study was conducted in India’s oldest PA, the Jim Corbett Tiger Reserve (CTR). Established as a national park in 1936, it was converted into a tiger reserve at the launch of a landmark royal tiger conservation initiative, Project Tiger, in 1973. Lying in the Terai-Arc Landscape in the foothills of the Himalayas, it is among the 200 globally important ecoregions (Badola et al., 2021). The aggregate geographical spread of CTR is about 1288 km², comprising Jim Corbett National Park (521 km²), Sonanadi Wildlife Sanctuary (301 km²), and a buffer zone (466 km²) (Figure 1). Biologically, the CTR vegetation includes Sal-dominated forest, Sal-mixed forest, riverine forest, mixed and miscellaneous forest, and an abundance of plantations (Badola et al., 2010). It also supports 50 species of mammals, 575 species of birds, 33 species of reptiles, and 7 species of amphibians (Badola et al., 2010). The reserve is a natural habitat for globally endangered wildlife species like tigers (*Panthera*

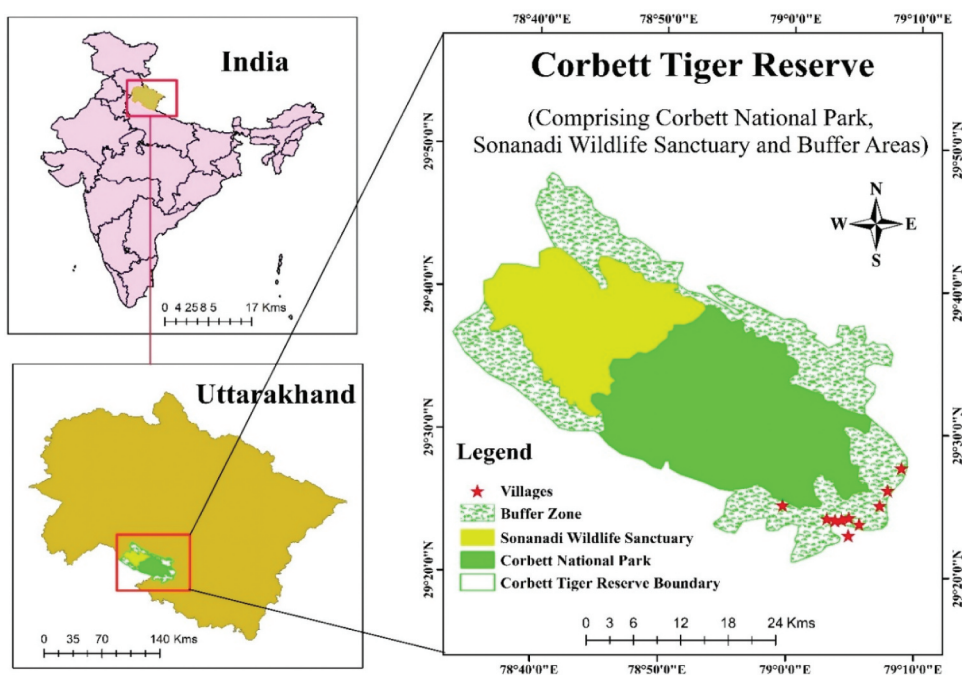


Figure 1. Study area.

tigris), Asian elephants (*Elephas maximus*), and hog deer (*Axis porcinus*); vulnerable species like leopards (*Panthera pardus*) and sambar (*Rusa unicolor*); and species of least concern like the chital (*Axis axis*), wild boar (*Sus scrofa*), and nilgai (*Boselaphus tragocamelus*) (International Union for Conservation of Nature IUCN, 2022). According to the latest Tiger Census of 2018, India has the highest population of tigers in the world ($n = 2,967$); of them, 231 live in the CTR, the highest amongst of all PAs (Siddhartha, 2021). There are several culturally and geographically diverse communities residing in villages located in the buffer zone of the CTR and frequently experiencing HWC.

The HWC quantitative data was collected from different sources. For wildlife-induced damage, we collected the compensation records from 2015–2019 of the CTR research division (*shodh* range). These records contain data about the location, date and nature of the conflict (e.g., cattle depredation), as well as wildlife involved, and the amount of compensation paid for damages. The data of retaliatory wildlife killing were collected from CTR research division and official website of Wildlife Crime Control Bureau (WCCB).

The qualitative data were collected through in-depth personal interviews of key conservation stakeholders to explore perceptions toward wildlife management strategies and explain trends and patterns of HWC. A pilot survey was conducted with two park employees, two presidents of EDCs, and ten local households to pretest the questionnaire.

Recognizing that each stakeholder has a different background and role in wildlife management, we adopted a different sampling procedure to select participants for the study. First, we divided park employees into different groups based on their job position and drew a sample of participants ($n = 20$). Based on employees' consultations and field observations, we identified EDC villages situated in two popular ranges: *Bijrani* range and *Dhela* range. The *Bijrani* range includes Amdanda, Ringora, and Dhikuli villages ($n = 3$), whereas the *Dhela* range includes Kaniya, Himmatpur Dautiyal, Sewal Khalia, Devipur Bansiteela, Sawalkeh East, Sawalkeh West, and Dhela villages ($n = 7$). We interviewed the president of each EDC. Finally, we interviewed local households ($n = 150$) selected from these EDC villages using a simple random sampling method.

Stakeholders who verbally consented to participate in the survey were interviewed by the researcher using a semi-structured questionnaire.¹ We assigned different code names to different stakeholders, such as park employees (PE), EDC presidents (EDC), and local informants (LI) (e.g., LI140 represents the 140th local informant). The interviews of park employees and EDC presidents lasted about 50 minutes to an hour, while the interviews of local informants lasted about 20 to 30 minutes. The study was conducted from December 2020 to April 2021.

Data Analysis

The quantitative data were analyzed using the linear regression and trend line approach² to exhibit the trends of HWC. The trend is statistically significant if the p-values are less than .05 or 5% significance level and statistically meaningful if $R^2 \geq .65$ and p-value $\leq .05$ (Bryhn et al., 2011). Additionally, a pie chart and cross tabulation was used to show patterns of conflict, wildlife involved, and financial compensation.

For qualitative analysis, Grounded Theory was used to uncover underlying meanings and processes that shape social phenomena (Glaser & Strauss, 1967). It is used when there is no existing theory to explain the social phenomenon or when the theory exists but is

potentially incomplete to study the social phenomenon (Delve, 2023). The present study applied Grounded Theory to analyze the qualitative data on the stakeholders' perceptions about wildlife management strategies in the study area. The first step is to use the purposive sampling for data collection, followed by initial coding, intermediate coding, advance coding, and then finally, generation of theory from the data (Tie et al., 2019).

We applied thematic analysis as a coding procedure for the Grounded Theory following Braun and Clarke's (2006) six-phase guide. Thematic analysis provides a flexible and systematic approach that can be applied to explore patterns and themes and generate new insights and a theoretical framework for explaining the social phenomenon under study (Boyatzis, 1998; Ryan & Bernard, 2000). Thus, Grounded Theory and thematic analysis were used as complementary approaches for qualitative data analysis.

Statement on Positionality and Reflexivity

In qualitative research, positionality and power differentials between a researcher and participants is a common challenge that may influence the process of qualitative data collection, analysis, interpretation, and drawing conclusions. In the context of conservation social science research, IUCN (2023) stated that acknowledging and examining individual and institutional positionalities, i.e., individual motivations, value and belief systems, priorities, and agendas, is central to understanding the impacts of a researcher's position and background on the HWC situation. The present study is no exception to this challenge. We acknowledge that we have no personal experience of HWC, and our perspectives and views about HWC are mainly shaped by the extant literature. Therefore, it is quite possible that our perspectives and views about the wildlife management may differ from those of stakeholders, who frequently experience HWC. We also acknowledge that our previous knowledge has the potential to bias the research process, findings, and conclusion. Therefore, we took several steps to minimize the impact of our biases and positionalities on the present study. First, at every stage of this study, we engaged in reflexivity, i.e., examining biases, values, assumptions, and preconceived notions that may have influence on the research. Second, we interviewed multiple stakeholders, having varying experiences and performing different roles and responsibilities in wildlife management. Third, we did not intervene while stakeholders were sharing their views so to allow them to freely express their perceptions, even if they contradicted our belief systems and intuitions.

Results

Trends and Patterns of HWC

A statistically meaningful decline was documented for human casualties ($R^2 \geq .90$; p-value $\leq .01$), cattle depredation ($R^2 \geq .82$; p-value $\leq .04$), and crop damage ($R^2 \geq .82$; p-value $\leq .04$) (Figure 2), satisfying the Bryhn et al. (2011) criteria. Specifically, between 2015 and 2019, human casualties declined by about 55.56%, cattle depredation by about 26.51%, and crop damage by about 86.51%. Cows ($n = 149$), buffalos ($n = 133$), calves ($n = 42$), ox and bulls ($n = 29$), and goats ($n = 26$) were the primary victims of wildlife attacks, and the most damaged crops were paddy ($n = 376$), wheat ($n = 348$),

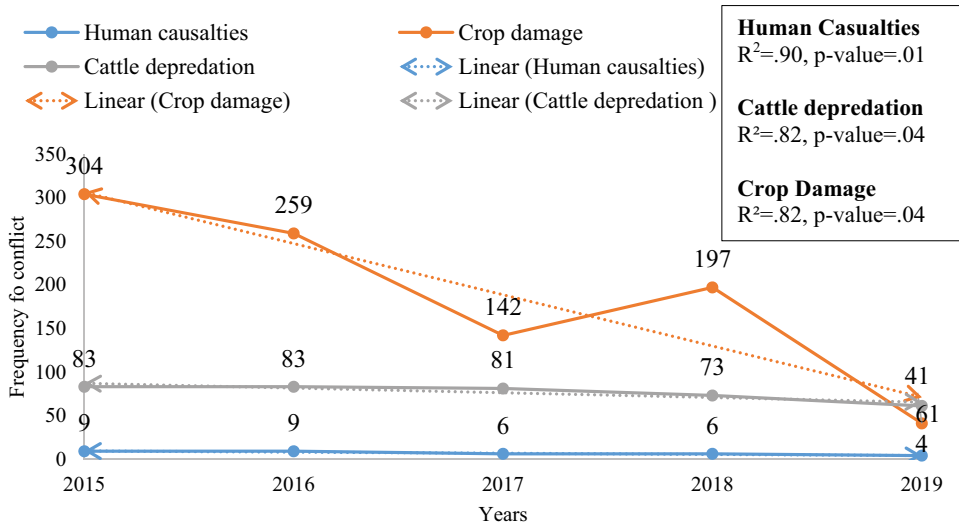


Figure 2. Trends of human-wildlife conflict.

soybean ($n = 117$), and sugarcane ($n = 53$). The reduction in cattle depredation may be a result of fear of wildlife among local people, who were wary of cattle grazing and fuelwood gathering inside the CTR. Local people also stated that they keep fewer cattle due to the fear of cattle depredation. Local informants (LI = 2%), for example, commented that the village road used to be full of cattle grazing in the morning hours, which does not happen that much anymore. Interestingly, the cases of property damage are negligible; only one incidence was reported in 2016 in the *Dhela* range, which is a “conflict hotspot,” i.e., most incidences were reported from this range.

Most of the human casualties were caused by snakes ($n = 12$), followed by tigers ($n = 11$), leopards ($n = 6$), and elephants ($n = 3$) (Table 1). Cattle depredation was caused primarily by tigers ($n = 357$), leopards ($n = 15$), and snakes ($n = 10$), while crop damage by wild boars ($n = 397$), elephants ($n = 396$), and deer ($n = 150$) (Table 1).

Retaliatory wildlife killing is another form of HWC, which results from wildlife-induced damage to life and livelihood to the local people. Data show that there had been no reported incidence of poaching or intentional wildlife killing by local people. The last case of wildlife poaching was reported in 2014, when two people from Ramnagar (where CTR is located) were convicted for the illegal trade of wildlife products (WCCB, 2022).

Stakeholders' Perceptions About Wildlife Management Strategies

Patterns of Preventive Measures

Local informants perceived electric fencing to be ineffective in preventing elephants from entering crop fields (LI = 61%) (Table 2). Other issues related to this preventive measure were the lack of regular fence maintenance (LI = 7%) by CTR staff, and limited availability of fences (LI = 3%). Local informants and EDC presidents also reported that there was an

Table 1. Total amount of financial compensation (amounts in US\$) and wildlife 2015 and 2019.

Wildlife Species	Human Casualties		Cattle Depredation		Crop Damage		Total	
	Frequency	Compensation	Frequency	Compensation	Frequency	Compensation	Frequency	Compensation
Elephants	3	7918.28			396	10129.78	399	18048.06
Tigers	11	19064.78	357	54063.58			368	73128.36
Snakes	12	10354.67	10	1510.56			22	11865.23
Monkeys	1	182.73					1	182.73
Deers					150	5035.28	150	5035.28
Leopards	6	11938.33	15	925.83			21	2573.61
Wild boars	1	182.73			397	12048.29	398	12864.16
Total	34	49641.52	382	56499.97	943	27213.35	1359	123697.43

Source: Authors' calculation.

Notes: US\$ 1 = INR 82.09. Freq. and Comp. represent the frequency and compensation.

Table 2. Perceived challenges of conflict management strategies.

Themes	Challenges	Local Informants (LI) (n = 150)	EDC Presidents (EDC) (n = 10)	Park employees (PE) (n = 20)
1. Solar-based fencing and spotlights, and guarding	1a. Ineffective to prevent the intrusion of elephants	61% (92)	10% (1)	35% (7)
	1b. No regular maintenance of fencing	7% (11)	-	-
	1c. Limited crops are fenced	3% (5)	-	-
	1d. Carelessness of local people in maintaining the fence	-	30% (3)	25% (5)
	1e. Shortage of funds for fencing	-	100% (10)	45% (9)
	1f. Corruption in installation of spotlights	3% (4)	-	-
	1g. Resource misallocation by the EDCs	15% (23)	-	-
	1h. Insufficient number of village guards (Chawkidaars)	38% (57)	20% (2)	-
2. Financial compensation schemes	2a. The lengthy and cumbersome process of filing the compensation	92% (138)	30% (3)	-
	2b. Delay in getting the approval of Patwari (village registrar)	71% (107)	20% (2)	-
	2c. Insufficient amount of ex-gratia financial compensation	94% (141)	30% (3)	-
3. Micro-level integrated conservation and development projects	3a. Insufficient tube wells for drinking water	13% (20)	20% (2)	-
	3b. Poor service of solar-based water tanks	48% (73)	20% (2)	-
	3c. Poor quality of water from solar-based tube-wells	11% (16)	-	-
	3d. Limited funds for development projects	-	100% (10)	-
4. Ecotourism-based livelihoods	4a. Ownership of a Gypsy at the time of applying for wildlife safari	83% (124)	100% (10)	-
	4b. Two-years driving experience inside the CTR	60% (90)	70% (7)	-
	4c. Registration of wildlife safari in the name of locals by outsiders	10% (15)	20% (2)	30% (6)
5. Conservation-based livelihoods	5a. Daily wage and seasonal employment	42% (63)	90% (9)	35% (7)
	5b. Low level of remuneration	33% (49)	30% (3)	10% (2)
	5c. Delay in payment of daily wages	76% (114)	70% (7)	50% (10)
	5d. Fewer entitled leave days	15% (23)	30% (3)	10% (2)

Source: Compiled by authors

Notes: values in parentheses represent the number of informants.

insufficient number of guards to protect the village from problematic wildlife (LI = 38%; EDC = 20%). A local informant, who is a farmer, stated:

The electric fencing is sensitive; even minor damage can put the whole fence out of service. Elephants damage the fence by trampling the rubber-wrapped portion of the electric pole of the fencing. When it is damaged, no one from the CTR office comes here to repair it.

On the other hand, EDC presidents and park employees blamed the carelessness of local people in maintaining electric fences (EDC = 30%; PE = 25%) and the shortage of funds for installing adequate number of fences for crops (100% and 45%, respectively). To quote a park official:

Since electric fences are installed at no cost, local people don't take care of these fences. They completely rely on the park for everything. Besides, we receive very limited funds to manage these activities. Whatever amount of funds we receive, we channel them for the fences.

The local informants in *Kaniya* village opined that there was corruption in the installation of solar lights (LI = 3%) and resource misallocation by the EDC members (EDC = 15%).

Patterns of Mitigation Measures

Patterns of financial compensation are shown in Figure 3. Compensation is mostly used for cattle depredation (42%), human casualties (37%) and crop damage (21%) (Figure 3a), caused by tigers (59%), elephants (15%), wild boars (10%), and snakes (10%) (Figure 3b).

Financial compensation schemes are facing some serious challenges in CTR due to the lengthy and cumbersome procedure for filing the compensation claims (LI = 92%; EDC = 30%), delay in obtaining the approval from *patwari*, i.e., the village registrar (LI = 71%; EDC = 20%, respectively), and the insufficient amount of compensation (LI = 94%; EDC = 30%) (Table 2). A local informant said:

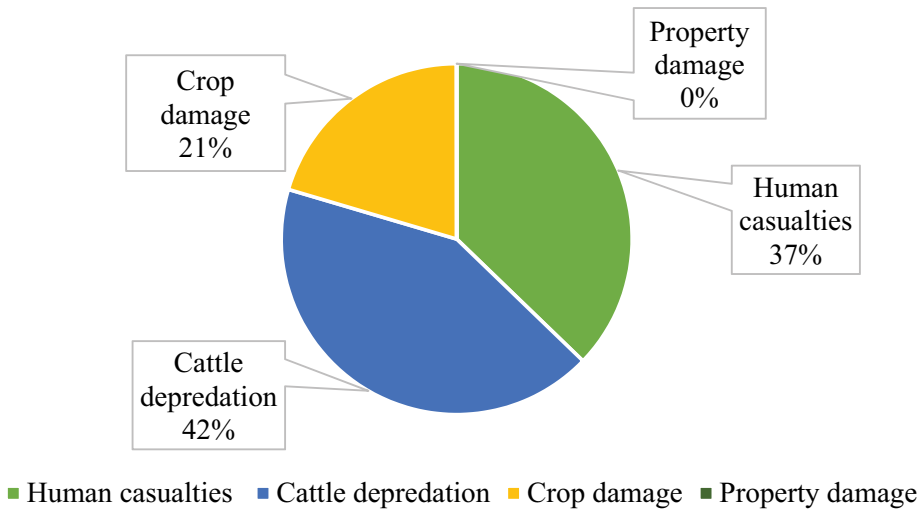
The compensation amount is insufficient. The CTR compensates approximately 20–30% of the total damage caused by wildlife. Consider the buffalo: a full-grown buffalo is worth around US\$ 974.54, but only US\$ 182.73–243.61 is compensated. Agriculture and cattle farming are the main sources of our livelihoods. If the damage done to these sources by wildlife is not sufficiently compensated, we will fall into unemployment and poverty.

While explaining the issue of the lengthy process, one local informant enunciated:

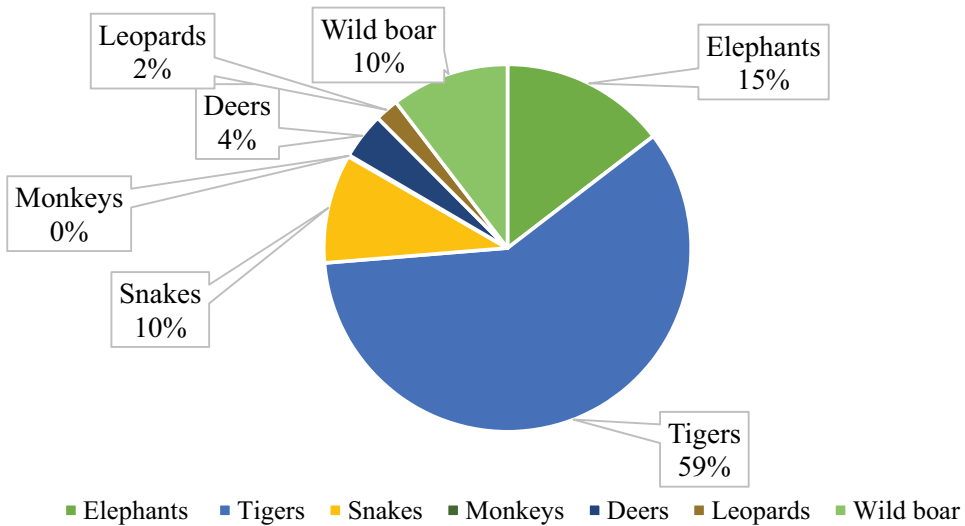
Filing for compensation is a tedious and lengthy process. Once the damage has occurred, we must report it to the concerned range officer for approval and prepare documents with photographs of the damaged assets. It is followed by the approval of the *patwari*, who confirms whether or not the damaged assets (e.g., a crop field) are registered in the applicant's name. The field investigation for Geographic Information System (GIS) mapping of the land, in case of crop damage, is also conducted to measure the size of the damage. If the claim is found valid, it is recommended for financial compensation. Even after approval, it may take months.

Livelihoods and Sustainable Local Economies

Other key themes arose when interviewing local informants and EDC presidents on HWC, specifically the limited funds provided by CTR to support local communities and the constraints to develop alternative sustainable local economies. The CTR provides funds for the construction of village roads and drinking water supply. Since the CTR is located in a hilly area, extracting groundwater is quite difficult and expensive, and acute water shortage remains a dominant concern for local communities. Stakeholders, indeed, expressed dissatisfaction about the drinking water supply (Table 2). Specifically, local people and EDCs recognize that there was an insufficient number of tube wells (LI = 13%; EDC = 20%) and that the solar water tanks remain out of service most of the time (LI = 48%; EDC = 20%). Local informants reported poor water quality (LI = 11%) and a local informant stated:



a



b

Figure 3. Pattern of compensation across wildlife and conflict.

Although EDC members are working towards resolving the water problem in the village, there is a long road ahead. One tube well or water tank for a village is not sufficient. If, unfortunately, it gets damaged, the whole village gets into trouble. They need to spend more on the availability and quality of drinking water.

Furthermore, presidents of EDCs informed that they received a minimal amount of funds for running water-related projects (EDC = 100%). An EDC member stated:

Funds allocated to us by CTR authorities are short of our demand. The fresh funds are utilized for repairing or maintaining the existing electric fences, solar lights, and other activities. Given

the limited funding, we could only spend a little on water, village road construction, etc. We always receive lesser amounts of funds than we need.

Regarding developing sustainable local economies, the CTR has institutionalized the employment of local people in two high-earning ecotourism-based livelihoods, namely, nature guiding and operating wildlife safaris inside the park. As per the guidelines for wildlife Safari, there is a reservation quota for two nature guides from each EDC village and 50 Gypsies³ (out of 300) from the total EDC villages. However, the local informants and EDC presidents stated that this reservation quota rests on the condition that applicant must own a Gypsy before applying for the quota (LI = 83%; EDC = 100%) (Table 2). In this regard, a local informant stated:

This is a very tough condition and risky as well. The cost of a Gypsy is around \$8527.23. If I take a loan and buy a Gypsy to operate a wildlife safari in the park and apply for registration, but the park administration rejects my application, what will I do with this Gypsy? It has no alternative use. Therefore, I have canceled my plan of operating a wildlife safari in the CTR.

Another problem with this strategy, as explained by local informants and EDC presidents, is that the Gypsy driver must have two years of driving experience inside the CTR (LI = 60%; EDC = 70%). This condition is rarely met because those with two years of driving experience are already engaged in Gypsy driving in the area. One EDC member explained:

For many years, I have been driving large vehicles, mainly trucks. But since I never drove inside the CTR, I couldn't apply for this reservation. I want to leave truck driving and join the wildlife safari so that I can stay in my local area and spend time with my family. However, due to this condition, it is not possible for me to work in my local area

These conditions limit local participation in ecotourism. Thus, outsiders, who are financially, and politically powerful urban elites contact poor villagers and apply for the registration of their Gypsies using the identity of the local villagers in exchange for money, as confirmed by local informants (LI = 10%), EDC presidents (EDC = 20%), and park staff (PE = 30%).

Another opportunity to develop sustainable local economies is employing local people in various conservation-related activities within the CTR, including anti-poaching patrolling, afforestation, plantation, and forest fire crews. Employing local people is seen by CTR as a way to diversify and divert local livelihoods from farm to off-farm income sources, thereby a possible path toward reducing HWC (Alam & Nayak, 2020; Mathur et al., 2011). Local informants, EDCs, and park employees pointed out four major problems with this approach: employment status is seasonal (LI = 42%; EDC = 90%; PE = 35%); it provides a low level of remuneration (LI = 33%, EDC = 30%; PE = 10%); there is a delay in payment of remuneration (LI = 76%; EDC = 70%; PE = 50%); and there are fewer leave days (LI = 16%; EDC = 30%; PE = 10%, respectively) (Table 2). One local informant explained:

Employment in the forest fire crew is available for 3–4 months during the summer season; the rest of the time, we are unemployed. Park officials repeatedly ask us not to harm the wildlife and extract resources from the park, and in exchange, they provide us with these low-paying and seasonal job opportunities.

A park employee involved in patrolling shared:

A patrol crew has to work the entire day. We have limited leave days. Even during leave, we are called back in times of emergency. Besides, there is a huge risk of wildlife attacks during patrolling. Despite these issues, the daily wage amount is quite low, i.e., US\$100.38 per month or US\$3.35 per day. The payment of our wages is usually delayed by three to four months and sometimes eight months.

Discussion and Policy Implications

The decline in human casualties and cattle depredation could be the result of the conservation awareness programs organized by the CTR in collaboration with the EDCs, which focuses on educating locals about using preventive measures, such as abstaining from fuelwood gathering, grass cutting, and cattle grazing in CTR, which are the primary causes of the human casualties and cattle depredation (Kandel et al., 2020; Srivathsa et al., 2019). Messick et al. (2022) demonstrate that environmental awareness and education cultivate pro-conservation behavior and motivate local people to adopt new conservation strategies, such as rotational grazing and game-species management. Although declining, the current number of cattle depredations is still considerably high, underscoring the need to increase the frequency of the awareness programs to inform local people about, and facilitate the adoption of, modern husbandry practices, e.g., constructing predator-proof corrals (Distefano, 2005; Lamichhane et al., 2018) and stall-feeding (Karanth et al., 2012). As the study shows that tigers and leopards mainly cause cattle depredation, husbandry practices should consider these wildlife species while designing potential husbandry practices.

The cattle depredation and crop damage incidences are mostly concentrated in the *Dhela* range, making it a “conflict hotspot.” This may be because the *Dhela* range has more villages than the *Bijrani* range. Secondly, unlike the *Bijrani* range, all the villages in the *Dhela* range are revenue villages, which are allowed to practice agriculture and cattle-rearing in the buffer zones. In the *Bijrani* range, 50% of the selected villages are non-revenue (*khatta*) villages (*Amdanda* and *Ringora* villages), which are not allowed to grow crops on their lands. Thus, the wildlife is more attracted to the villages in the *Dhela* range.

The significant decline in crop damage cases may imply the effectiveness of the existing preventive strategies, i.e., electric fencing of the crop fields, solar-based lights to spot problematic wildlife, and guarding. Karanth et al. (2012) conclude that physical measures (e.g., fencing), lights, and guarding are associated with lower crop loss in the Kanha Tiger Reserve, India. Similarly, Lamichhane et al. (2018) observed that decreased forest dependency, and electric and mesh-wire fences have contributed to keep the incidences of HWC in control in Chitwan National Park, Nepal. While the electric fencing reduces the incidence of damage caused by deer, chital, and wild boar, it fails to prevent elephants from entering the crop fields in CTR. In CTR, elephants account for approximately 15% of the financial compensation, calling for an urgent management response to prevent elephant incursion into human habitations. Davies et al. (2011) suggest the following strategies: 1) chili smoke made by burning cardboard wrapped in dried chilies and positioned at the village border to chase away the elephant; 2) chili fencing made by engine grease mixed with ground chili paste and spread on to a jute or coconut rope; 3) powerful, rechargeable search- spotlights used for chasing elephants away by directing the light at their eyes. Using these strategies with electric fencing and guarding would help prevent crop damage by all problematic species, namely elephants, wild boars, and deer.

Furthermore, the decline in crop damage incidences might result from mitigation strategies, i.e., livelihood diversification and transition through ecotourism and conservation-based livelihoods. Alam and Nayak (2020) and Maheshwari and Sathyakumar (2019) find that ecotourism and other conservation-based livelihoods mitigate the carnivore-human conflict by shifting livelihood patterns from on-farm to off-farm avenues and bringing economic benefits to the local people. This is consistent with Lamichhane et al. (2018), who argue that a reduction in the livelihood reliance on the forest via shifting livelihood patterns to non-farm income sources mitigates the HWC in Nepal's Chitwan National Park. Less reliance on agriculture implies less crop production and, thus, fewer crops available for crop raiding by wildlife. Given the contribution of the management strategies, the study explored various challenges undermining the potential of these mitigation strategies.

Based on the key stakeholders' interviews, the study finds that the eligibility conditions for operating a wildlife safari, i.e., the ownership of a gypsy vehicle at the time of applying for registration and two years of driving experience inside the CTR, are the major constraints to local participation in ecotourism. Therefore, the management authorities should reconsider and modify these conditions in consultation with the local households, and EDCs to make ecotourism an economically viable livelihood option. Furthermore, the conservation-based livelihoods are found to be less attractive to the local people due to the problems of longer working hours and fewer leave days, coupled with lower remuneration and greater danger. According to the official data, CTR has only 279 regular employees, which is significantly lower than the sanctioned number of 461 employees. Therefore, employees have to take on greater responsibilities with extended working hours, and having fewer leave days. Therefore, the sanctioned number of employees as approved by the CTR management should be hired while increasing the remuneration for the daily-wage activities. This would reduce the workload on the existing staff and ensure local participation in the conservation-based livelihoods that mitigate the HWC.

The study further suggests that there has been negligible incidence of retaliatory wildlife killing in the CTR since 2014. It is based on assumption that there are no secretive or unrecorded retaliatory wildlife killing in CTR. The decline in the wildlife killing might be attributed to the strict enforcement of environmental protection and conservation laws (Karanth & Kudalkar, 2017), such as the Wildlife (Protection) Act 1972, improvement in patrolling activities through an increase in patrolling staff, patrolling stations (*chowkis*), the use of modern technologies (e.g., GPS, drones), and voluntary resettlement of the *Van Gujjar* (pastoralist communities), which were blamed for wildlife killing.

Other factors that may have mitigated the conflict include compensation schemes, local development projects, and livelihood generation for locals.

Karanth et al. (2018) and Archabald and Naughton-Treves (2001) comment that compensation increases the community's tolerance toward wildlife, discourages retaliatory wildlife killing, and builds support for conservation. However, stakeholders' perceptions suggest that compensation scheme in CTR is lacking due to cumbersome and lengthy processes of filing the claims, bureaucratic delays due to the involvement of *patwari*, and insufficient payment. Badola et al. (2021), Karanth et al. (2018), and Karanth and Kudalkar (2017) further highlighted that the compensation claims involve a high level of transaction costs, i.e., documentation, photographs, multiple visits to various government offices, filling out the claims, and follow-up visits to ensure that the claim is processed, which deter the

victims from applying for the claim. It is, therefore, recommended that the CTR authorities ensure timely reimbursement of an appropriate amount of compensation with minimal transaction costs, emulating the practice in Kanha Tiger Reserve, Madhya Pradesh (India), where the compensation amount is reimbursed in less than three weeks after the livestock is depredated (Miller et al., 2016).

Moreover, the local development projects, mainly focusing on the drinking water supply, are insufficient to resolve the acute water shortage due to inadequate funds, underscoring the need to increase the funds allocation to EDCs. This can be accomplished by designating a portion of ecotourism revenue for local development activities (Mathur et al., 2011). The National Tourism Revenue Sharing Policy of 1994 in Uganda mandated that 20% of the tourists' entry fee be allocated for financing local development projects in PAs (Ahebwa et al., 2012). In 1996, Nepal enacted a by-law that guaranteed that 50% of the entry fee revenue should be shared with local people, particularly those affected by wildlife attacks and livelihood restrictions (Bookbinder et al., 1998). Therefore, the government needs to channel more funds directly and/or indirectly through local institutions like EDCs to rural development projects and ensure meaningful participation of local people in ecotourism and conservation-based livelihoods. Besides, retaliatory wildlife killing can be mitigated by supporting the development of alternative and sustainable livelihoods (e.g., ecotourism) since locals who perceive wildlife as a source of income are more likely to support conservation (Yen et al., 2015).

Conclusion

The study contributes to the academic understanding of HWC and its management strategies. Based on the stakeholders' interviews, the study highlights the challenges associated with existing management strategies and recommends a few policy implications that aid conservation planners, managers, and practitioners in devising the appropriate policies for achieving a peaceful co-existence between local communities and wildlife. There is a need to address these challenges to mitigate HWC and enhance communities' tolerance toward wildlife.

The study reports a statistically meaningful decline in the incidences of HWC between 2015 and 2019, possibly due to a mix of preventive and mitigation strategies of wildlife management. The documented wildlife killing by local people also seems to have declined to negligible level owing to effective patrolling, compensation for damage, and diversification of local livelihoods. However, it is observed that the existing incidences of crop damage and cattle depredation are still high that might cause secretive wildlife killing, forest fire, and other anti-conservation activities by affected households, which indicates tenuous relationship between people and park management. Therefore, there is a need to install more solar fencing and regularly maintain the existing ones, while ensuring timely and sufficient reimbursement of financial compensation for wildlife-caused damage. The policy response may also include increasing funds for sustainable local economies and local participation in ecotourism and other non-farm livelihoods.

While adding to the literature by examining HWC and wildlife management strategies using a mixed "methods" approach, the study highlights implications for future research. Prospective research should quantitatively assess the impact of each wildlife

management strategy on HWC in Indian PAs. This will provide a basis for objectively evaluating the most effective management strategy. Prospective research should analyze the spatial distribution of HWC to help CTR management in identifying and prioritizing conflict hotspots.

Notes

1. The questionnaire is provided in supplementary file.
2. The full results of the linear regression analysis are provided in supplementary file.
3. A Gypsy is a fully open (from the top) four-wheel drive car used to transport tourists inside the protected areas.

Acknowledgments

We want to thank the Chief wildlife warden of the State Forest Department and the Director of the Jim Corbett Tiger Reserve (CTR), India, for permitting primary surveys at CTR. We are grateful to Shodh Range (the research division of the reserve) for providing the secondary data regarding wildlife conflict. We would also like to thank the staffs (deputy director, rangers, deputy rangers, patrolling crew, gatekeepers, etc.), local representatives, and residents for cooperating and participating in the survey. Without their support, it was not possible to conduct the primary surveys.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

References

- Ahebwa, W. M., van der Duim, R., & Sandbrook, C. (2012). Tourism revenue sharing policy at Bwindi Impenetrable National Park, Uganda: A policy arrangements approach. *Journal of Sustainable Tourism*, 20(3), 377–394. <https://doi.org/10.1080/09669582.2011.622768>
- Alam, R., & Nayak, D. (2020). Trends and patterns of ecotourism research: Practices and implications. *International Journal of Tourism Policy*, 10(4), 351–379. <https://doi.org/10.1504/IJTP.2020.112642>
- Archabald, K., & Naughton-Treves, L. (2001). Tourism revenue-sharing around national parks in Western Uganda: Early efforts to identify and reward local communities. *Environmental Conservation*, 28(2), 135–149. <https://doi.org/10.1017/S0376892901000145>
- Badola, R., Ahmed, T., Gill, A. K., Dobriyal, P., Das, G. C., Badola, S., & Hussain, S. A. (2021). An incentive-based mitigation strategy to encourage coexistence of large mammals and humans along the foothills of Indian Western Himalayas. *Scientific Reports*, 11(1), 1–14. <https://doi.org/10.1038/s41598-021-84119-7>
- Badola, R., Hussain, S. A., Mishra, B. K., Konthoujam, B., Thapliyal, S., & Dhakate, P. M. (2010). An assessment of ecosystem services of Corbett Tiger Reserve, India. *The Environmentalist*, 30(4), 320–329. <https://doi.org/10.1007/s10669-010-9278-5>
- Bargali, H. S., Ahmed, T., & Umapathy, G. (2018). Patterns of livestock depredation by tiger (*Panthera tigris*) and leopard (*Panthera pardus*) in and around Corbett Tiger Reserve, Uttarakhand, India. *PloS ONE*, 13(5), 1–12. <https://doi.org/10.1371/journal.pone.0195612>
- Bookbinder, M. P., Dinerstein, E., Rijal, A., Cauley, H., & Rajouria, A. (1998). Ecotourism's support of biodiversity conservation. *Conservation Biology*, 12(6), 1399–1404. <https://doi.org/10.1111/j.1523-1739.1998.97229.x>

- Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Sage.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp0630a>
- Bryhn, A. C., Dimberg, P. H., & Rapallo, F. (2011). An operational definition of a statistically meaningful trend. *PloS ONE*, 6(4), 1–9. <https://doi.org/10.1371/journal.pone.0019241>
- Chartier, L., Zimmermann, A., & Ladle, R. J. (2011). Habitat loss and human-elephant conflict in Assam, India: Does a critical threshold exist? *Oryx*, 45(4), 528–533. <https://doi.org/10.1017/S0030605311000044>
- Creswell, J., Klassen, A. C., Plano, V., & Smith, K. C. (2011). Best practices for Mixed Methods Research in the health sciences. In *Office of Behavioral and Social Sciences Research (OBSSR)*. <https://doi.org/10.1002/cdq.12009>.
- Davies, T. E., Wilson, S., Hazarika, N., Chakrabarty, J., Das, D., Hodgson, D. J., & Zimmermann, A. (2011). Effectiveness of intervention methods against crop-raiding elephants. *Conservation Letters*, 4(5), 346–354. <https://doi.org/10.1111/j.1755-263X.2011.00182.x>
- Delve. (2023). *Practical Guide to Grounded Theory Research*. <https://delvetool.com/groundedtheory>
- Distefano, E. (2005). Human-wildlife conflict worldwide: Collection of case studies, analysis of management strategies and good practices. *Food and Agricultural Organization of the United Nations (FAO), Sustainable Agriculture and Rural Development (SARD) Paper*.
- Glaser, B., & Strauss, A. L. (1967). *The discovery of grounded theory*. Aldine Publishing Company,
- Gross, E. M., Jayasinghe, N., Brooks, A., Polet, G., Wadhwa, R., & Hilderink-Koopmans, F. (2021). *A future for all: the need for human-wildlife coexistence*. WWF, Gland, Switzerland. Design and infographics by Levent Köseoglu, WWF-Netherlands Text editing by ProofreadNOW. com Cover photograph: DNPWC-WWF Nepal, 3. <https://www.wwf.nl/globalassets/pdf/nieuws/a-future-for-all-the-need-for-human-wildlife-coexistence.pdf>
- IUCN. (2022). *IUCN RED LIST*. <https://iucnredlist.org/>
- IUCN. (2023). *IUCN SSC guidelines on human-wildlife conflict and coexistence* (First edit). <https://doi.org/10.2305/YGIK2927>
- Kandel, S., Harada, K., Adhikari, S., Dahal, N. K., & Dhakal, M. (2020). Local perceptions of forest rules and interactions between rules, ecotourism, and human-wildlife conflicts: Evidence from Chitwan National Park, Nepal. *Tropics*, 29(1), 25–39. <https://doi.org/10.3759/tropics.MS19-07>
- Karanth, K. K., Gopalaswamy, A. M., DeFries, R., Ballal, N., & Gratwicke, B. (2012). Assessing patterns of human-wildlife conflicts and compensation around a central Indian protected area. *PloS One*, 7(12). <https://doi.org/10.1371/journal.pone.0050433> e50433
- Karanth, K. K., Gupta, S., & Vanamamalai, A. (2018). Compensation payments, procedures and policies towards human-wildlife conflict management: Insights from India. *Biological Conservation*, 227(June), 383–389. <https://doi.org/10.1016/j.biocon.2018.07.006>
- Karanth, K. K., & Kudalkar, S. (2017). History, location, and species matter: Insights for human-wildlife conflict mitigation from India. *Human Dimensions of Wildlife*, 22(4), 331–346. <https://doi.org/10.1080/10871209.2017.1334106>
- Karanth, K. K., & Ranganathan, P. (2018). Assessing human-wildlife interactions in a forest settlement in Sathyamangalam and mudumalai tiger reserves. *Tropical Conservation Science*, 11, 194008291880275. <https://doi.org/10.1177/1940082918802758>
- Lamichhane, B. R., Persoon, G. A., Leirs, H., Poudel, S., Subedi, N., Pokheral, C. P., Bhattarai, S., Thapaliya, B. P., de Jongh, H. H., & Apollonio, M. (2018). Spatio-temporal patterns of attacks on human and economic losses from wildlife in Chitwan National Park, Nepal. *PloS ONE*, 13(4), 1–18. <https://doi.org/10.1371/journal.pone.0195373>
- Maheshwari, A., & Sathyakumar, S. (2019). Snow leopard stewardship in mitigating human-wildlife conflict in Hemis National Park, Ladakh, India. *Human Dimensions of Wildlife*, 24(4), 395–399. <https://doi.org/10.1080/10871209.2019.1610815>
- Mathur, V. B., Gopal, R., Yadav, S. P., & Sinha, P. R. (2011). *Management effectiveness evaluation (MEE) of tiger reserves in India: Process and outcome*. National Tiger Conservation Authority, Government of India.

- Messick, J. A., Serenari, C., Daniel, K. L., Idema, J. L., Bates, E., Crump, P., & Lute, M. L. (2022). Determinants influencing recruitment in the Houston toad programmatic safe harbor agreement. *Human Dimensions of Wildlife*, 27(5), 472–488. <https://doi.org/10.1080/10871209.2021.1959961>
- Miller, J. R. B., Jhala, Y. V., & Jena, J. (2016). Livestock losses and hotspots of attack from tigers and leopards in Kanha Tiger Reserve, Central India. *Regional Environmental Change*, 16(1), 17–29. <https://doi.org/10.1007/s10113-015-0871-5>
- Ministry of Environment, Forest and Climate Change, Government of India. (n.d.). *Joint Forest Management: A Handbook*. https://ifs.nic.in/Dynamic/pdf/JFM_handbook.pdf
- Naha, D., Sathyakumar, S., Dash, S., Chettri, A., Rawat, G. S., & Bhadauria, T. (2019). Assessment and prediction of spatial patterns of human–elephant conflicts in changing land cover scenarios of a human-dominated landscape in North Bengal. *PLoS ONE*, 14(2), 1–19. <https://doi.org/10.1371/journal.pone.0210580>
- Nayak, B. P., Kohli, P., & Sharma, J. (2012). *Livelihood of local communities and forest degradation in India: Issues for REDD+*. In Policy Brief.
- Nayak, D., Upadhyay, V., & Puri, B. (2018). Recognising “conservation of poor” towards holistic sustainability: Study of an Indian national park. *International Journal of Global Environmental Issues*, 17(2/3), 230–261. <https://doi.org/10.1504/IJGENVI.2018.091473>
- Nyhus, P. J. (2016). Human–wildlife conflict and coexistence. *Annual Review of Environment and Resources*, 41, 143–171. <https://doi.org/10.1146/annurev-environ-110615-085634>
- Ripple, W. J., Estes, J. A., Beschta, R. L., Wilmers, C. C., Ritchie, E. G., Hebblewhite, M., Berger, J., Elmhagen, B., Letnic, M., Nelson, M. P., Schmitz, O. J., Smith, D. W., Wallach, A. D., & Wirsing, A. J. (2014). Status and ecological effects of the world’s largest carnivores. *Science*, 343(6167). <https://doi.org/10.1126/science.1241484>
- Ryan, G., & Bernard, H. R. (2000). Data management and analysis methods. *Handbook of Qualitative Research*, 769–802. https://qualquant.org/wp-content/uploads/text/2000%20Ryan_Bernard.denzin.pdf
- Sengupta, A., Binoy, V. V., & Radhakrishna, S. (2020). Human–Elephant Conflict in Kerala, India: a Rapid Appraisal Using Compensation Records. *Human Ecology*, 48(1), 101–109. <https://doi.org/10.1007/s10745-020-00128-6>
- Sharma, P., Chettri, N., Uddin, K., Wangchuk, K., Joshi, R., Tandin, T., Pandey, A., Gaira, K. S., Basnet, K., Wangdi, S., Dorji, T., Wangchuk, N., Chitale, V. S., Upreti, Y., & Sharma, E. (2020). Mapping human–wildlife conflict hotspots in a transboundary landscape, Eastern Himalaya. *Global Ecology and Conservation*, 24, e01284. <https://doi.org/10.1016/j.gecco.2020.e01284>
- Siddhartha. (2021). *Celebrating great news for India’s Tigers, Corbett Records Highest Density of Tigers in world*. Corbett National Park. <https://www.corbettnationalpark.in/blog/celebrating-great-news-for-indias-tigers-corbett-records-highest-density-of-tigers-in-world/>
- Siljander, M., Kuronen, T., Johansson, T., Munyao, M. N., & Pellikka, P. K. E. (2020). Primates on the farm – spatial patterns of human–wildlife conflict in forest-agricultural landscape mosaic in Taita Hills, Kenya. *Applied Geography*, 117(January), 102185. <https://doi.org/10.1016/j.apgeog.2020.102185>
- Srivathsa, A., Puri, M., Karanth, K. K., Patel, I., & Samba Kumar, N. (2019). Examining human–carnivore interactions using a socio-ecological framework: Sympatric wild canids in India as a case study. *Royal Society Open Science*, 6(5). <https://doi.org/10.1098/rsos.182008>
- Tie, Y. C., Birks, M., & Francis, K. (2019). Grounded theory research: A design framework for novice researchers. *SAGE Open Medicine*, 7, 7. <https://doi.org/10.1177/2050312118822927>
- Tiller, L. N., Humle, T., Amin, R., Deere, N. J., Lago, B. O., Leader-Williams, N., Sinoni, F. K., Sitati, N., Walpole, M., & Smith, R. J. (2021). Changing seasonal, temporal and spatial crop-raiding trends over 15 years in a human–elephant conflict hotspot. *Biological Conservation*, 254 (December 2020), 108941. <https://doi.org/10.1016/j.biocon.2020.108941>
- Tripathy, B. R., Liu, X., Songer, M., Kumar, L., Kaliraj, S., Chatterjee, N. D., Wickramasinghe, W. M. S., & Mahanta, K. K. (2021). Descriptive spatial analysis of human–elephant conflict (HEC) distribution and mapping HEC hotspots in Keonjhar Forest Division, India. *Frontiers in Ecology and Evolution*, 9(June), 1–17. <https://doi.org/10.3389/fevo.2021.640624>

- WCCB. (2022). *List of Convicts in Wildlife cases*. Wildlife Crime Control Bureau, Ministry of Environment, Forest and Climate Change, Government of India. <http://wccb.gov.in/Content/Convicts.aspx>
- Wilson, S., Davies, T. E., Hazarika, N., & Zimmermann, A. (2015). Understanding spatial and temporal patterns of human-elephant conflict in Assam, India. *Oryx*, 49(1), 140–149. <https://doi.org/10.1017/S0030605313000513>
- Yen, S.-C., Chen, K.-H., Wang, Y., & Wang, C.-P. (2015). Residents' attitudes toward reintroduced sika deer in Kenting National Park, Taiwan. *Wildlife Biology*, 21(4), 220–226. <https://doi.org/10.2981/wlb.00047>