



Integrating community insights into leopard and tiger conservation: Lessons from the Indian sub-Himalayan forest

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ABSTRACT

The coexistence of humans and wildlife often leads to conflicts that could create negative attitudes toward predators like tigers (*Panthera tigris*) and leopards (*Panthera pardus*), resulting in retaliatory killings or a lack of support for conservation efforts. However, human-wildlife cohabitation is critical for the long-term conservation of several endangered species. Effective conservation in this setting demands an understanding of local perspectives toward wildlife. This study surveyed forest villagers in India's Buxa Tiger Reserve regarding their opinions on leopard and tiger conservation. Attitudes of 345 households across 10 forest villages were analyzed using a five-point Likert scale and a Generalized Ordered Logistic model, revealing predominant positive inclinations toward conservation, particularly for leopards. Positive views on leopard conservation were common among men, non-tribal communities, larger households, and Buxa East Division residents. Besides, positive attitudes toward tiger conservation were prevalent among men, villagers belonging to the Hindu religion, larger households, higher annual incomes, and the residents of Buxa East Division. The study proposes gender-specific approaches, alternative livelihoods, awareness campaigns, and spatial planning to bolster the conservation of leopards and tigers. The findings of this study hold global significance in promoting co-habitation strategies, fostering a landscape where both humans and apex predators can coexist harmoniously while enabling local residents to take an increased responsibility for biodiversity conservation.

1. Introduction

The Eastern Himalayas contain a diverse and important landscape that provides crucial habitat for various endangered and threatened species, including tigers (*Panthera tigris*) and leopards (*Panthera pardus*) (Sharma et al., 2020). These big cats are facing significant challenges due to factors like habitat loss, fragmentation, reduced availability of prey, illegal hunting, and conflicts between humans and wildlife (Naha et al., 2020; Dhungana et al., 2022). Tigers, which are classified as endangered, have experienced a drastic 95 % decrease in their range, and some remaining areas are at risk of local extinction (Wolf and Ripple, 2017). Despite leopards'

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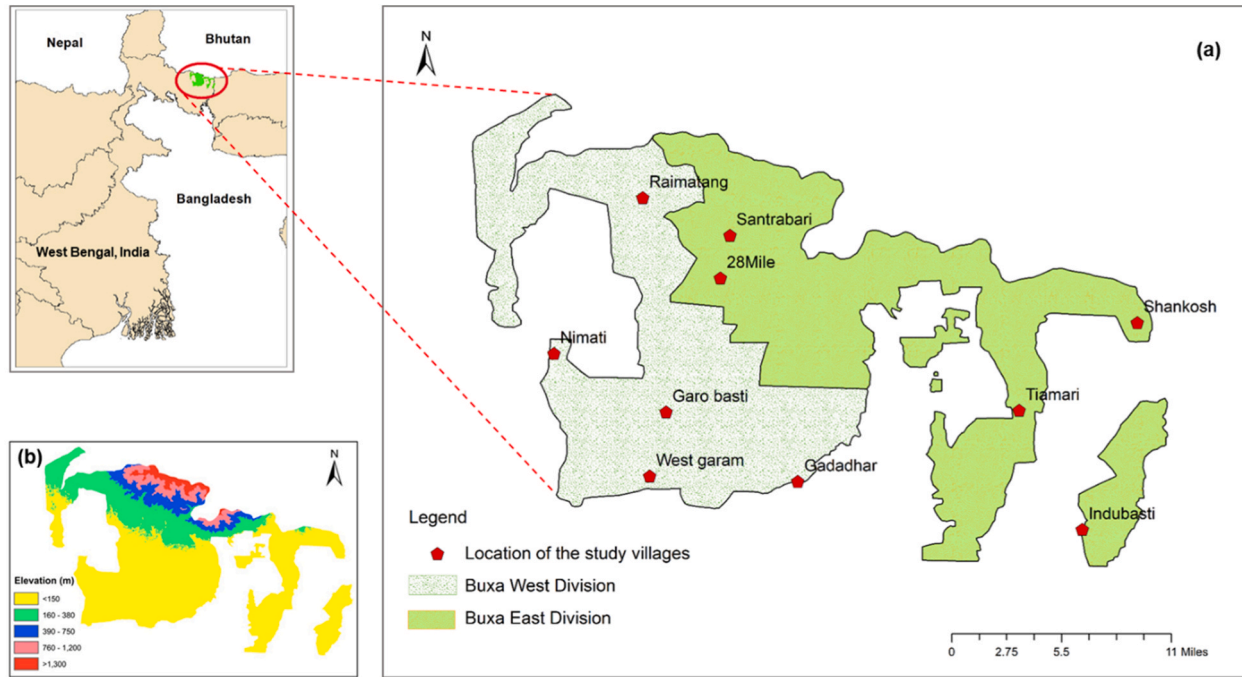


Fig. 1. Location of the Buxa Tiger Reserve; (a) Buxa East and West Division and the location of the study villages; (b) Physiography of the reserve.

adaptable characteristics, such as their ability to survive in various habitats, versatile hunting behaviors, and physical attributes that aid their survival, they still face significant threats that affect their conservation status (Rajaratnam et al., 2016). It is important to note that, on average, leopards now occupy only 25–37 % of their historical range (Jacobson et al., 2016).

Conservation of leopards and tigers is important as these are the apex predators in many ecosystems (Puri et al., 2020). Their presence influences the behavior and distribution of their prey species, which helps maintain a balanced predator-prey relationship and ensures the proper functioning of ecological processes (Ripple et al., 2014). Besides that, a recent study conducted in India revealed that when forests were given enhanced protection for tiger conservation, 24 % of the forests effectively reduced deforestation rates and provided climate benefits (Lamba et al., 2023). Additionally, these big cats might indirectly contribute to seed dispersal and forest regeneration while providing economic opportunities through nature-based tourism (Hämäläinen et al., 2017; Bhattarai et al., 2021; Sarasola et al., 2016; Brackowski et al., 2018; Rubalcava-Castillo et al., 2021). Moreover, Thinley et al. (2018) discovered that conserving tigers can mitigate crop loss and livestock predation by wild animals, including leopards, which are the primary predators of livestock in the Eastern Himalayan landscape. When tigers are present, other wild predators are displaced from deep forests and move closer to cropland boundaries, where they prey on herbivores that damage crops, thus reducing crop loss and predation on unattended livestock (Thinley et al., 2018).

Considering the future challenges of increasing human resource demands and climate change, the conservation of both the tiger and leopard are crucial for maintaining ecosystem resilience and preventing the loss of their irreplaceable ecological functions (Ripple et al., 2014). However, to a large extent, the conservation of these wild animals requires the support and cooperation of local communities residing in the forested landscape. Although carnivores have shown the ability to adjust to densely populated human areas and limited prey availability (Gehr et al., 2017), humans must adapt to carnivores and be willing to tolerate certain conflicts, like livestock depredation, to foster a successful coexistence between humans and carnivores (Lute et al., 2018). Leopards and tigers often come into conflict with humans due to competition for space and resources (Sharma et al., 2020). The coexistence of humans and wildlife often leads to attacks on livestock or, in some cases, on humans themselves (Rajaratnam et al., 2016; Dhungana et al., 2018). Such conflicts can foster negative attitudes regarding predators, which can lead to retaliatory killings or a lack of support for conservation initiatives (Aryal et al., 2014; Vasudeva et al., 2021). Thus understanding the forest villagers' attitudes towards conservation initiatives is essential for devising effective strategies that engage and empower local communities in preserving these iconic species.

Against this backdrop, this study was conducted in the Buxa Tiger Reserve of India to (i) assess the attitudes of forest villagers towards the conservation of leopards and tigers and (ii) identify and analyze the factors affecting such attitudes. In recent years, there has been a growing concern over the increasing incidents of livestock depredation and loss of human life by leopards in this Tiger reserve (Kshetry et al., 2017). Leopards are distributed quite uniformly throughout the reserve since anthropogenic disturbances do not seem to have a direct impact on their presence (TCP, 2016). Additionally, plans are underway to reintroduce tigers into the Buxa Tiger Reserve from the neighboring state of Assam as part of efforts to restore the ecosystem (The Telegraph, 2022; The Times of India, 2021). Remarkably, there had been no concrete proof of the tigers' existence in the reserve since 1998; however, in December 2021, a camera trap successfully captured an image of an adult male tiger (Guha, 2022). It is believed that the scarcity of herbivore prey has led tigers to move away from Buxa, and as a result, more than 85 spotted deer (*Axis axis*) were released into the reserve in 2023 to augment the prey population (The Telegraph, 2023a, 2023b).

In recent times, the opposition from local communities, however, has presented a significant obstacle to India's initial efforts to relocate tigers between reserves, as evidenced in the Satkosia Tiger Reserve in Odisha (Jhala et al., 2021). This highlights the crucial need to understand the perspectives of forest villagers in the Buxa Tiger Reserve regarding the conservation of leopards and tigers. The reserve already experiences leopard attacks on humans and livestock (Naha et al., 2018), and the reintroduction of tigers after many years could elicit negative sentiments among the villagers, potentially leading to the failure of the initiative. Past studies suggest that concerns related to potential livestock loss and fear of tiger movement in and around the village have a negative impact on people's attitudes (Gray et al., 2017; Hiroyasu et al., 2019). Unfortunately, there is currently a lack of studies addressing the attitudes of forest villagers in this context. Hence, the findings of this study will assist conservationists in devising more effective strategies that consider the needs and concerns of the local communities, ultimately aiming to promote positive attitudes towards conservation and mitigate conflicts between humans and wildlife.

2. Study area

The Buxa Tiger Reserve is situated in the northeastern region of West Bengal, India. It is nestled in the southern part of the Eastern Himalayas and shares borders with Bhutan in the north and Assam in the east (Fig. 1). It is characterized by a wide range of forest types, including northern dry deciduous, east Himalayan moist mixed deciduous forest, eastern sub-montane semi-evergreen forest, northern tropical evergreen forest, and moist sal savannah (Wildlife Wing, 2023). The reserve is also known for its remarkable wildlife, with notable species such as the Tiger (*Panthera tigris*), Asian elephant (*Elephas maximus*), Leopard (*Panthera pardus*), Clouded leopard (*Neofelis nebulosa*), and Indian bison (*Bos gaurus*) being present.

The establishment of the Buxa Tiger Reserve (BTR) took place in 1983 (Das and Behera, 2023). The reserve covers a total area of 760.87 km², with 390.58 km² designated as a Wildlife Sanctuary and National Park and the remaining 370.29 km² as Reserved Forests and Other Protected Forests (TCP, 2016). The Buxa Tiger Reserve is administratively divided into two main sections, namely the East Division and the West Division. Within the boundaries of the reserve, there are 37 forest villages (TCP, 2016). In order to address the need for labor in teak plantations and fire prevention in forests, the British created these forest villages in this region, relocating indigenous populations from Madhya Pradesh, Jharkhand, and the Chotanagpur plateau (Das and Behera, 2023). As a result, these forest villages are often populated by indigenous or tribal groups, such as Rava, Garo, Mechia, Oraon, Santhal, Bhutia, and

so on. The livelihoods of these communities are deeply connected to the natural resources of the area (Datta and Behera, 2022a). They rely on activities such as subsistence farming, gathering non-timber forest products and firewood, and raising livestock (Datta and Behera, 2022b; Datta and Behera, 2023). They also participate in eco-tourism initiatives, providing services such as guided tours, homestays, and handicraft production.

3. Data and methods

3.1. Sampling and primary data collection

The study utilized primary data collected from 345 households from ten forest villages of the Buxa tiger reserve (namely, Sankosh, Indubasti, Garo Basti, Garam (West), Santrabari, 28 Mile, Raimatang, Nimati, Tiymari, and Gadadhar) (Fig. 1) through face-to-face interviews conducted from April to May 2023. To ensure representation from both administrative divisions of the reserve (East and West), five villages were randomly selected from each division. The chosen villages were distributed across the reserve to minimize any spatial bias.

To determine the appropriate sample size, the study employed the formula developed by Cochran (1977), which is presented as Eq. (1).

$$N = \frac{z^2 ab}{e^2} \quad (1)$$

In this equation, N represents the estimated sample size, z is the critical value corresponding to the desired confidence level, a is the estimated proportion of the attribute in the population, b is equal to 1 – a, and e denotes the allowable error. In this study, assuming the maximum variability at 50 % (a = 0.5) and a confidence level of 95 % with an allowable error of 5.27 % (0.0527 as a decimal), the estimated sample size was determined to be 345 households.

The households from each forest village were selected using simple random sampling. The survey primarily targeted the heads of households as respondents. In cases where the household heads were not available, the interviews were conducted with the second head of the household. Additionally, the objective of the study was explained to each respondent, and their consent was obtained. The interviews were then conducted in Bengali and Hindi, as per the agreement and consent of the interviewees.

The interviews were conducted using semi-structured schedules developed by incorporating inputs from various sources, including a key informant survey, a review of relevant literature (e.g., Bhattarai and Fischer, 2014; Mir et al., 2015; Hariohay et al., 2018; Dhungana et al., 2022; Sharma and Neupane, 2023), and pre-testing. The key informants who contributed to this process comprised 2–3 older forest villagers (aged 55 and above) from each village, two forest officials from the Forest Department of the Government of West Bengal, and two forest guards. To ensure the effectiveness and appropriateness of the interview schedule, a pilot survey was also carried out with eight respondents from the Sankosh village (from the Buxa East division) and Nimati village (from the Buxa West division). The interview schedules contained questions on forest villagers' socio-economic conditions, the experience of livestock predation, cultural background, as well as their attitude towards leopard and tiger conservation.

Forest villagers' viewpoints on the conservation of leopards and tigers were assessed using a 5-point Likert scale, which ranged from 1 (strongly disagree) to 5 (strongly agree). Participants were asked to express their level of agreement with two statements concerning the significance of conserving leopards ("To what extent do you agree that leopard conservation is important in Buxa Tiger Reserve?") and tigers ("To what extent do you agree that tiger conservation is important in Buxa Tiger Reserve?"). Before inquiring about their attitudes towards tiger conservation, the respondents were briefed about the official decision to reintroduce tigers into the Buxa area. This background information was provided to ensure respondents were informed before expressing their attitudes toward tiger conservation. Each interview lasted approximately 50–55 min, allowing ample time for the respondents to freely express their

Table 1

Choice of explanatory variables for analyzing the factors influencing the conservation attitude of forest villagers towards the conservation of leopards and tigers.

Variables	Description	Source
Age	Continuous, age of the respondent in years	Dhungana et al. (2022); Sharma and Neupane (2023)
Gender	Dummy, 1 =Male, 0 =Female	Mir et al. (2015); Hariohay et al. (2018); Doubleday and Rubino (2022)
Religion	Dummy, 1 =Hindus, 0 =Non Hindu	Bhattarai and Fischer (2014)
Ethnicity	Dummy, 1 =Tribal, 0 =Non-tribal	Roy et al. (2022); Dhungana et al. (2022)
Education	Continuous, years of formal education of the respondent	Dhungana et al. (2022); Sharma and Neupane (2023)
Household size	Continuous, the total number of the household members	Mir et al. (2015); Roy et al. (2022)
Migration	Continuous, the total number of the migrated members in the household	Field experience
Landholding size	Continuous, the landholding size of the household in hectares	Mir et al. (2015)
Annual income	Continuous, log of the total annual income of a household in Rs.	Hariohay et al. (2018)
Livestock size	Continuous, total number of livestock in the household	Mir et al. (2015); Hanson et al. (2019)
Livestock depredation	Continuous, total number of livestock depredation by leopard during the last two years in the household	Mir et al. (2015); Hanson et al. (2019); Sharma and Neupane (2023)
Division	Dummy, 1 =Respondent from the Buxa East division, 0 = Respondent from the Buxa West division	Field experience

views and opinions.

3.2. The generalized ordered logit regression model

To analyze the factors influencing the attitudes of forest villagers towards the conservation of leopards and tigers, the generalized ordered logistic regression was conducted using the Stata program ‘gologit2’. Since the dependent variable (i.e., attitude towards leopards and tigers) was in an ordered scale, the ordered logistic model was most appropriate. However, an important assumption underlying the ordered logistic model is that the relationship between each pair of outcome groups is identical. This assumption is referred to as the proportional odds assumption or the parallel regression assumption. In cases where this assumption is violated, a more appropriate model to use would be the generalized ordered logistic model (Williams, 2006). The explanatory variables used in the analysis are detailed in Table 1, derived from previous research and the uniqueness of the study area.

In our case, as per the test of parallel lines, the proportional odds assumption has not held, since the Chi-Square statistic was 0.003 and 0.000 for the models for leopard and tiger conservation attitude, respectively. Both of the values are < 0.05, therefore, the generalized ordered logit regression is the most appropriate. It offers a flexible modeling approach that relaxes the restrictions of the proportional odds or parallel lines models used in ordinary ordered logit regression. It also provides a balance between model simplicity and interpretability compared to non-ordinal methods like multinomial logistic regression (Abegunde et al., 2019). The model can be represented by Eq. (2):

$$P(Y_i > j) = g(X_i\beta_j \frac{\exp(\alpha_j + X_i\beta_j)}{1 + [\exp(\alpha_j + X_i\beta_j)]}), j = 1, 2, \dots, M - 1 \tag{2}$$

Here, M refers to the number of categories in the ordinal dependent variable. From the above equation, we can determine the probabilities of Y taking on each value from 1 to M:

$$P(Y_i = 1) = 1 - g(X_i\beta_1) \tag{3}$$

$$P(Y_i = j) = g(X_i\beta_j - 1) - g(X_i\beta_j) \quad j = 2, \dots, M - 1 \tag{4}$$

$$P(Y_i = M) = g(X_i\beta_M) \tag{5}$$

The dependent variable Y_i represents the dependent variable, which denotes the level of agreement ranging from 1 (strongly disagree) to 5 (strongly agree). The $X_1 \dots X_n$ are the explanatory variables, and the $\beta_1 \dots \beta_n$ are the parameters associated with the explanatory variables. The intercept is represented by β_0 ; and μ_i stands for the error term.

The generalized ordered logistic regression can be considered equivalent to the logistic regression model when $M = 2$, but when $M > 2$, it requires estimating a series of $M - 1$ binary logit regressions (Williams, 2006). For instance, regarding attitudes towards the importance of leopard and tiger conservation, with $M = 5$, four binary logit regressions are performed, sequentially combining the categories of the dependent variable. In the first regression (indicated as $Y > 1$ in the results tables), category $j = 1$ is recoded as zero, while all other categories $j = 2, \dots, 5$ are recoded as one. In the second binary regression ($Y > 2$), the initial two categories ($j = 1$ and

Table 2
Demographic and socio-economic details of the sample forest villagers ($n = 345$) residing in the Buxa Tiger Reserve.

Particulars	Min (Max)	Mean	(St. Dev)
Age	18 (84)	45.03	(13.12)
Education	0 (17)	4.71	(4.52)
Household size	1 (10)	4.19	(1.31)
Migrated household members	0 (3)	0.36	(0.61)
Landholding size (hectare)	0.01 (8.27)	1.15	(0.86)
Annual income (Indian Rupee)	12,500 (842,000)	131,481.04	(96,899.31)
Livestock size (no.)	Cattle	0 (25)	2.57 (3.29)
	Bufalo	0 (13)	0.16 (1.15)
	Goat	0 (60)	2.20 (4.36)
	Sheep	0 (1)	0.01 (0.11)
	Pig	0 (8)	0.50 (1.06)
	Chickens	0 (150)	4.31 (10.06)
Livestock depredation during last 2 years (no.)	0 (19)	1.41	(2.76)
Particulars	Category	Count	(%)
Religion	Hindus	214	(62.03)
	Buddhists	16	(4.64)
	Christians	115	(33.33)
Gender	Male	259	(75.07)
	Female	86	(24.93)
Ethnicity	Tribal	213	(61.74)
	Non-tribal	132	(38.26)
Landholding size (hectare)	< 1	198	(57.39)
	1–2	108	(31.30)
	2–9	39	(11.31)

$j = 2$) are transformed into zeros, while the rest of the categories are converted into ones. Likewise, in the third regression ($Y > 3$), categories 1–3 are set as zeros, and in the fourth regression ($Y > 4$), categories 1–4 are designated as zeros, respectively.

Higher values on the explanatory variable are indicated by positive coefficients, suggesting an increased likelihood of the respondent belonging to a higher category of Y . On the other hand, negative coefficients indicate that higher values on the independent variable raise the likelihood of being in the current category or a lower category (Abegunde et al., 2019). However, a limitation of the Generalized Ordered Logistic model is that it releases all variables from the parallel-lines constraint, even though only a few may violate the assumption (Williams, 2006).

To address this issue, we utilized the ‘autofit’ option in ‘gologit2’, and the global Wald test revealed that in the final model for attitude towards leopard conservation, twenty-four constraints were imposed, while for attitude towards tiger conservation, twenty-seven constraints were imposed. This corresponds to eight variables (education, livestock, household size, migration, gender, age, age square, and income) in the leopard conservation model and nine variables (age, age square, gender, landholding size, migration, livestock, division, income, ethnicity) in the tiger conservation model, ensuring their effects adhere to the parallel-lines assumption.

4. Results

4.1. General information on the sample forest villagers

Table 2 presents the descriptive statistics of 345 forest villagers and their households who were part of the sample. The observed ages ranged from 15 to 84 years, with a mean age of 45.03 years, indicating that the majority of the villagers were in their working age. The sample consisted of 259 males, representing 75.07 % of the participants, and 86 females, accounting for 24.93 % of the sample. This gender disproportion can be attributed to the fact that household heads, who were primarily interviewed, are predominantly men, aligning with the sociocultural norms of the villages. The sample also included a significant proportion of tribal communities, such as Rabha, Dukpa, Garo, Oraon, Munda, Mech, Khariya, and Nagesia, comprising approximately 61.74 % of the forest villagers. The respondents had an average of 4.71 years of schooling, with a maximum of 17 years. More than 36 % of the sample villagers had no formal education, while only 7.25 % and 5.80 % had completed secondary education (10 years) and higher secondary education (12 years), respectively. This can be attributed to a lack of local educational facilities, poor financial circumstances, early involvement in earning activities, and a devaluation of formal education, all contributing to low educational attainment.

The average number of people living in each household within the surveyed village was four, with the largest household consisting of ten individuals (Table 2). On average, the villagers owned 1.15 ha of land. The majority of respondents belonged to the marginal landholder group (below 1 hectare) at 57.39 %, followed by the small landholder group (1–2 ha) at 31.30 %. The remaining villagers possessed land ranging from over 2–9 ha. Common crops cultivated by the farmers in these forest villages included paddy (*Oryza sativa*), maize (*Zea mays*), potato (*Solanum tuberosum*), areca nut (*Areca catechu*), banana (*Musa*), and seasonal vegetables. Approximately 30.14 % of the households had 1–3 members who migrated to other states, such as Tamilnadu, Sikkim, and Kerala, for employment. When asked open-ended questions about the work type of the migrated members, the respondents mentioned different non-farm occupations such as day laborers, drivers, army personnel, and hotel workers.

Livestock rearing was also a significant part of the villagers’ livelihoods, with an average of 10 livestock per household and a

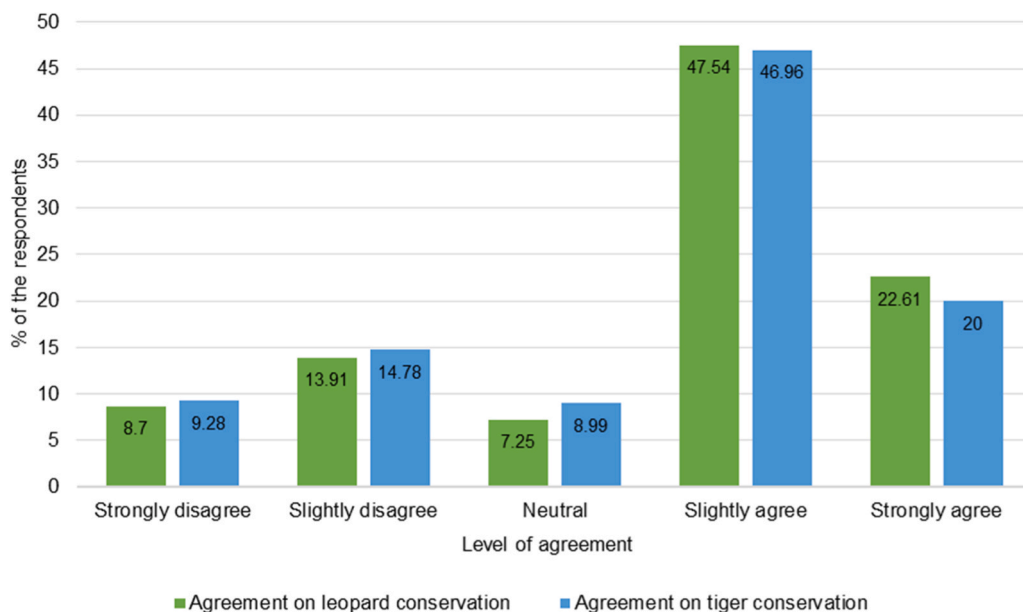


Fig. 2. Forest villagers’ ($n = 345$) level of agreement regarding the importance of conserving leopard and tiger in the Buxa Tiger Reserve.

maximum of 154. Over the past two years (2021–2022), the villagers experienced an average loss of one livestock, with a maximum loss of 19. Most of these losses occurred during nighttime, according to the villagers' reports. The average annual income of the surveyed households amounted to Rs. 131,481.04, ranging from Rs. 12,500 to Rs. 842,000, with a standard deviation of Rs. 96,899.31. Apart from income derived from livestock and agriculture, various government programs such as old age pensions, basic income assistance for women (Lakshmi Bhandar Scheme), off-farm activities (e.g., wage labor, income from eco-tourism), and remittances from migrants also played a significant role in supplementing the villagers' income (Table 2).

4.2. Attitude of forest villagers toward leopard and tiger conservation

The analysis reveals that a considerable majority of the villagers demonstrated a positive outlook toward conservation efforts (Fig. 2). Specifically, when asked about their level of agreement regarding leopard conservation, 47.54 % of the sample villagers expressed a slight agreement, while a slightly lower proportion of 46.96 % showed a similar level of support for tiger conservation. Moving on to stronger levels of agreement, approximately 22.61 % of the surveyed villagers exhibited a strong agreement towards conserving leopards, while 20.00 % showed an equivalent level of strong agreement towards tiger conservation.

On the contrary, a small percentage of the respondents, 9.28 %, expressed strong disagreement with tiger conservation, whereas slightly less, 8.70 %, displayed strong disagreement with leopard conservation. In addition to the above, several respondents, comprising 13.91 % for leopards and 14.78 % for tiger conservation, exhibited a slight disagreement with the conservation efforts for these felines. Overall, the findings of this study signify that the majority of forest villagers possess a positive inclination towards the conservation of both leopards and tigers, with higher proportions expressing a slight agreement compared to strong agreement and a relatively smaller percentage expressing disagreement with conservation efforts (Fig. 2).

4.3. Factors influencing forest villagers' attitude toward leopard and tiger conservation

Among the selected explanatory variables, five factors were found to have a significant influence on forest villagers' attitudes toward leopard conservation (Table 3), specifically regarding more positive attitudes ($Y > 3$ and $Y > 4$). These factors include gender, ethnicity, household size, migration, and Buxa division. The analysis revealed that forest villagers were more likely to exhibit a positive attitude towards leopard conservation if they were male, had larger household sizes, and resided in the Buxa East Division (Table 3). Conversely, individuals who were from the tribal communities as well as had greater numbers of family members who migrated to other states for work, had a more negative attitude toward leopard conservation. Notably, no significant associations were observed between forest villagers' age, religion, education, landholding size, annual income, total livestock size, and livestock depredation with their positive attitudes toward leopard conservation.

Regarding tiger conservation, six variables were identified as statistically significant predictors of more positive attitudes ($Y > 3$ and $Y > 4$). These variables include gender, religion, household size, migration, annual income, and division (Table 4). The analysis revealed that men exhibited a greater propensity for positive attitudes toward tiger conservation when compared to females. Additionally, forest villagers belonging to the Hindu religion, residing in households with larger family sizes, higher annual incomes, and located in the East division of Buxa displayed an increased likelihood of holding positive attitudes toward tiger conservation. Conversely, respondents from households with a higher number of family members who had migrated were found to be less likely to hold positive attitudes toward tiger conservation (Table 4).

Table 3

Generalized ordered logistic regression analysis results of variables affecting forest villagers' ($n = 345$) attitude towards the importance of leopard conservation in the Buxa Tiger Reserve.

Variables	Y > 1		Y > 2		Y > 3		Y > 4	
	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std. err.
Age	-0.0132	0.0476	-0.0132	0.0476	-0.0132	0.0476	-0.0132	0.0476
Age Sq.	0.0003	0.0005	0.0003	0.0005	0.0003	0.0005	0.0003	0.0005
Gender	1.1638***	0.2568	1.1638***	0.2568	1.1638***	0.2568	1.1638***	0.2568
Religion	-0.2356	0.5408	0.9462	0.3801	-0.4072	0.3135	0.2058	0.3243
Ethnicity	-1.7437**	0.8312	0.8779**	0.4050	-0.7498**	0.3402	-0.2803	0.3210
Education	0.0145	0.0280	0.0145	0.0280	0.0145	0.0280	0.0145	0.0280
Household size	0.1604*	0.0884	0.1604*	0.0884	0.1604*	0.0884	0.1604*	0.0884
Migration	-0.4741***	0.1930	-0.4741***	0.1930	-0.4741***	0.1930	-0.4741***	0.1930
Landholding size	-0.7121**	0.3390	-0.6159**	0.2531	0.2473	0.1997	-0.0848	0.1644
Log annual income	0.3508	0.5202	0.3508	0.5202	0.3508	0.5202	0.3508	0.5202
Log livestock size	0.1633	0.2810	0.1633	0.2810	0.1633	0.2810	0.1633	0.2810
Livestock depredation	-0.3972***	0.0952	-0.5070***	0.0942	0.0712	0.0736	-0.0480	0.0546
Division	-0.3210	0.5939	1.0362***	0.3334	0.7472***	0.2892	0.5384*	0.2936
Pseudo R ² = 0.1398								

* = $p < 0.1$; ** = $p < 0.05$ and *** = $p < 0.01$.

Table 4

Generalized ordered logistic regression analysis results of variables affecting forest villagers' ($n = 345$) attitude towards the importance of tiger conservation in the Buxa Tiger Reserve.

Variables	Y > 1		Y > 2		Y > 3		Y > 4	
	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std. err.
Age	-0.0362	0.0471	-0.0362	0.0471	-0.0362	0.0471	-0.0362	0.0471
Age Sq.	0.0004	0.0005	0.0004	0.0005	0.0004	0.0005	0.0004	0.0005
Gender	0.7301***	0.2474	0.7301***	0.2474	0.7301***	0.2474	0.7301***	0.2474
Religion	0.0497	0.4278	0.4224	0.3282	-0.3987	0.2927	0.9395***	0.3634
Ethnicity	-1.2091**	0.5954	0.2205	0.3284	-0.3082	0.3050	-0.1868	0.3235
Education	0.0011	0.0280	0.0011	0.0280	0.0011	0.0280	0.0011	0.0280
Household size	0.1581*	0.0861	0.1581*	0.0861	0.1581*	0.0861	0.1581*	0.0861
Migration	-0.3992**	0.1883	-0.3992**	0.1883	-0.3992**	0.1883	-0.3992**	0.1883
Landholding size	-0.0479	0.1346	-0.0479	0.1346	-0.0479	0.1346	-0.0479	0.1346
Log annual income	-1.0304	0.9423	-0.7972	0.7525	1.3173**	0.6501	1.2609*	0.6703
Log livestock size	0.0835	0.2754	0.0835	0.2754	0.0835	0.2754	0.0835	0.2754
Livestock depredation	-0.3409***	0.0765	-0.2926***	0.0690	0.0307	0.0555	-0.0633	0.0557
Division	0.8766***	0.2389	0.8766***	0.2389	0.8766***	0.2389	0.8766***	0.2389
Pseudo R ² = 0.3334								

* = $p < 0.1$; ** = $p < 0.05$ and *** = $p < 0.01$.

5. Discussion

Our study revealed that forest villagers generally exhibit a positive inclination toward conserving leopards and tigers. Interestingly, the respondents showed a slightly stronger preference (0.58–2.61 %) for leopard conservation over tiger conservation. These findings align with the prior research conducted in India (Reddy and Yosef, 2016; Krishnakumar and Nagarajan, 2020) and Nepal (Dhungana et al., 2022), showing positive attitudes toward leopard and tiger conservation among respondents. However, attitudes as to which feline is considered might not be always positive since studies have also found negative attitudes of the majority towards the conservation. For instance, Uduman et al. (2022) revealed a prioritization of livelihoods over leopard conservation in Sri Lanka, including a willingness to resort to leopard killing, while Vasudeva et al. (2021) found just 35 % of the villagers in Odisha, India, support for tiger conservation.

The positive attitudes among the forest villagers in the Buxa Tiger Reserve can be attributed to several factors. Living in close proximity to the forest allows communities to develop a deeper understanding of the ecosystem's importance and biodiversity (Muhamad et al., 2014; Mavhura and Mushure, 2019). Studies have revealed that villagers residing in the same landscape with leopards and other wildlife for a prolonged duration, interacting with them regularly, acknowledge the vital roles these predators play (Kumbhojkar et al., 2019). Since the forest villages within Buxa Tiger Reserve have a history dating back to colonial times, the long coexistence with wildlife across generations could be an important factor shaping the positive attitude observed among the villagers. Some respondents, while expressing their attitude towards the leopard and tiger conservation, also highlighted that these big cats play a vital role in cleaning the environment by scavenging on wild animal carcasses inside the forest. Moreover, the villagers' comprehension of the complexities of the food web was evident, as they reasoned that the absence of tigers could lead to unchecked growth in herbivore populations, resulting in greater agricultural damage to their farmlands. Such understanding of the ecological value of these species might have contributed to the positive attitude among the forest villagers, as also observed in the study by Reddy and Yosef (2016) in central India.

In addition to the above, some respondents even mentioned that conservation efforts can have a positive impact on eco-tourism. The presence of tigers and leopards in the area can attract tourists who are interested in observing these creatures in the natural setting (TCP, 2016). This tourism activity could bring income and employment opportunities to the local communities through homestays, guided wildlife tours, and other related activities (Bhattarai and Fischer, 2017). Furthermore, the preference for leopard conservation over tiger conservation may be influenced by the perception that tigers pose a greater threat to human safety due to their larger size, as expressed by forest villagers during the interviews. This suggests that some villagers may perceive the risks associated with tigers to outweigh the perceived benefits of their conservation. It is important to note that these opinions can be shaped by experiences with wildlife, as well as various demographic, social, and economic factors (Shrestha and Alavalapati, 2006; Kumbhojkar et al., 2019; Dhungana et al., 2022).

Several South Asian studies (Mir et al., 2015; Dhungana et al., 2022) have indicated that gender plays a significant role in determining the level of support for leopard and tiger conservation, with women displaying lower levels of support compared to men. Our research aligns with these findings, but are contrary to the findings of Vasudeva et al. (2021), who found women to be more supportive of tiger conservation as compared to men in Eastern India. The gender disparity in conservation attitude as observed in our study may be attributed to women's heightened fear of losing family members to big cat attacks, as such incidents can lead to social stigma and economic burdens (Datta et al., 2023). Furthermore, it is worth noting that in developing countries, women are often assigned the role of gathering firewood, fiber, fruits and other timber and non-timber forest products, which holds true in our research as well. This can result in women being disproportionately exposed to risks associated with wildlife, such as physical safety concerns (Doubleday and Rubino, 2022). On the other hand, men in our survey frequently emphasized the economic advantages of tigers and leopards, likely due to their labor roles, as they often highlighted the increased employment opportunities through eco-tourism

stemming from the presence of wildlife in Buxa.

A positive attitude towards conservation of the leopards and tigers was found among the individuals from larger households possibly due to the increased sense of security they experience in forested areas, stemming from the presence of numerous family members. However, this finding contradicts the results of [Shrestha and Alavalapati \(2006\)](#) and [Dhungana et al. \(2022\)](#) in Nepal. As per these studies, a greater number of family members can result in heightened reliance on forest resources to meet the expanded family's requirements, consequently increasing the likelihood of encounters with wildlife. Besides, households with more members having migrated to other states in our study area tend to show decreased support for leopard and tiger conservation, possibly due to safety concerns due to decreased members in the household.

Notably, respondents belonging from the Hindu religion exhibited a significant positive attitude toward tiger conservation, and non significant positive towards the leopard conservation. This could be attributed to the fact that in Hinduism, the tiger is associated with the goddess Durga and is considered her 'vahana' (vehicle) ([Panda and Mohanty, 2021](#)). The cultural and religious significance of tigers within Hinduism may influence positive attitudes toward their conservation ([Bhattarai and Fischer, 2014](#)). Also, forest villagers with higher incomes exhibit a stronger affinity towards the conservation of tigers, in line with previous research by [Vasudeva et al. \(2021\)](#) in India and [Dhungana et al. \(2022\)](#) in Nepal. This association may be linked to wealthier families who can bear the loss associated with wildlife damage compared to economically disadvantaged ones, who bear a higher burden of such incidents. Our study also revealed that tribal communities, typically considered marginalized, display a lower likelihood of supporting leopard conservation initiatives. In the case of tiger conservation, a negative attitude was also prevalent among them, however not significant. This finding could be attributed to their precarious financial conditions, making it more challenging for them to endure losses resulting from leopard attacks.

Unlike many other studies ([Mir et al., 2015](#); [Hanson et al., 2019](#); [Sharma and Neupane, 2023](#)), we did not find any significant association between the size of livestock owned by the sample villagers and the occurrence of livestock losses due to predation by leopards over the past two years with the individual's attitudes towards the conservation of these big cat species. Since depredation incidents are quite common in reserve ([TCP, 2016](#); [Naha et al., 2018](#)), the villagers might have adjusted their preferences or desires based on their limited opportunities, social circumstances, or external constraints, which [Sen \(2000\)](#) referred to as "adapted preferences". Besides, education and age are also not significant in both models ([Tables 3 and 4](#)). Therefore, education and age might not necessarily lead to changes in deeply ingrained cultural or traditional beliefs, as evidenced in this study. Therefore, attitudes towards conservation can be shaped by local customs and practices that may not be easily altered by age and/or formal education ([Reddy and Yosef, 2016](#); [Dhungana et al., 2022](#)).

6. Conclusion and policy implication

This study examined the attitudes of 345 villagers from ten forest villages within the Buxa Tiger Reserve, India, towards leopard and tiger conservation. Overall, most villagers demonstrated a favorable attitude towards conservation efforts, with a slightly stronger inclination towards leopard conservation. The results further indicated that for both the leopard and tiger conservation, positive attitudes were more common among male respondents, individuals from larger households, residents of the Buxa East Division, and those having less migrated members in the family. Whereas forest villagers from the Hindu religion and having higher annual income showed a significant positive attitude towards tiger conservation, which was not present in the case of leopard conservation. Furthermore, non-tribal people were in favor of leopard conservation; but no such association was found for the tiger conservation attitude.

Based on the findings of this study, several policy recommendations can be proposed to enhance leopard and tiger conservation efforts in the Buxa Tiger Reserve: (i) Developing targeted initiatives to engage women and villagers residing in the Buxa-West division in leopard and tiger conservation through awareness campaigns, and education programs highlighting the ecological importance of leopards and tigers; (ii) implementing livelihood support programs and promoting alternative income generation activities for forest villagers, especially those from tribal communities and households with higher migration rates; and (iii) considering the geographic distribution of positive attitudes towards leopard and tiger conservation, especially in the Buxa East Division, allocating the resources and prioritizing conservation initiatives in this area with higher local community support would be beneficial. This can involve habitat restoration initiatives and enhancing community-based conservation models.

These policy measures should be implemented in a holistic and integrated manner, considering the interplay of various factors influencing attitudes toward leopard and tiger conservation. Collaboration with local communities, continuous monitoring and evaluation, and adaptive management are crucial for the success of conservation efforts. Therefore, future studies could conduct longitudinal studies to track attitudes over time to provide insights into the dynamics of attitude formation and changes. This would help identify the long-term effectiveness of conservation interventions and assess the impact of socio-economic and environmental changes on attitudes towards leopard and tiger conservation. In conclusion, the findings of this study have relevance far beyond the boundaries of the Buxa Tiger Reserve. By shedding light on the complex interplay between human communities and apex predators, the research contributes to developing effective and culturally sensitive conservation strategies that can be adapted and applied in diverse ecosystems worldwide.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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