Factors Influencing People's Response Toward Tiger Translocation in Satkosia Tiger Reserve, Eastern India

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Local communities are an important stakeholder in any carnivore translocation programme and therefore, their acceptance of the translocation and support are essential to ensure its viability. Recent tiger augmentation efforts in Satkosia Tiger Reserve, India received mixed responses from the local communities, causing a stalemate in its progress. As a part of the adaptive management strategy, it was required to assess the concerns and issues to provide a practical solution. Hence, we analyzed the attitude of the people toward conservation in general and tiger specifically. We used structured questionnaire surveys and interviewed 1,932 households from 43 villages located in and around the reserve. We tested the influence of several variables representing four categories- (1) socio-economic, (2) ecosystem values and dependence, (3) relationship with the forest department and (4) losses and fear, on the attitude toward tiger conservation. The villages were clustered based on the responses received under these categories. While conserving forest was important to 91% of respondents, 71% of respondents supported wildlife conservation and only 35% felt important to conserve tiger. The logistic binary regression predicted that at the household level attitude toward tiger conservation is influenced positively by economic well-being, sense of forest ecosystem services, resource dependence and negatively influenced by restrictions from the forest department, and previous experience of loss due to wildlife. At the village level, literacy, resource dependence, access to clean cooking fuel and cooperation from the forest department predicted a positive attitude toward tiger conservation. Restriction from the forest department, fear for livestock, and experience of losses due to wildlife had a negative influence on attitude. We recommend that the villages in the landscape are prioritized based on their needs and accordingly, specific interventions are made to address their concerns. Future augmentation programme must give importance to intangible factors such as fear and perceived restrictions and opt for the involvement of the local community in the decision-making process.

Keywords: human-wildlife interaction, large carnivore conservation, perception analysis, people-forest interface, reintroduction

INTRODUCTION

Large terrestrial carnivores across the world have experienced significant geographic range contractions and continuously face the risk of local or total extinction (Ripple et al., 2014; Wolf and Ripple, 2017). Tigers (*Panthera tigris*) have experienced a 95% decline in their geographic range and several remnant sites are facing local extirpation (Wolf and Ripple, 2017). Habitat fragmentation, high human densities and poaching of the tigers and their prey are among the major drivers of population decline (Ramakrishnan et al., 1999; Woodroffe, 2000; Narain et al., 2005; Chapron et al., 2008; Sankar et al., 2010; Wildlife Institute of India, 2013; Ripple et al., 2014; Wolf and Ripple, 2016). In India, tigers have received dedicated conservation efforts through the initiation of the Project Tiger in 1973, constitution of the Tiger Task Force, National Tiger Conservation Authority and expansion of the Tiger Reserve network (Jhala et al., 2021). While an overall continuous increase in tiger population has been recorded, several sites in India have recorded a decline due to degraded habitat and prey (Jhala et al., 2020). With photographic evidence of only one surviving individual in the wild, the tiger population in Satkosia Tiger Reserve, Eastern India, had reached functional extinction (Jhala et al., 2020). This required active recovery efforts through translocation of individuals from higher density source areas.

Tigers were reintroduced in Sariska and Panna Tiger Reserves in 2008 and 2009 respectively. After experiencing success in these reserves, first interstate translocation of tigers was initiated in Satkosia Tiger Reserve in 2018. However, long term success of such population augmentation programme is dependent on simultaneous improvement in habitat quality, prey base, habitatprotection and socio-political support (Johnsingh and Madhusudan, 2009; Gray et al., 2017). While carnivores can adapt to high human densities (Gehr et al., 2017) and low prey base, human adaptation to carnivores and acceptance of some conflict (such as livestock depredation) are important requirements for human-carnivore coexistence (Lute et al., 2018). Carnivore recoveries have been successful even in human-dominated landscapes where people and predators have traditionally co-existed (Woodroffe, 2000; Athreya et al., 2016). Understanding the attitudes and the needs of local communities is an important prerequisite to create strategies for such co-existence and enhance participation in conservation (Digun-Aweto et al., 2020).

Inadequate assessment of social and political aspects has been a major cause of failure of most reintroduction programmes of threatened or endangered species in the past (Griffith et al., 1989; Reading and Kellert, 1993). The support and cooperation of local people are therefore increasingly being recognized for successful population recovery and conservation, instead of the traditional exclusionary approach (Mishra, 1991; Seddon et al., 2007; Garekae et al., 2016; Kaplan-Hallam and Bennett, 2018). Social consultations in reintroductions are also integral part of the IUCN Guidelines for Reintroductions and Other Conservation Translocations (IUCN/SSC, 2013). Additionally, understanding human behavior and socio-economic and political

systems allows us to better understand the threats faced by biodiversity and the planning of best recovery strategies (Polasky, 2008).

Local communities, especially in rural landscapes, depend on the forest for their livelihood. Those living in remote areas tend to suffer high poverty, low income, scarce employment opportunities, and government services (Sunderlin et al., 2005; Belcher et al., 2015). Due to the high human population density human-wildlife interactions in forest fringes have become inevitable. These interactions can be positive, negative or neutral. While positive interactions with wildlife or perceived benefits may enhance support for conservation (Störmer et al., 2019), a prolonged negative outlook toward wildlife is often harmful to the current and future population recovery programmes. Presence of livestock in forest fringes often attracts carnivores outside the protected areas when native prey is difficult to find or kill (Patterson et al., 2004; Yirga et al., 2015; Athreya et al., 2016). This causes conflict with humans due to negative interactions such as injury, attacks and livestock predation (Cozza et al., 1996). In several cases, the human-wildlife conflict extends to retaliatory killings (Aryal et al., 2014; Van Eeden et al., 2018; Merson et al., 2019). Livestock depredation by carnivores has been identified as one of the major drivers of human-carnivore conflict, which poses a serious threat for carnivore conservation in India (Miller et al., 2016). Fear for their livestock and fear for movement in and around the village upon tiger release negatively affects people's attitude (Gray et al., 2017; Hiroyasu et al., 2019).

In local communities that are poor and lack opportunities, hostility to large carnivores can be reinforced by a perception of the negative impacts on their life and livelihood (Treves and Karanth, 2003; Badola et al., 2012; Chapron et al., 2014). In other cases, inaccurate perception of the level of threat faced due to human-wildlife conflict may lead to retaliatory killings or a lack of support for recovery programmes (Dickman, 2010; Bruskotter and Wilson, 2014). These actual or perceived negative impacts of wildlife stem from past experiences with the carnivores, inaccurate information, biased reporting by media or experiences with forest or protected area managers (Ericsson and Heberlein, 2003; Allendorf et al., 2012; Klich et al., 2018; Nanni et al., 2020). Additionally, some wildlife policies that exclude the local inhabitants from access to the forest resources emanate a contentious relationship between the locals and the forest managers (Western and Pearl, 1989; West and Brechin, 1991; Zeeshan et al., 2017). Thus, both tangible (monetary losses) and intangible (fear and trauma) factors play an important role in influencing people's support toward conservation.

Human-wildlife conflict in Satkosia is mainly due to Asian Elephant (*Elephas maximus*) and Wild Boar (*Sus scrofa*). The experience of people with large carnivores like tigers and leopards has been negligible due to their very low density. The tiger augmentation programme in Satkosia was brought to a halt due to the incidents of human attack and livestock predation after the release of translocated tigers in the wild. With this study, we attempted to understand people's attitude and perception toward tiger conservation after their experience with translocated tigers. The study was designed to answer three questions: (1) what is the overall attitude of people toward conservation after their

experience with translocated tigers? (2) What are the underlying factors and drivers that influence people's attitude toward tiger conservation? (3) With a monetary compensation mechanism already in place, which intangible factors can be potentially considered for future community engagement?

MATERIALS AND METHODS

Study Area

The study was carried out in villages located within a five-kilometer buffer of Satkosia Wildlife Division (area = 657.79 km^2) in Odisha, India (**Figure 1**). Satkosia Wildlife Division forms the northern part of both Satkosia Gorge Sanctuary and Satkosia Tiger Reserve (notified in 2007). Satkosia Tiger Reserve covers an area of 963.87 km^2 and is one of the two tiger reserves in Odisha. The surveyed villages come under two districts- Angul and Cuttack with a population density of 199 and 667 persons per km^2 respectively.

Household Surveys

Structured household questionnaire survey method (Gillingham and Lee, 2003; Bhattacherjee, 2012; Karanth and Ranganathan, 2018) was used to collect information from the households within the village. A pilot study was carried out in May 2019 in one of the villages, where 23 households were surveyed. Based on the responses received, the questionnaire was modified by addition of questions and response options. We also simplified some of the questions based on the ability of respondents to comprehend them. We then targeted to sample 100% of the households but depending upon the willingness of the people to participate in the survey, the response rates varied across 43 villages (**Supplementary Table 1**) (Karanth et al., 2018). A total of 1,932 households were sampled. The order in which the households were approached was random (Vodouhê et al., 2010; Hariohay et al., 2018; Karanth and Ranganathan, 2018) and it ended up to 100% where people were willing to participate in the entire village. Only one respondent from each household was interviewed, accounting for the total sample size of 1932. The interviews were conducted with the household head but in their absence, other family members who were willing to participate, were interviewed. By obtaining verbal consent and not providing any incentives or promises, we ensured ethical standard of the survey.

The questionnaire (**Supplementary Data Sheet 1**) was prepared both in the local language (Odiya) and English, but the questions were asked in the local language only. Both the respondent and the interviewer could understand and speak the local language and agreed to participate in the survey. The survey questions were organized into four categories- (1) socio-economic, (2) ecosystem values and dependence, (3) relationship with the forest department, (4) losses experienced as a result of conflict with wild animals and concerns regarding tiger release. Majority of the questions were close ended questions while some questions were open ended where fixed responses could not be predicted during pilot survey. At the end of the survey, the respondents were allowed to convey their opinion on any of the subjects within the questionnaire qualitatively.

These qualitative responses were used to interpret the objective responses received for the study. Open ended questions allowed us to capture the unique responses of the individuals, while close ended questions helped in avoiding individual biases while recording the responses. The interviews were conducted by a team of researchers, members of a local NGO and forest guards.
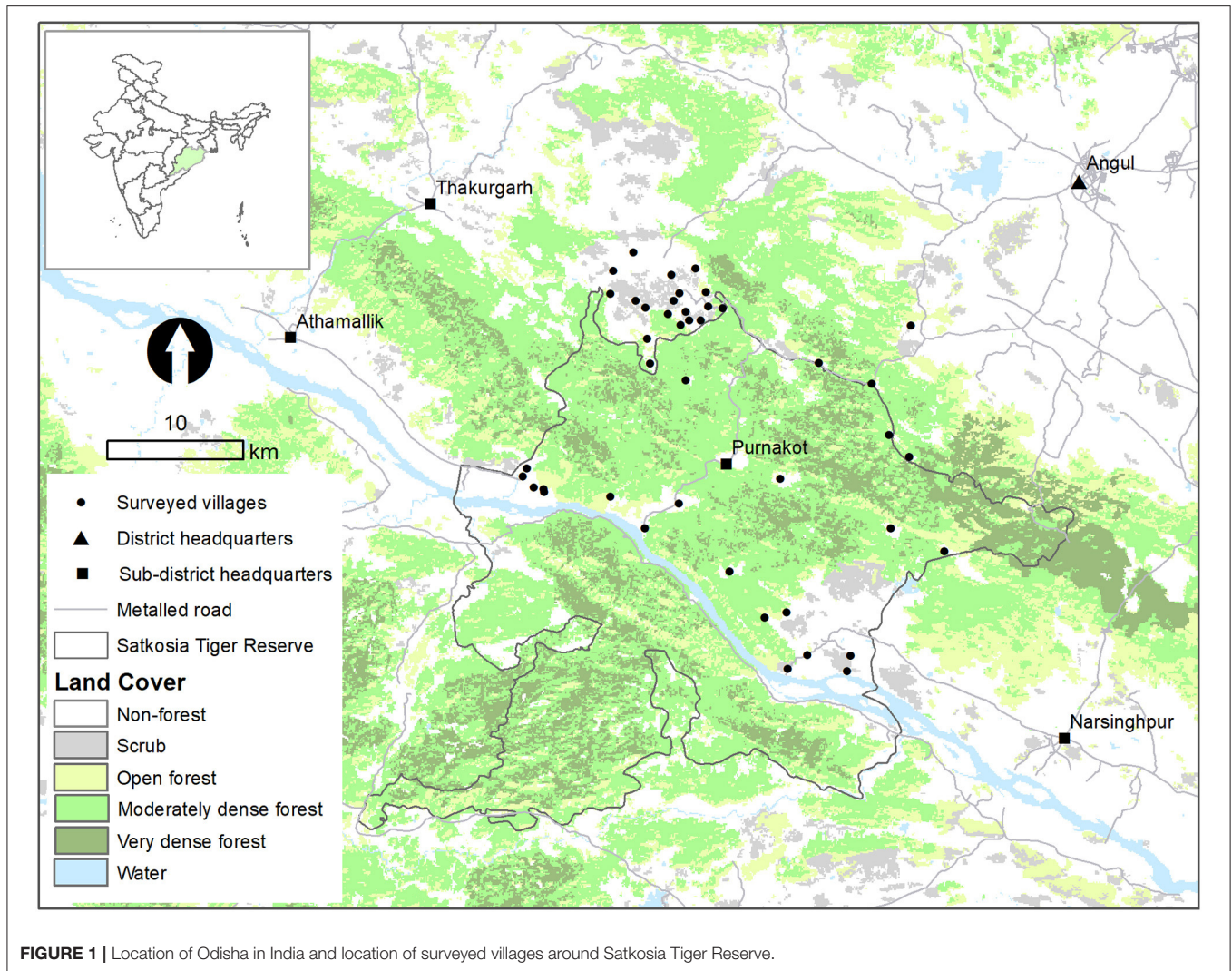
Variable Selection

Variables were selected based on the findings of previous studies involving assessment of people's response and attitude toward protected areas, conservation and reintroduction. For example, variables that belong to socio-economic category such as respondent age, gender, education, family size, and economic well-being have been known to influence forest resource use and ultimately the nature of interaction with forest and wildlife. Several studies have demonstrated a significant influence of these variables on the attitude toward conservation and reintroduction (Williams et al., 2002; Ericsson and Heberlein, 2003; Meadow et al., 2005; Ogra and Badola, 2008; Badola et al., 2012; Karanth and Ranganathan, 2018; Hiroyasu et al., 2019). Similarly, other studies have shown that the benefits from forest and wildlife can affect the attitude of people toward conservation in a positive manner (Williams et al., 2002; Lindsey et al., 2005; Lamichhane et al., 2018; Talukdar and Gupta, 2018; Sakurai et al., 2020). When people feel that their access to forest is restricted, it leads to negative perceptions toward the protected areas and management practices (Allendorf et al., 2006; Talukdar and Gupta, 2018).

Other variables such as benefits from government schemes, fear for livestock, and fear for human life were more specific to the study site but are also supported by research findings globally. Losses due to human-wildlife conflict, if not compensated appropriately, leads to a negative outlook in people who are already asset poor and lack livelihood opportunities (Allendorf et al., 2006; Karanth and Ranganathan, 2018). To some extent, a transparent and timely compensation has been known to promote community support, tolerance to wildlife and decreased retaliatory killings (Naughton-Treves et al., 2003; Ogra and Badola, 2008; Agarwala et al., 2010; Dickman et al., 2013; Persson et al., 2015; Digun-Aweto et al., 2020; LeFlore et al., 2020). Similarly, various intangible factors such as concern for life and livestock have been known to garner feelings of uncertainty and a negative attitude toward reintroduction of carnivores (Talukdar and Gupta, 2018; Hiroyasu et al., 2019; LeFlore et al., 2020).

Data Analyses

Data was tested for normality using Shapiro-Wilk test for normality with null hypothesis that data has normal distribution. Pairwise correlation between variables in each theme was tested using Spearman Rank Correlation. Correlation coefficient values (r) and p values for significance of correlation were calculated (**Supplementary Data Sheet 2**). Based on positive correlation coefficient (r) values within a theme of variables, some variables were grouped by creating more meaningful indices such as Economic Well-Being Index (EWBI) and Forest Dependence Index (FDI), Income Dependence Index

FIGURE 1 | Location of Odisha in India and location of surveyed villages around Satkosia Tiger Reserve.

(IDI) and Resource Dependence Index (RDI) at household level (Soman and Anitha, 2020) and Village Economic Diversity Index (VEDI) (Dewi et al., 2005) at village level (**Supplementary Data Sheet 3**). After computing derived variables, variable that still had very high correlation value ($r > 0.70$) with another variable within the same category was dropped from analyses. A total of 20 variables were analyzed at household level under the four broad categories mentioned in Section 2.2 (**Table 1**).

Forest dependence index ranges between 0 and 1, where 0 indicates low dependence and 1 indicates high dependence on forest. Forest dependence index was computed using two other indices, i.e., resource dependence index and income dependence index. Resource dependence index takes into account household dependence on six identified forest resources such as firewood, fodder, medicine, food, material for house construction and fishing. Income dependence index indicates the dependence of households on forest for income-generating activities such

as eco-tourism, employment by the forest department and collection of non-timber forest products (NTFPs). Both RDI and IDI range between 0 and 1. Economic well-being index was computed using ten variables that represent economic well-being, such as household income, land-size, household amenities (television, radio, fan, bulb, kerosene lamp, refrigerator and mobile phone), number of vehicles, number of agriculture equipment, access to electricity (power lines or solar panels), number of animals, concrete wall, and concrete roof. For variables that had a variation in monetary values (household amenities, vehicles, agriculture equipment, domestic animals), we multiplied the number of items by their current approximate market values. The value of this index ranges between 0 and 1, where 0 indicates poor economic well-being and 1 indicates good economic well-being. Village economic diversity index was calculated for each village and it indicates the diversity of livelihood opportunities in which people are currently engaged. A higher value indicates more diverse

TABLE 1 | Variables at household level used in logistic regression models to predict the attitude of people toward tiger conservation.

Theme	Variables (abbreviation)	Data scale	Description and response type
(I) Socio-economic	Gender (GEN)	Categorical	Gender of the respondent. Two levels: Male, Female
	Age group (AGE)	Categorical	Age group of the respondent. Five levels: 0–18, 19–25, 26–40, 41–65, older than 65 years
	Education level (EDU)	Categorical	Education received at the time of interview. Four levels: Illiterate, 1–5 standard (Primary), 6–10 standard (Secondary), 11th standard and higher (Higher Education)
	Family size (FAM)	Ratio	Number of family members in a household, where one household is taken as one physical structure
	Occupation (OCC)	Categorical	Occupation of the respondent.
	Economic Well-being Index (EWBI)	Ratio	An index that indicates the relative economic status of the households based on income of family members and assets within the household such as vehicles, land and livestock. Range: 0 (low) to 1 (high)
	Benefit from government schemes (SCHE)	Ratio	Total number of government schemes from which the household benefited at the time of interview
(II) Ecosystem values and dependence	Resource Dependence Index (RDI)	Ratio	An index that indicates the relative dependence of household on various forest resources such as fuelwood, fodder, medicine, food, and non-timber forest products. Range: 0 (low) to 1 (high)
	Income Dependence Index (IDI)	Ratio	An index that indicates the relative dependence of households on income generating activities related to forest and forest resources. Range: 0 (low) to 1 (high)
	Access to clean cooking fuel (LPG)	Categorical	Current use of liquefied petroleum gas (LPG) as cooking or heating fuel in the household. It only considered the households that were refilling LPG at the time of interview. Two levels: Yes and No
	Sense of Ecosystem Services from Forest (FECO)	Ratio	The ability of people to recognize and acknowledge the benefits available from forest (from a given set of benefits of forest). Sum of all the ecosystem services recognized and acknowledged by the respondent
	Sense of Ecosystem Services from Wildlife (WECO)	Ratio	The ability of people to recognize and acknowledge the benefits available from wildlife (from a given set of benefits of wildlife). Sum of all the ecosystem services recognized and acknowledged by the respondent
(III) Relationship with Forest Department	Restriction of daily activities (REST)	Ordinal	Experience of restriction by people from Forest Department in their day-to-day activities. Four levels: Always, Sometimes, Rarely, Never
	Received compensation for losses (COMP)	Ordinal	The experience of people with monetary compensation schemes (if applied). Four levels: Always, Sometimes, Rarely, Never.
	Satisfied with compensation received (SATS)	Categorical	The individual satisfaction with the monetary compensation received for the losses. Two levels: Yes and No
	Cooperation from Forest Department (COOP)	Ordinal	Experience of cooperation from the forest department on an everyday basis. Four levels: Always, Sometimes, Rarely, Never.
(IV) Losses and Fear	Losses experienced (LOSS)	Ratio	Experience of losses due to wildlife, such as loss of family member, livestock, crop depredation, damage to assets. Sum of all the categories recognized by the respondent
	Fear for human life upon tiger release (FHUM)	Categorical	Concern for human life after release of tiger in the wild. Two levels: Yes and No
	Fear for livestock upon tiger release (FLIV)	Categorical	Concern for livestock after release of tiger in the wild. Two levels: Yes and No
	Fear for movement upon tiger release (FFOR)	Categorical	Concern for movement inside the forest after release of tiger in the wild. Two levels: Yes and No

livelihood options and lower value indicates low diversity in livelihood options.

During the survey, the respondents were asked if they think that forest, wildlife and tiger conservation is important, and their responses were recorded as "Yes" and "No." No responses or unclear responses were recorded as "Unsure" or "No Response." We used binary logistic regression to analyze the important explanatory variables that can predict the responses toward conservation (Tessema et al., 2010; Allendorf et al., 2017; Störmer et al., 2019). Models were built using "glm" function in R, taking importance of conservation as

response variable ("Yes" and "No") and 20 explanatory variables described in **Table 1**. Considering various combinations of predictor variables, the best model was selected under each category based on the lowest Akaike Information Criterion (AIC). We used a threshold of 0.50 for probability values and assigned "Important" to responses having probability values greater than 0.50 and "Not Important" to values less than 0.50. The model efficiency was computed using a confusion matrix and area under the ROC Curve. R packages "pROC" (Robin et al., 2011) and "MASS" (Venables and Ripley, 2002) were used.

At village level, 18 variables (**Table 2**) were analyzed to predict the attitude of the local community toward tiger conservation. Percentages were calculated taking total surveyed households in that village. Generalized linear model was used to predict the importance of conservation at village level, using the function "glm" and log link-function in "poisson" family. In order to test which variables are most important in influencing attitude of people within each of the four categories, we created four models at household level and at village level. Multicollinearity was checked using Variance Inflation Factor using R package "faraway" (Faraway, 2016).

We used Chi-square test of independence to test if the attitude toward forest conservation and wildlife conservation has a significant relationship with attitude toward tiger conservation. The null hypothesis for this test was formulated as: there is no significant relationship between attitude toward forest conservation and attitude toward tiger conservation. A second

null hypothesis was formulated as: there is no significant relationship between attitude toward wildlife conservation and attitude toward tiger conservation. The hypotheses were tested at 95% confidence interval.

In order to group the surveyed villages and prioritize them for future management and community engagement, we used k-means cluster analysis by calculating Euclidean distances. Optimal number of clusters were found using average silhouette method using "silhouette" function in R. Cluster size corresponding to highest average silhouette value was chosen as the optimal cluster size. Villages were grouped based on variables under the categories (1) socio-economic, (2) ecosystem values and dependence, (3) relationship with forest department, (4) fear and losses and (5) attitude toward importance of forest, wildlife and tiger conservation. The ratio between cluster sum of squares and total sum of squares variance (BSS/TSS) was used as indicator of efficiency of classification. R packages

TABLE 2 | Variables at village level used in regression models to predict the attitude of people toward tiger conservation.

Theme	Variable (Abbreviation)	Description	Data scale
(I) Socio-economic	Literacy Rate (LIT)	Percentage of people in the village (respondents and their family members) who are literate.	Ratio
	Poverty (BPL)	Percentage of households below poverty line in the village.	Ratio
	Village Economic Diversity Index (VEDI)	It indicates the heterogeneity of livelihood opportunities within a village.	Ratio
	Electrified households (ELEC)	Percentage of households with access to electricity through power lines or solar panels.	Ratio
	Distance to facilities (DIST)	Distance to the facilities such as school, health centres, post office, common service centres and ATMs.	Ratio
	Government scheme beneficiaries (SCHE)	Percentage of government scheme beneficiaries in the village.	Ratio
(II) Ecosystem values and dependence	Resource Dependence (RDI)	Percentage of households dependent on forest for resources such as fuelwood, medicine, house-construction material.	Ratio
	Income Dependence (IDI)	Percentage of households dependent on forest and wildlife for their income.	Ratio
	Access to Clean cooking fuel (LPG)	Percentage households with access to clean cooking fuel- Liquefied Petroleum Gas (LPG)	Ratio
	Sense of Forest ecosystem services (FECO)	Level of sense of ecosystem services derived from forest. Binary values for each category of ecosystem services or benefits added and normalized to a scale of 0–1.	Ratio
	Sense of Wildlife Ecosystem Services (WECO)	Level of sense of ecosystem services derived from forest. Binary values for each category of ecosystem services or benefits added and normalized to a scale of 0–1.	Ratio
(III) Relationship with Forest Department	Cooperation by forest department (COOP)	Percentage of weighted sum of households who feel cooperation from the forest department.	Ratio
	Received compensation for losses (COMP)	Percentage of weighted sum of households who have received a monetary compensation for losses.	Ratio
	Satisfaction with compensation (SATS)	Percentage of weighted sum of households satisfied with the monetary compensation received for losses.	Ratio
	Perceived restrictions (REST)	Percentage of weighted sum of households who perceive their daily activities are restricted due to forest management or by the forest department.	Ratio
(IV) Losses and Fear	Experience of losses due to wildlife (LOSS)	Percentage of households with experience of loss of property, family members, livestock or damage to crops due to wildlife.	Ratio
	Fear for livestock (FLIV)	Percentage of households who have concern for livestock upon release of tigers.	Ratio
	Fear for movement (FFOR)	Percentage of households who have concern for safety in movement in their village or forest upon tiger release.	Ratio

"tidyverse" (Wickham et al., 2019), "factoextra" (Kassambara and Mundt, 2020) and "cluster" (Maechler et al., 2019) were used. All analyses were carried out in RStudio version 1.3.1.1073 (R Core Team, 2020).

RESULTS

General Household Profile

Percentage sampling per village ranged between 14 and 100%. Of the 1,932 respondents interviewed, 62.63% (1,210) were male and 37.37% (722) were female (**Table 3**). The respondents could not be differentiated based on specific ethnic groups in the landscape. Thirty-five percent (681) respondents had not attended any school, 35.82% (692) had received at most primary education, 24.43% (472) respondents had received at most secondary education, and 4.19% (81) respondents have received higher education. Mean household size was found to be 4.49 persons. Farming and daily wage labor were the two major occupations employing nearly 60% of the people. Nearly seventy percent of the households were land holders and 59% owned livestock. Nearly 90% (1,736) households were dependent on various forest resources for their everyday requirements such as for fuelwood, fodder for livestock, food (fruits and fish), medicines, and raw material for house construction and repairs. Agriculture was the primary source of income and survival for 620 respondents (32%), followed by daily-wage labor (589 respondents, 30.49%). Only 7.92% (153) households reported to depend on forest resources for their livelihood directly or indirectly.

TABLE 3 | Characteristics of surveyed households.

Total respondents	1,932
Gender	Male = 1,210 (62.63%)
	Female = 722 (37.37%)
Education	Illiterate = 681 (35.25%)
	At most primary education = 692 (35.82%)
	At most secondary education = 478 (24.74%)
	Higher education = 81 (4.19%)
Occupation	Unemployed = 92 (4.76%)
	Cannot work = 71 (3.67%)
	Daily wage laborer = 589 (30.49%)
	Farmer = 620 (32.09%)
	Business = 59 (3.05%)
	Employed by forest department = 31 (1.60%)
	Private job = 29 (1.50%)
	Driver = 27 (1.39%)
	Government employee = 21 (1.08%)
	Earning through rent = 9 (0.46%)
	Grazer = 8 (0.41%)
	Eco-tourism = 3 (0.15%)
Mean family size	4.49 persons
Land holders	1,383 (71.58%)

Overall Attitude Toward Conservation

While conserving forest was important to 91% respondents, 71% respondents supported wildlife conservation and only 35% felt important to conserve tiger (**Figure 2**). Additionally, 70.13% (1,355) respondents thought that Forest and Wildlife conservation were important, 29.50% (570) thought Wildlife and Tiger conservation were important and 33.17% (641) thought Tiger and Forest Conservation were important. Twenty-eight-point nine eight percent (560) respondents expressed importance of conservation for all three and 1.44% (28) supported none of the three.

The chi-square test of independence found that there is a significant association between attitude toward forest conservation and tiger conservation X^2 (df = 1) = 5.84, p = 0.016 and between attitude toward wildlife conservation and tiger conservation X^2 (df = 1) = 16.36, $p < 0.001$.

Drivers of Attitude Toward Tiger Conservation

Socio-Economic Drivers

The "socio-economic model" at household level had four significant predictors ($p < 0.05$) (**Table 4**). According to the model, a person having a positive attitude toward importance of tiger conservation was positively related to gender (female) (ß = 0.292) and economic well-being index (ß = 1.052). In other words, females were more likely to support tiger conservation and a state of greater economic well-being at the household level was more likely to influence support toward tiger conservation. Higher education (ß= −0.816) and access to government schemes (ß= −1.112) had a negative influence in predicting attitude toward importance of tiger conservation (**Table 4**). At village level, according to the generalized linear model, four variables were found to be significant predictors ($p < 0.05$) of importance of tiger conservation within this category. Literacy (ß = 0.610), access to electricity (ß = 1.413), village economic diversity index (ß = 0.565) and poverty (ß = 1.566) was found to have a positive influence on support for tiger conservation (**Table 5**). This implies that higher literacy rate, higher number of electrified households, greater diversity of livelihood options was significant in enhancing support for tiger conservation. Additionally, it was found that villages that had a higher percentage of households below poverty line, expressed support for tiger conservation.

Ecosystem Values and Dependence

At the household level, the "ecosystem values and dependence model" had three significant predictors ($p < 0.05$) of importance of tiger conservation. According to the model, the higher the sense of wildlife ecosystem services in people, less likely it was that people were supportive of tiger conservation (ß= −1.004). Additionally, a person supporting tiger conservation was positively related to resource dependence index (ß = 1.905) and access to clean cooking fuel (ß = 0.453) (**Table 4**). At village level, three significant predictors were found in the generalized linear model for this category. Two of the variables- sense of forest ecosystem services (ß = 0.023), and resource dependence index (ß = 0.727) had positive influence on support for tiger
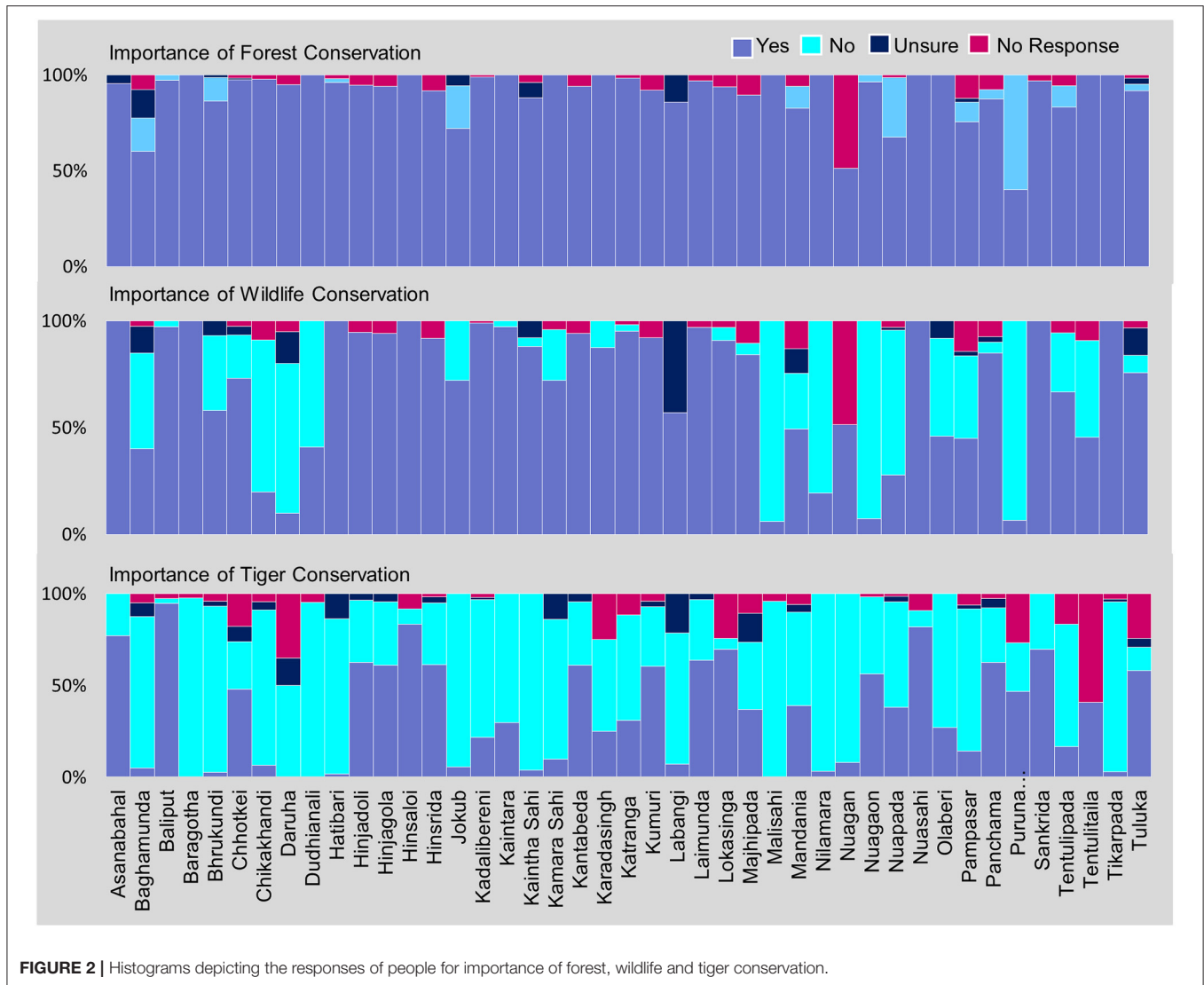
FIGURE 2 | Histograms depicting the responses of people for importance of forest, wildlife and tiger conservation.

conservation and one variable- income dependence index had a negative influence (ß = −0.275) (**Table 5**).

Relationship With Forest Department

In the third model describing relationship of people with forest department at household level, a person supporting tiger conservation was positively related to cooperation from forest department (ß = 0.683) and negatively related to restriction from forest department (linear) (ß = −1.409) (**Table 4**). We found the same variables to be significant predictors at the village level. The estimates of generalized linear model indicate that greater the cooperation from forest department higher the support for tiger conservation (ß = 1.145) and greater the restrictions from forest department lesser the support (ß = −0.347) (**Table 5**).

Losses and Fear

The logistic regression model for "losses and fear" category at household level indicates that a person supporting tiger conservation was negatively related to both fear for livestock (ß = −0.198) and previous experience of losses due to wildlife

(ß = −0.912) (**Table 4**). Among the four models at household level, this model was observed to have the highest model efficiency at 0.679. At village level, three variables were significant predictors of support for forest conservation. Villages with higher number of households having experience of losses due to wildlife (ß= −0.023), and fear for livestock (ß= −0.279) were less supportive of tiger conservation. On the other hand, villages wherein a higher percentage of people have expressed a concern or fear for movement in the forest were more supportive of tiger conservation (ß = 0.311) (**Table 5**).

Priority Villages for Future Community Engagement

Forty-three surveyed villages could be clustered into eleven distinct clusters (BSS/TSS = 0.78) based on socio-economic characteristics, four clusters (BSS/TSS = 0.67) based on their ecosystem values and dependence, two clusters based on their relationship with forest department (BSS/TSS = 0.28), five clusters based on the fears, concerns and losses experienced

TABLE 4 | Significant variables at household-level predicting attitude of local community toward conservation for category-wise sub-models using logistic binomial regression.

Significant predictor variables	Estimate (ß)	Standard error	z-value	p-value, significance level	e^ß (odds ratio)
MODEL 1: SOCIO-ECONOMIC (N = 1,465)					
Gender (GEN) (female)	0.292	0.127	2.298	0.021*	1.339
Education (EDU) (higher education)	−0.816	0.307	−2.655	0.008**	0.442
Economic well-being index (EWBI)	1.052	0.379	2.772	0.005**	2.863
Government schemes (SCHE)	−1.112	0.350	−3.173	0.002**	0.329
AIC (initial model) = 1937.676					
AIC (final model) = 1928.219					
Area under curve = 0.591					
Model efficiency = 0.623					
MODEL 2: ECOSYSTEM VALUES AND DEPENDENCE (N = 1,747)					
Intercept	−1.178	0.115	−10.200	< 0.001***	0.308
Sense of wildlife ecosystem services (WECO)	−1.004	0.284	−3.540	0.001***	0.366
Access to clean cooking fuel (LPG)	0.453	0.116	3.917	<0.001***	1.573
Resource dependence index (RDI)	1.905	0.248	7.684	<0.001***	6.719
AIC (initial model) = 2267.409					
AIC (final model) =2264.702					
Area under curve = 0.627					
Model efficiency = 0.623					
MODEL 3: RELATIONSHIP WITH FOREST DEPARTMENT (N = 818)					
Intercept	−0.557	0.114	−4.893	<0.001***	0.573
Cooperation from Forest Department (COOP) (L)	0.683	0.219	3.118	0.002**	1.979
Cooperation from Forest Department (COOP) (Q)	−0.427	0.217	−1.966	0.049*	1.050
Restriction from Forest Department (REST) (L)	−1.409	0.189	−7.447	<0.001***	4.091
Restriction from Forest Department (REST) (Q)	−0.521	0.201	−2.589	0.00963**	1.683
AIC (initial model) = 977.954					
AIC (final model) = 974.427					
Area under the curve = 0.691					
Model efficiency = 0.677					
MODEL 4: LOSSES AND FEAR (N = 1,747)					
Experience of losses (LOSS)	−0.912	0.275	−3.315	0.001***	0.402
Fear for movement (FFOR)	−0.198	0.111	−1.791	0.073	0.820
AIC (initial model) = 2330.403					
AIC (final model) = 2326.865					
Area under curve = 0.550					
Model efficiency = 0.610					

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05.
(L) indicates linear, (Q) indicates quadratic.

(BSS/TSS = 0.79), and six clusters (BSS/TSS = 0.85) based on their attitude toward conservation. Clustering was poorest based on the variables indicating relationship with forest department (BSS/TSS = 0.28), and best with variables indicating attitude toward conservation (BSS/TSS = 0.85).

DISCUSSION

Attitude of Local Community Toward Conservation

Our study attempts to reveal the post-translocation outlook of the local community toward the importance of tiger conservation in Satkosia Tiger Reserve, with implications in other similar sites across the tiger range countries. Understanding the community response was essential to devise future strategies to revive the tiger population augmentation programme. The local community has strongly expressed support for forest conservation with 91% of respondents attaching importance to it. In comparison to tiger conservation (35% respondents), more people have expressed the importance of wildlife conservation (71% respondents). An observed gap of roughly 50% in support for wildlife and tiger conservation could be attributed to several factors or their combination.

TABLE 5 | Estimates and significant variables at village-level predicting attitude of local community toward conservation for category-wise sub models using generalized linear regression.

Significant predictor variables	Estimate	Standard error	z-value	p-value, significance level
MODEL 1: SOCIO-ECONOMIC				
Literacy (LIT)	0.610	0.120	5.087	<0.001***
Electrified households (ELEC)	1.413	0.169	8.344	< 0.001***
Distance to facilities (DIST)	0.181	0.105	1.727	0.084.
Village economic diversity index (VEDI)	0.565	0.103	5.474	<0.001***
Poverty (BPL)	1.566	0.178	8.787	<0.001***
AIC (initial model) = 1252.291				
AIC (final model) = 1250.425				
MODEL 2: ECOSYSTEM VALUES AND DEPENDENCE				
Intercept	2.470	0.082	30.048	<0.001***
Sense of Forest Ecosystem Services (FECO)	0.023	0.002	12.308	<0.001***
Resource dependence (RDI)	0.727	0.143	5.075	<0.001***
Income dependence (IDI)	−0.275	0.114	−2.410	0.016*
AIC (initial model) = 1017.591				
AIC (final model) = 1015.503				
MODEL 3: RELATIONSHIP WITH FOREST DEPARTMENT				
Intercept	3.291	0.056	58.355	<0.001***
Cooperation from Forest Department (COOP)	1.145	0.102	11.225	<0.001***
Restriction from Forest Department (REST)	−0.347	0.104	−3.341	<0.001***
AIC (initial model) = 1328.452				
AIC (final model) = 1326.877				
MODEL 4: LOSSES AND FEAR				
Intercept	4.102	0.058	70.614	<0.001***
Experience of losses (LOSS)	−0.023	0.003	−9.178	<0.001***
Fear for livestock (FLIV)	−0.279	0.085	−3.288	0.001**
Fear for movement (FFOR)	0.311	0.082	3.772	<0.001***
AIC (initial model) = 1301.951				
AIC (final model) = 1301.951				

*Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05.*

Firstly, the social (local community) acceptance prior to translocation was not adequately assessed. Also, post-release attitudes may differ from the pre-release (Greenspan et al., 2020), pertaining to the negative or positive experiences the locals face (Ericsson and Heberlein, 2003). In Satkosia, the local communities in some villages experienced human attack, human death and livestock depredation and protested for the capture of one of the translocated animals. In the absence of such unfortunate incidents, we believe that there would have been a higher support for tiger conservation in the present study. Secondly, it is possible that poor economic condition of people has forced them into unlawful activities such as hunting for bushmeat or illegal entry into the forest for forest-resource collection. Tiger release and therefore better protection measures would restrict their hunting activities or affect their livelihood, projecting tiger release as a perceived loss (Shibia, 2010). Third reason could be the long absence of interaction of people with large carnivores has made the normal behavior of livestock predation by tiger appear as "problem animal" or a "nuisance" and the two incidents of human death reinstated the dangerous nature of tigers in people's mind (Kellert et al., 1996; Røskaft et al., 2007). The qualitative responses of people (optional remarks in questionnaire) revealed that people are supportive of translocation of tigers as long as tigers do not venture into human habitation. As some of the respondents expressed "Tiger is a carnivorous animal. As long as it stays in the forest, it is not a problem," "Don't release tiger. We are facing many problems." This also suggests that it is important to assess how accurately people perceive the risks, as an overestimation of risks by people could pull back support for conservation. Fourth, the attitude of local people could have been negatively influenced by incorrect or exaggerated reporting of events by local media (Houston et al., 2010; Arbieu et al., 2019; Hiroyasu et al., 2019) and among local people themselves (Klich et al., 2018). Education, community outreach, and awareness programs can help people understand the ecology and conservation practice and build up positive attitudes toward large carnivore conservation (Bath, 1989; Vaughan et al., 2003; Datta et al., 2008; Davies-Mostert et al., 2009; Pinheiro et al., 2016; Arbieu et al., 2019; Hiroyasu et al., 2019; Morehouse et al., 2020; Sampson et al., 2020).

Socio-Economic Drivers

The socioeconomic drivers at household and village level indicate that while literacy is an important variable at village level, people with higher education do not tend to support tiger conservation. While education in general has been known to be positively associated with attitude toward reintroductions (Williams et al., 2002), people with higher education are possibly better equipped to assess the costs and benefits associated with translocation and perceive it as non-beneficial. Also, the attitude of people was found to differ by gender, where women are more supportive of tiger conservation as compared to men, which is contrary to other sites where women are more apprehensive of tiger (Bhattarai and Fischer, 2014; Carter and Allendorf, 2016; Gray et al., 2017).

Ecosystem Values and Dependence

Both correlation values and logistic regression coefficients suggested that having a sense of appreciation for the benefits derived from forest influences the attitude of people in a positive manner. People who were only dependent for their everyday needs were more supportive (positive relationship with resource dependence index), while those who completely or partially depend on forest or wildlife for income generating activities lacked a similar perspective (negative relationship with income dependence index). It could be due to the fact that livelihood options offered by eco-tourism in Satkosia are fairly low and the tourism is mainly based on Gharial Research and Conservation Unit (GRACU) rather than tigers. People who did not see any direct benefits from tiger release or through eco-tourism, for themselves, did not find motivation to support tiger conservation (Lindsey et al., 2005; Digun-Aweto et al., 2020). This also explains the negative coefficient of sense of wildlife ecosystems services in predicting importance of tiger conservation. While people recognize provision of ecosystem services by wildlife in general,

they do not associate these services with tiger in the same way. At household level, people with access to clean cooking fuel (Liquefied Petroleum Gas-LPG) have acknowledged the importance of tiger conservation. Previous studies (Dash et al., 2018; Rahut et al., 2019) as well pair-wise correlation in our data suggests that the use of LPG is positively related with household economic well-being and education. Promoting education and introducing diverse livelihood options would not only enhance support for conservation but will also allow people to transition to cleaner fuel, promote well-being of women and reduces the frequency of visits to forest (Wan et al., 2011).

Relationship With Forest Department

Perceived restrictions by people in their day-to-day life by forest staff has a negative influence on support for tiger conservation. Present conservation approaches in India are primarily based on "restriction of access" that refute the idea of the coexistence of humans and tigers (Bijoy, 2011; Jain and Sajjad, 2016). Local communities residing in proximity of the forest depend on the forest for their living and livelihood due to poor economic condition and lack of opportunities. While the restrictions on entry cannot be revoked due to protection status of the tiger reserve, changes in management strategies can improve the relationship between people and forest managers (Allendorf et al., 2012). On the other hand, people who felt more cooperation from forest department and have received monetary compensation for losses were found to be more supporting of tiger conservation. In some cases, the delays are perceived, given that there is no mechanism to inform the claimants as soon as they receive the compensation amount. Devising innovative ways to make compensation process smoother and affordable for residents of remote villages would strengthen the trust of people in the management.

TABLE 6 | Suggested priority villages for future community engagement and interventions, specific to each category.

Category	Priority clusters	Cluster description	Priority villages
Socio-economic	Cluster 1 and 10	Low literacy rate, low village economic diversity and fewer electrified households	Jokub, Majhipada, Olaberi, Pampasar, Puruna Kantabeda
Ecosystem values and dependence	Cluster 2	High resource and income dependence on forest, poor sense of forest ecosystem services, poor access to clean cooking fuel	Bhurkundi, Chhotkei, Katrang, Labangi, Majhipada, Pampasar, Tulka
Relationship with Forest Department	Cluster 2	Rarely received compensation, poor satisfaction with compensation, but low sense of restriction of daily activities.	Asanbahal, Baghamunda, Baliput, Baragotha, Bhurkundi, Chikankhandi, Daruha, Dudhianali, Hatibari, Hinjadoli, Hinjagola, Hinsaloi, Hinsrida, Jokub, Kadalibereni, Kaintara, Kaintasahi, Kamarasahi, Kantabeda, Karadasingh, Katrang, Kumuri, Laimunda, Lokasingha, Malisahi, Mandania, Nilamara, Nuagan, Nuapada, Nuasahi, Olaberi, Pampasar, Panchama, Puruna Kantabeda, Sankrida, Tentulipada, Tuluka
Fear and Losses	Cluster 1	High losses and fear for livestock and movement in and around village	Baliput, Baragotha, Bhurkundi, Chhotkei, Daruha, Dudhianali,Kardasingha, Katrang, Labangi, Malisahi, Nilamara, Nuagan
Attitude toward conservation	Cluster 6	Support forest and wildlife conservation but do not support tiger conservation	Baragotha, Hatibari, Kadalibereni, Kaintara, Kaintasahi, Kamarasahi, Karadasingh, Katrang, Majhipada, Tikarpada

Losses and Fear

Nearly 70% households owned livestock and 4.4% had lost their animals due to carnivores. Fear for the loss of livestock emerged out as significant driver of attitude toward tiger conservation. When the livelihood of people is linked with livestock, they are less tolerant of carnivores (Mishra, 1997; Patterson et al., 2004; Frank et al., 2005). Fear for their own lives upon tiger release also affects support negatively (Hiroyasu et al., 2019). In our study site, 15.5% households had experienced attack by wild animals and 0.7% had experienced death of a family member. Constant fear to venture into the forest and roaming within the village may be psychologically detrimental with sudden appearance of tigers in the landscape and requires dedicated management interventions to address both actual and perceived fears. As some respondents expressed their concerns "Tiger Conservation is dangerous for human life," "Provide us protection, and then release tiger," "Release of tiger is better, but it should not harm us." In addition to the psychological aspects of loss or perceived risks, experience of losses due to wildlife has a negative influence on people's attitude toward conservation (Shibia, 2010; Best and Pei, 2018). Crop depredation was experienced by 75.1% households and 15.6% households were affected by damage to their property. While these losses cannot be attributed to tigers, it has an indirect negative influence on tiger conservation. Besides its effect on the livelihood, negative emotions and stress involving the uncertainty of receiving compensation are important issues to address.

Prioritization for Future Community-Engagement

Priority village clusters were identified based on the regression models at village level under each category (**Table 6** and **Supplementary Table 2**). Under socio-economic category, villages with low literacy rate, low economic-diversity and a smaller number of electrified households were suggested for future interventions related to better education facilities, alternate livelihood options and access to electricity (**Table 6**, **Supplementary Table 2**, **Supplementary Data Sheet 4**). For ecosystem values and dependence category, village cluster with a higher dependence on forest for resources and livelihood, but a poor sense of forest ecosystem services was prioritized for education and sensitization programmes that would allow people to understand the linkages between conservation, livelihood and human well-being (**Table 6**, **Supplementary Table 2**, **Supplementary Data Sheet 4**). Village cluster with a lack of sense of cooperation from forest department, an experience of gaps in receiving compensation and an overall lack of satisfaction from compensation were prioritized in the third category- relationship with forest department (**Table 6**, **Supplementary Table 2**, **Supplementary Data Sheet 4**). Under the fourth category, villages with higher number of households that have experienced losses due to interaction with wildlife and have expressed fear for their livestock and their own life, can be prioritized for counseling and workshops aimed at addressing their concerns (**Table 6**, **Supplementary Table 2**, **Supplementary Data Sheet 4**). For the fifth category indicating attitude toward conservation, cluster of

villages that think forest and wildlife conservation are important, but tiger conservation is not, can be engaged in awareness and education sessions specifically aimed at tiger behavior, biology and translocation education (**Table 6**, **Supplementary Table 2**, **Supplementary Data Sheet 4**).

Synthesis

There are various instances of community-based conservation being successful facilitated by multiple factors (Bajracharya et al., 2005; Brooks et al., 2013; Western et al., 2015; Morehouse et al., 2020). In the present case, promoting education along with conservation awareness measures would be effective for community-based conservation. Because nearly entire surveyed population depends on forest for fuelwood, assisting the local communities in having access to clean cooking fuel will considerably reduce the frequency of visits to forest, forest degradation and promote well-being of women. As our study highlights the importance of intangible factors, for example, previous losses due to wildlife, perceived restrictions and concern for own life influence community attitudes. Therefore, organizing awareness and counseling camps, especially for people who have suffered losses previously and whose livelihood is affected, should be adequately considered. Lastly, considering the conservation importance of the reserve and possible future translocation it will be important to integrate a shared vision and aspirations of the forest management and the local communities.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**. Further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Training, Research and Academic Council (TRAC) of Wildlife Institute of India, Ministry of Environment, Forest and Climate Change, Government of India. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

VV: conceptualization, methodology, data collection, formal analysis, software and visualization, writing-original draft, and writing-review and editing. RP and PK: conceptualization and methodology, funding acquisition, resources, project administration, and supervision. RP: conceptualization and methodology, and writing-original draft and review. GB: data collection. RK: conceptualization and methodology, funding acquisition, resources, project administration and supervision, and writing-review and editing. All authors contributed to the article and approved the submitted version.

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