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Human dimensions of animal translocations

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Human dimensions of animal translocations

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Editorial: Human dimensions of animal translocations

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Editorial on the Research Topic
Human dimensions of animal translocations

Introduction

Conservation translocations are intentional movements of wildlife for conservation purposes (IUCN 2013). They are widely used management interventions that offer solutions to wicked problems: reversal of dramatic population declines, local extinction of species, defaunation and empty forests, and wildlife restoration. As such, translocations are inherently complex and are most effective as part of a broader long-term integrated conservation effort.

Human dimension considerations include human-wildlife interactions (HWIs) customarily treated as human-wildlife conflict but we also consider positive interactions; (2) relationships among stakeholders and the conservation network that creates the social milieu that influences governance and the perception of success or failure, and local community engagement and participation; (3) perceptions, values and ethics of stakeholders and local community; (4) issues about profits and other benefit sharing (such as ecotourism or wildlife watching revenues); and (5) planning, exiting, and the decision-making framework for translocations. Human dimensions are dynamic and influenced by context and by previous experience, trends in society, and individual processes.

International biodiversity conservation conventions encourage the use of conservation translocations to restore populations of native species (see Bern Convention (1979), Article 11(2); and CBD (1992), Article 9(c)). They provide key actions to help achieve recovery goals and targets of the post 2020 Global Biodiversity Framework (CBD, 2021). Although the IUCN's guidelines for conservation translocations state that to establish a viable, free-ranging population in the wild it is necessary to enlist public support (IUCN/SSC 2013), considerations for human dimensions are often not well recognized or accounted for during implementation of these endeavors. Nevertheless, overlooking or treating such aspects lightly may jeopardise the success of the translocation project.

The study of human dimensions requires multidisciplinary integration of knowledge systems. Formed in 2018, the Human-Wildlife Interactions Working group of the IUCN/SSC Conservation Translocation Specialist Group (CTSG) aims to develop networks and collaborations, to provide advice to projects in all stages of development, and to support

and inform the IUCN Conservation Translocation Guidelines. This special issue is part of our goal to promote discussion and share evidence, to aid practitioners in finding solutions to restore biodiversity.

The articles

Achieving success in conservation translocations requires developing long-term relationships with groups of interest, rooted on built understanding of context-specific interactions between people, groups and project. The practice review article by the HWIWG, *Guidelines to Facilitate Human-Wildlife Interactions in Conservation Translocations*, outlines a framework for taking into consideration human dimensions across all stages of the project life cycle: planning, initiation, implementation, ending stage, and post-exit (Consorte-McCrea et al.). The perspective article *Evolving Our Understanding and Practice in Addressing Social Conflict and Stakeholder Engagement Around Conservation Translocations* argues for the use of a Conservation Conflict Transformation approach to underpin such relationship building and recommends a "Levels of Conflict" model for the analysis of social conflict (Glikman et al.).

Direct human-wildlife interactions and conflicts were treated in four articles. The research article, *Assessment of leopard translocations in South Africa*, focusses on the role of translocations in mitigating human-carnivore conflict, and evaluates the success of 60 leopard translocation events (McManus et al.). Findings suggest translocations benefit from the use of protocols and of non-lethal alternatives to address human-carnivore conflict. *Paradox of Success-Mediated Conflicts: Analysing Attitudes of Local Communities Towards Successfully Reintroduced Tigers in India* examines the socio-economic drivers of the attitudes of local communities towards the reintroduced tigers in the Panna and Sariska Tiger Reserves (Malviya et al.). Their findings reinforce a need for community engagement, particularly of women and the elderly. In *Factors Influencing People's Response Toward Tiger Translocation in Satkosia Tiger Reserve, Eastern India* attitudinal research investigates the concerns and issues of the local communities towards the carnivore translocation programme, as part of an adaptive management strategy (Vasudeva et al.). They recommend that the needs of villages and landscape be addressed by context-specific interventions. Finally, the issue of public perception of translocations of "problem animals" is explored *via* analysis of institutional social media profiles in the paper *Social repercussion of translocating a jaguar in Brazil* (Martins et al.).

Social perceptions and community involvement were two other overarching themes covered by the articles from different methodological approaches. After 20 years of one of the first beaver reintroduction to the UK, following a 400 years' absence, the research paper *A glimpse of the long view: Human attitudes to an established population of Eurasian beaver (castor fiber) in the lowlands of south-east England* investigates local attitudes towards its presence, and perceived benefits and impacts (Oliveira et al.). The article, *Human Dimensions of the Reintroduction of Brazilian Birds*, analyses the inclusion of community engagement in various bird National Action Plans, Brazil´s strongest governance tool for endangered species developed by the Chico Mendes Institute for Biodiversity Conservation (Martins et al.). The power of integrating tools of wildlife ecology and social science to examine the feasibility of translocation for population reinforcement is demonstrated in *When Ecological Analysis Reveals Hidden Human Dimensions: Building on Long-Term Community Participation to Enable a Conservation Translocation of Mountain Bongo in Kenya* (Sheppard et al.). The study of local perceptions of the factors affecting the outcomes of wildlife translocation into a community conservation area was used in the article *Stakeholders' Perceptions of the Outcomes of Translocated Eland in Nyae Nyae Conservancy, Namibia* to highlight the complexities that are not experienced by reintroductions in state protected areas (Lendelvo et al.).

Where to go from this?

The articles published in this Research Topic address several topics of the Human Dimension of animal translocations in various countries. They show the diversity of approaches and tools available to address Human Dimension issues, and their application to specific cases. Collectively, they demonstrate how human dimensions are crucial to evaluate feasibility of a project and the likelihood of success after implementation. We hope the collection shows the significance of Human Dimensions for Translocation and fosters interest for further study and to incorporate these considerations into all phases of translocation projects. We see this publication as a starting point to foster more discussion, research or inclusion of these themes in animal translocations.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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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

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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

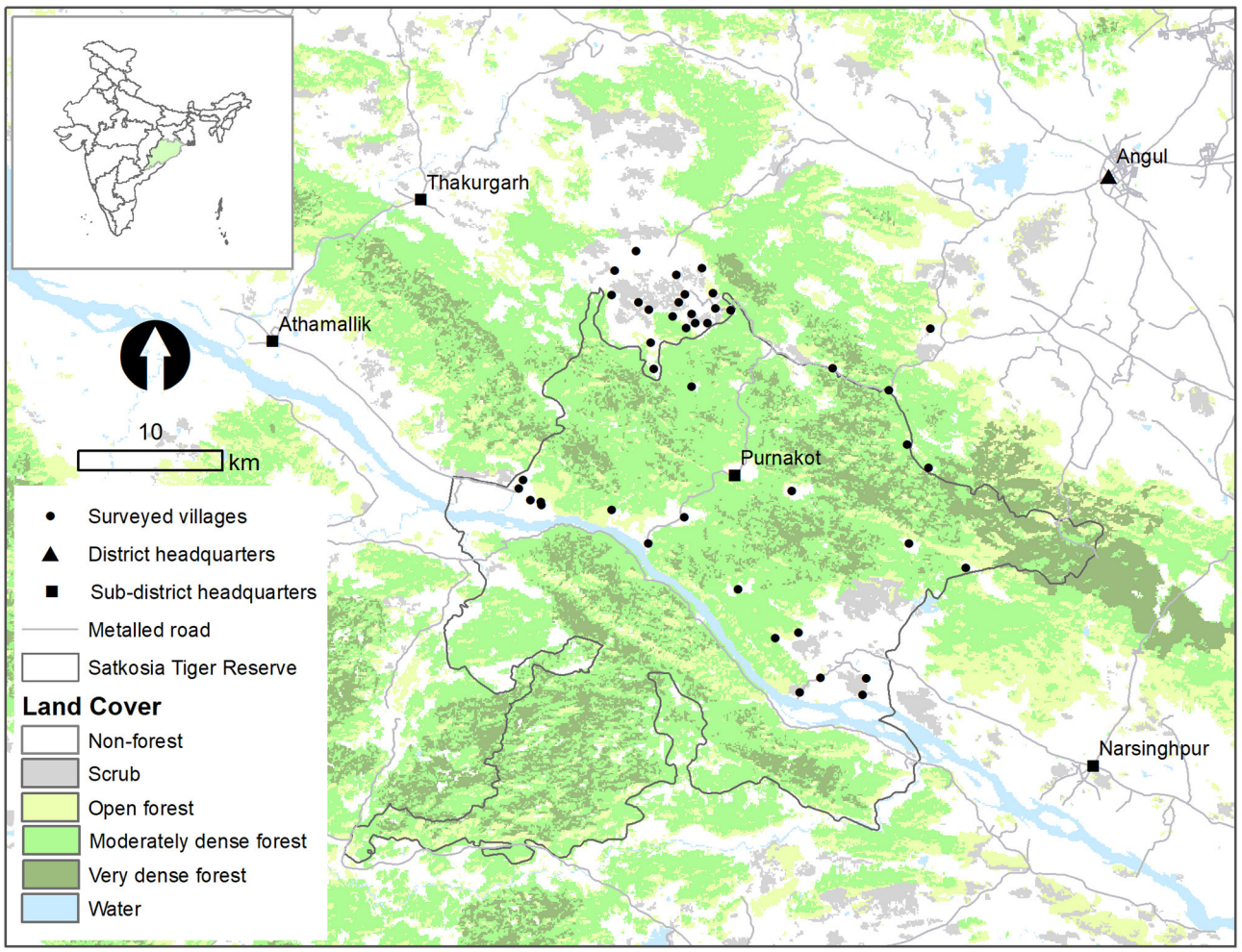

FIGURE 1 | Location of Odisha in India and location of surveyed villages around Satkosia Tiger Reserve.

(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

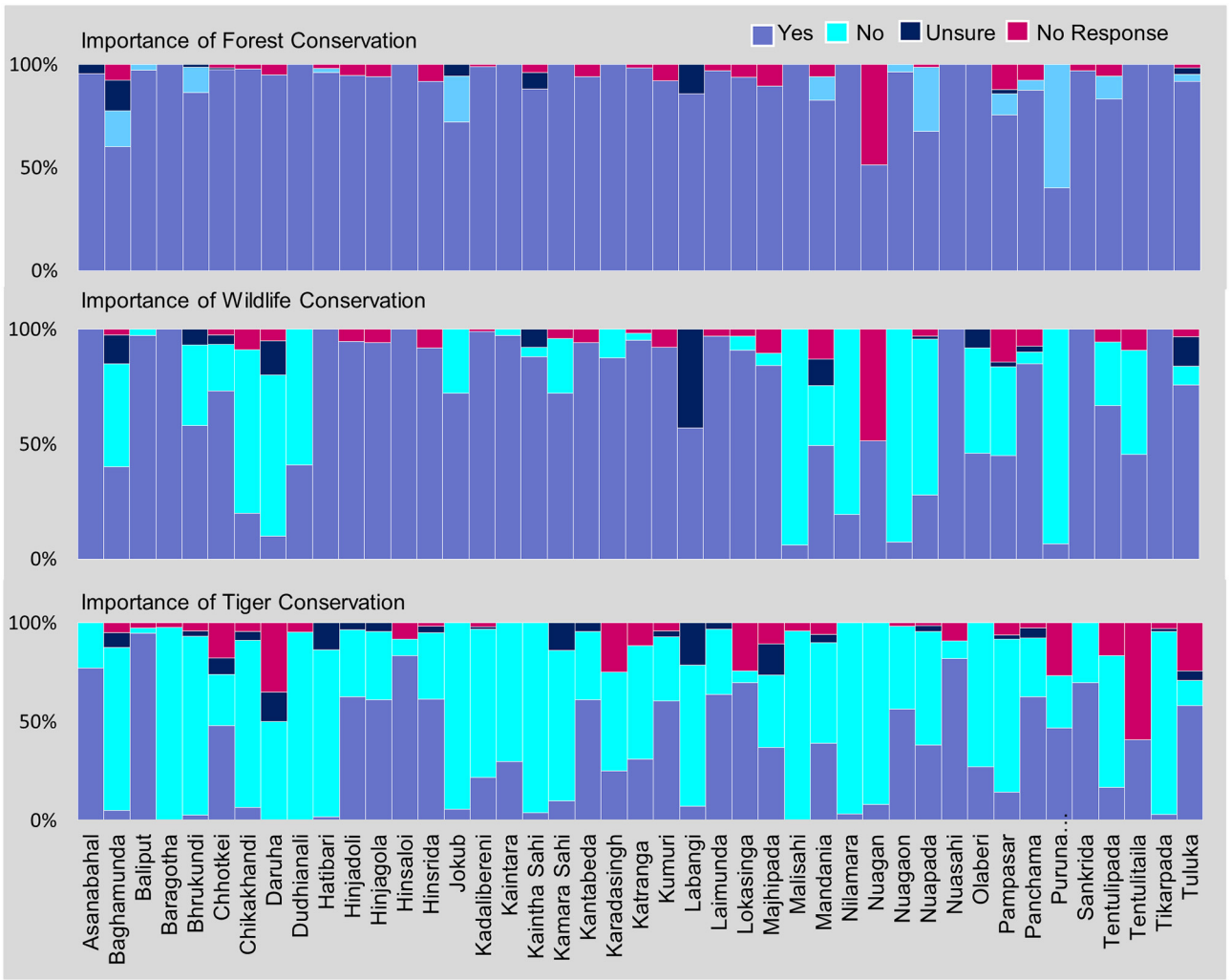

FIGURE 2 | Histograms depicting the responses of people for importance of forest, wildlife and tiger conservation.

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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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcosc.2021.664897/full#supplementary-material

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Social Repercussion of Translocating a Jaguar in Brazil

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The translocation of "problem-animals" is a common non-lethal strategy to deal with human-wildlife conflict. While processes of wildlife translocation have been widely documented, little is known about the social repercussions that take place once the capture and the return of a problem-animal to its natural habitat fail and it has to be permanently placed in captivity. We investigated how the public, an important stakeholder in wildlife conservation, perceived the translocation of a female jaguar to a wildlife captivity center. The objectives were to (1) assess the public's perceptions (e.g., attitudes, emotions, awareness) toward the jaguar and its translocation process, and (2) how these psychological constructs are related. We used the social media profiles of the three institutions involved in the process (one responsible for the jaguar rescues, one that supported its recovery, and the one responsible for the jaguar's final destination) and analyzed the comments left by their followers on posts related to the jaguar and the translocation itself during 25 days. A total of 287 comments were analyzed through coding, a categorizing strategy of qualitative analysis; 33 codes were identified. Results showed high admiration for the work done, positive attitudes and emotions, and concern toward the animal. Lack of awareness about the translocation process was high, with comments of curiosity toward the situation being one of the most commonly found. To a lesser extent, people felt sad for the jaguar not being able to return to the wild and criticized the need for translocation. Admiration for the work had a strong relation with gratitude and broader positive perceptions toward the jaguar's story. Criticism related to concern, which was also related to a need for more information and curiosity. Our findings suggest that the public who engaged with those institutions through their Instagram accounts were grateful for seeing the jaguar safe, but were not aware of the complexity of the operation nor about the nature of the conflict with farmers. The public can either reinforce a particular action or jeopardize an entire operation, depending on their perceptions of the matter. In the case of this jaguar, the public held a positive view; however, we acknowledge the limitations of our sample and recommend further analyses

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of social repercussions among people who are not followers of these organizations. Furthermore, we recommend engaging other stakeholders to fully understand the human dimensions of translocating this jaguar. Finally, for social acceptance, we highlight the importance of transparency and reliability of the organizations operating the translocation.

Keywords: social media, human-wildlife conflict, conservation institutions, public impact, code analysis

INTRODUCTION

Human-wildlife conflict (HWC) is a growing worldwide issue, receiving great attention not only by conservationists and researchers, but by society in general (Frank et al., 2019). The proximity between people and wildlife and the challenges that it imposes on both parts has reached such extended levels that it is impossible to promote conservation without taking the social aspects into account (Manfredo, 2008). A growing human population, coupled with agricultural and urban expansion, has contributed to human-wildlife encounters that oftentimes leads to conflicts. These conflicts may take the form of direct interaction with humans, which can result in injuries or fatality to either the animal or the human, or more indirectly, when crops are damaged or livestock are injured or killed by the predator. In both cases, when the animal escapes and continues causing problems, retaliation is often the strategy adopted to deal with the situation. Lethal control of "problem-animals," however, is polemic, often illegal (when done in the form of poaching), and contributes to the decline of the species population in the wild, exacerbating the problem (Bergstrom, 2017).

A common non-lethal strategy to deal with human-wildlife conflict is the translocation of problem-animals (Weise et al., 2014; Nyhus, 2016; Berger-Tal et al., 2020). Translocation refers to the process of capturing, moving and releasing an animal from an area to another for the purpose of conservation (Linnell et al., 1997; Craven et al., 1998; Berger-Tal et al., 2020). Intended to reduce conflicts, this non-lethal strategy is typically well-accepted among the public (Linnell et al., 1997). The problem, however, arises when the animal keeps returning to the conflict area. In sound situations, wild animals can sometimes be relocated to wildlife sanctuaries and kept in captivity for the remaining of their lives.

In the Caatinga domain, a Seasonally Dry Tropical Forest located in Northeast Brazil, conflicts between humans and carnivores are marked by a strong and historical secular tradition of free-grazing livestock, and are mostly related to the depredation of domestic animals, generally resulting in the persecution and slaughter of jaguars (*Panthera onca*) and pumas (*Puma concolor*) (da Silva et al., 2017). A recurrent event of depredation within the Environmental Protected Area of "Boqueirão da Onça," located in the north of the state of Bahia, resulted in two apprehensions and rescues of a 12-years old female jaguar (later named *Luísa*). Different people and institutions were mobilized for the translocation of this animal, but the return of the jaguar to the wild was not successful; mainly due to the advanced age of the jaguar and its repeated behavior of predating domestic animals. According to local authorities involved in this endeavor, after careful analysis of the situation it was decided to translocate the jaguar to a legal wildlife captivity center. Based on the definition of translocation, we consider "a translocation effort" every time that the jaguar was captured and moved to another area, different from the location where it was captured.

While the success, or failure, of translocating an animal has been widely documented (e.g., Weise et al., 2014; Berger-Tal et al., 2020; Hoogesteijn et al., 2020), little is known about the social repercussions of removing (i.e., translocating) a problem-animal from the wild and placing it in captivity to avoid further conflict with humans and potentially a premature death; particularly among those who financially support the organizations involved in the process. Wildlife conservation is intimately related to interpersonal relationships (Manfredo, 2008). Thus, identifying, describing, and understanding the human dimensions of wildlife translocation is paramount to an appropriate, ethical and conciliatory management.

The objectives of this paper were to assess the public's perceptions (e.g., attitudes, emotions, awareness) toward the jaguar and its translocation process, and how these psychological constructs are related. The public in this case refer to those people who do not necessarily live in the community or region where the conflict happened (as locals were already involved in the process since the beginning; details in the Case Study description), but people who support the organizations involved. With the growing popularity of the internet and the potential impact of media on public perceptions and awareness of wildlife (Wu et al., 2018), social media has become a useful source to examine public views on wildlife issues (Fidino et al., 2018). We used comments left on Instagram posts published by the three organizations involved in the translocation of the jaguar (one responsible for the jaguar rescues and decision-making of every taken step of translocation, one that supported its recovery, and the one that became the jaguar's final destination) to analyze the social repercussions of this translocation case. This is the first time that certain aspects of translocating this jaguar have been analyzed through a human dimensions' lens.

Case Study—A Jaguar in the Brazilian Caatinga

The Caatinga, a highly diverse Brazilian semi-arid region, is home to the largest feline in the Americas, the jaguar, whose population is fragmented and declining, mainly due to habitat loss and hunting in retaliation for depredation on goats and sheep (de Paula et al., 2012). The environmental conditions in the Caatinga, such as high air and soil temperatures, irregular rainfall, thorny and deciduous plants, and water scarcity result in adapted and resilient fauna, flora and local people (known as *sertanejo* in

Portuguese). This scenario, intensified by economic, educational, and health challenges along with lack of governmental assistance (Martins et al., 2021), perpetuated a rural economic base sustained by extensive goat and sheep farming and small-scale agriculture. This was inherited from the colonial system with the sugar mills (large slave-owning properties with sugar cane plantations for processing and producing sugar and *aguardente*) in the coastal cities. The *sertões* served as the yard for the livestock of these sugar mills' owners in the dry season, when the *vaqueiros* (cowboys) commitment was to drive livestock into hinterland and its highlands, where it would stay for grazing in the wild for 5 or 6 months. When the sugar engines lost their economic prominence, the *vaqueiros* lost their role, left embedded in something like a nomadic state-of-mind and able to replicate the model of free-ranging for the rough cattle he could afford: goats and sheep (Andrade, 1963). Jaguars and *sertanejos* have learned to live in the Caatinga, taking advantage of its resources and sharing the territory. Despite sharing the same environment, their relationship, however, is not of harmonious coexistence, and the imbalance of this relationship is the great generator of HWC.

The Northeast region of Brazil is the one that historically and culturally presents the greatest hunting pressure (Bragagnolo et al., 2019). It is also one of the inland regions with the greatest potential for renewable energy as wind and solar plants (Neri et al., 2019). The increasing development of these renewable energy projects modifies the habitat and behavior of these cats, by clearing vegetation, opening roads, excessive artificial light, intense circulation of people and vehicles and noise from turbines (Helldin et al., 2012). These factors combined with a decline of the jaguar's natural prey and the presence of free-ranging herds, contributes to an increase in livestock depredation events and consequently retaliation. Thus, programs and projects to reduce livestock depredation by large felines and the consequent retaliatory killing are crucial to short and long-term mitigation actions.

The female jaguar was rescued twice from caves (dolines), after being cornered and trapped by local residents for preying on sheep. The team from the *Programa Amigos da Onça* (PAO), a regional program of a Brazilian NGO and *one* of the institutions analyzed in this study, was contacted to help in the situation. Due to the complexity of the mission, the team mobilized in the first rescue (in two attempts) involved 12 professionals from different areas and it took 22 days to capture the jaguar. Very weakened by being held for a long time without food and water, the jaguar was immediately taken to an enclosure in the nearest wild animal rehabilitation center (Cemafauna/UNIVASF-Caatinga), where its sex, age, and physical condition were assessed. Community engagement began at this stage, which proved to be of paramount importance for the jaguar's post-devolution survival in the wild. On the occasion, the residents were gathered several times to be informed about the situation and oriented by one team member of PAO about the importance of adopting actions that would allow the coexistence with jaguars and pumas in the region. After 2 months of rehabilitation, it was decided to return the jaguar to the wild, fitted with a GPS-satellite collar for remote monitoring. The release of the jaguar was carried out about 18 km from the point of its rescue, in an area of caatinga vegetation.

After 4 months of telemetry monitoring, the jaguar movements were again close to the areas where the domestic herds grazed in the native vegetation. Some frightening devices were undertaken at the location, making use of primary repellents as alternative measures in preventing depredation and damage to livestock (Shivik et al., 2003; Gese, 2006). In addition, a farmer close to the area where the jaguar was passing by was instructed by the personnel responsible for monitoring it to confine his sheep for a month. Despite the extreme investment effort due to the unbearable cost of feed for the locals, the farmer complied with the suggestion. These combined actions were aimed at keeping the jaguar away and avoiding retaliation in case of further attacks. The preventive actions, however, were not effective to deter the jaguar from preying on the local herds and the PAO team was contacted again by locals to rescue the jaguar from another nearby cave. A team of eight professionals was mobilized for a second rescue and the weakened jaguar was captured after 15 days of imprisonment. After a new evaluation, a generalized oral infection was identified in the jaguar and two specialists from *AMPARA Silvestre* were sent to perform the treatment. It was necessary to decide its destination after the recovery. Considering its physical conditions, its age, the specific environmental characteristics of the Caatinga and the persisting conflict with livestock farmers, the team involved with the case decided to keep the jaguar in captivity. As final destination, the jaguar was sent to *NEX Institute*, a wildlife captivity center, with the authorization of the Chico Mendes Institute for Biodiversity Conservation (ICMBio), a national agency linked to the Ministry of Environment and responsible for wildlife management and protected areas. Therefore, Luísa became the only jaguar of Caatinga kept in captivity, making it a valuable resource for science as a reservoir of a genetic heritage of a poorly known population.

This jaguar represents many other jaguars (and pumas) in the Caatinga, sharing territory with the local communities of *sertanejos*, and bringing challenges to *in situ* conservation efforts for the species. The conflicts with big cats are not easy to solve and involve ethical issues with different scenarios, social groups and institutions. Although the jaguar has not been able to return to the wild, the success in this particular case lies primarily in its survival and also in the engagement between the PAO team and the community over the years, showing mutual trust and cooperative work.

METHODS

Data Collection

The social media repercussions of a jaguar translocation was analyzed from three different Instagram profiles: (1) *Programa Amigos da Onça: grandes predadores e sociobiodiversidade na Caatinga* (PAO), of the Institute for the Conservation of Neotropical Carnivores, which works with the conservation of big cats in Caatinga biome and was responsible for organizing the jaguar rescues in partnership with other environmental institutions, companies, fire brigade and army, as well as its

health care and final translocation; (2) *AMPARA Silvestre*, a Civil Society Organization of Public Interest (acronym OSCIP in Portuguese) responsible for the jaguar's specific health treatment and translocation for the permanent captivity; and (3) *Instituto NEX—No Extinction*, a NGO that maintains specimens of native wildlife in captivity for carrying out and subsidizing conservation programs, and that received the legal guard of the jaguar in permanent captivity in the Midwest Brazil.

All three profiles created social media content (*posts*) on Instagram in February of 2021, when the jaguar was translocated from Northeast to Midwest Brazil. NEX and AMPARA did the first post on February 6th, when the jaguar started its journey to the center, while PAO did the first publication about the jaguar on February 14th, 1 week later. The publications created by PAO were made in a series of four posts, one per day, reporting the whole detailed story about the jaguar, including the two different rescues, the treatments that it received, the difficulties of capturing it, the jaguar releasing attempt, the communities involved with the jaguar and its final destination to permanent captivity at NEX. The post also mentioned the reasons for not returning the jaguar to the wild. AMPARA created only one post on February 6th telling a short story about the jaguar's trajectory, translocation, and final destination to captivity at NEX. This institution (NEX) created several posts about the jaguar, most of them focused on leveraging money for its new inhabitant. The first post, on February 6th, was about the jaguar traveling and anticipated arrival to its new home. Due to the large number of posts created by NEX related to the jaguar case, we selected the first five made during a 7-day interval (from February 06th to February 12th).

The subject of this study was the general public represented by the followers of the Instagram profiles of the three institutions considered in the translocation of the jaguar. No connection was established between individuals' Instagram profiles and reactive comments to the institution's posts. Moreover, to keep the subjects anonymous and follow the ethics requirements, no data from the Instagram profiles was collected, we have only assessed the origin of the commenters (national or international). For the purpose of this analysis, we only considered comments left until March 02nd, 2021—about 15 days after the last post made by PAO—accounting for 25 days in total. Hence, we analyzed comments from a total of 281 different profiles, 279 national and written in Portuguese and two internationals written in Spanish. From this total, 22 profiles commented on PAO, 86 on AMPARA, and 173 on NEX posts. Two profiles commented both on PAO and AMPARA posts, while 12 profiles commented both on AMPARA and NEX posts, and three commented both on PAO and NEX posts. The comments and replies made by the original Instagram profiles (PAO, AMPARA, and NEX) were not analyzed, nor were the comments containing just "emojis" (varied small images, symbols or icons used for electronic communication to express the emotional attitude of the writer, without the need to use words). Thus, we analyzed a total of 287 comments (23 from PAO, 58 from AMPARA, and 206 from NEX).

Social Repercussion Analysis

We analyzed the comments following a categorization strategy of qualitative analysis, called coding, in the software Atlas.ti 9.0 (Scientific Software Development GmbH). This method organizes data based on similarities and differences in relation to the subjects of interest, being useful to organize and compare the data and to know which topics appear in a speech (Maxwell and Miller, 2008; Maxwell, 2012). Firstly, we transcribed faithfully all comments (except the ones with only emojis) in three Word documents, each document according to each institution. Then these documents were imported by the software Atlas.ti and we began the process of coding. Initially, we created citations for each written comment and then we attributed one or more codes for each citation. Codes are substantive categories that describe concepts and beliefs of the subjects of the study. These substantive categories are topics closed to data that help to understand ideas of the participants and the researchers. The codes were then grouped into organizational categories that represent broader subjects of research interest (Maxwell and Miller, 2008; Maxwell, 2012). For instance, "financial support" was a substantive category created inside the organizational category called "engagement." There were no predetermined codes before the analysis began, so we decided to create both codes and groups of codes during the analysis according to the characteristics of the comments and the subjects that appeared. For instance, the sentence "Thanks for the attention, this episode is very sad, congratulations to all those who were involved" received the codes "gratitude," "sadness," and "admiration for work." Thus, we didn't prioritize any sentence or concept. All the sentences were analyzed and received at least one code. This process of coding was done by three authors simultaneously, so we could discuss the concepts according to the sentences in order to avoid misunderstandings. We read the sentences together and then each one spoke which code should be used, or if a new code appeared and should be created. We then discussed until we reached an agreement and codified the citation. This process was also important to avoid the subjectivity of only one researcher. We then evaluated the social repercussions of the translocation by analyzing the frequency of each code (the number of citations codified with it) and the content of them.

In order to assess how participants' reactions and beliefs interact and the relationship among the topics of social repercussion, we performed an analysis of co-occurrence of codes. This is a function of analysis in Atlas.ti that shows which codes appear simultaneously in the same citation/sentence, as well as the frequencies of these co-occurrences. It is possible to select one or more specific codes to check its co-occurrence with other codes, or select all codes. In this case, we chose to verify the co-occurrence among all the codes, because we didn't have a specific interest in a particular code. The software enables us to create a co-occurrence table (**Supplementary Table S1**), in which we can visualize the frequencies of co-occurrence among the codes, and also a Sankey diagram to graphically represent these relationships. We present here the Sankey diagram, which makes it easy to visualize the associations among the codes. Once the table is created, the cell representing the co-occurrence of codes

is filled with the number of times the codes occurred together. In the Sankey Diagram, this co-occurrence will be represented by an edge, and the codes will be represented by nodes. The width of the edge is proportional to the quantity of frequencies of co-occurrence.

RESULTS

It is important to note that our results strictly represent the comments that were made about the specific posts of each institution, in the time period cited in the methodology. We categorized 33 codes, which were distributed in eight organizational categories (group of codes): admiration, attitude, characteristics of the jaguar, emotions and feelings, engagement, perception, criticism, and information (**Table 1**).

The frequency of all codes is listed in **Figure 1**. Admiration toward the institutions' work was, by far, the code with the highest number of citations (104 times). Comments like "congratulations" and "wonderful work" were the most cited in this category, which related to the other five codes that had the most significant presence: "hope" (46 citations), "curiosity" (45 citations), "positive perception" (38 citations), and "gratitude" (32 citations). "Hope" was related to the expectations about the future of the jaguar. For instance, comments like "good luck" and "a long and happy life for her" [referring to the jaguar] were frequent in this category. In the category "curiosity," all the questions about the jaguar's situation, its story and possible ways to help were coded.

A frequent question was if the jaguar would return to the wild and why it was unable to feed by itself, and what had happened to its teeth. "Positive perception" was related to the reactions toward the jaguar's story, which was described in the posts. In this category there were comments like "fantastic story" and "amazing." There were no negative perceptions about the jaguar's story, but we computed nine comments that were coded as "negative perception," all of them related to humankind, like "planet Earth would be thankful if that kind of people was completely extinct" [referring to those who pursue and poach jaguars]. The fifth most frequent code, "gratitude," was related to people who were thanking the institutions: "Thank you for your dedication and love to these beautiful animals."

"Welcoming" (25 citations) and "nominations" (23 citations) also had an expressive frequency. "Nominations" was a code included in the category called "characteristics of the jaguar," that was related to all the words used in reference to the jaguar Luísa, like warrior, darling, beloved, brave, precious and poor thing. We found that within this variety of adjectives used by people to describe the jaguar, "warrior" was the most cited.

The codes "concern," "information," and "financial support" came eighth in the general frequency of codes (18 citations each). The code "information" was related to all kinds of informative contents posted by people, like details about the institutions, the jaguar's story, the species, the Caatinga biome, etc. It occurred only in posts posted by NEX. In general, we found that these comments were a way to interact with the institution and with other followers, as sometimes comments were responses to the questions of others. The third emotion most codified in the category "emotions and feelings" was "concern." After "hope" and "gratitude," people expressed in various comments their concern about the jaguar's health and safety. Some comments involving concern also were related to the species in general.

The comments related to donations were codified as "financial support." They were related especially to NEX, which announced its bank account in one post, and launched a campaign to build an appropriate place for its newly arrived jaguar. "Financial support" also occurred in one comment of PAO. There were also people who offered other kinds of help, like sharing the post

TABLE 1 | A list of all the items that were coded in the posts of NEX, AMPARA e PAO.

Group of codes	Codes	Examples
Admiration	Admiration for the community	*God bless the woman who called the person who could save Luísa*
	Admiration for work	*What a wonderful work!*
Attitude	Attitude toward conservation	*Loving is protecting!*
Jaguar's characteristics	Appearance	*She looks healthy!*
	Bravery	*She is a warrior! A survival!*
	Fragility	*So fragile!*
	Age	*She is an old lady!*
	Nominations	*Princess!*
	Resilience	*Such a unique resilience!*
Emotions / feelings	Love	*We love you!*
	Anxiety	*I hope you arrive soon, Luísa!*
	Happiness	*I am glad to know that she is fine!*
	Caused emotion	*Luísa's story is very touching!*
	Gratitude	*Thanks to NEX for receiving her!*
	Proud	*Such an honor filming her when she was released.*
	Pity	*Poor thing, she must be very scared.*
	Concern	*Won't she come back to nature?*
	Sadness	*All this is so sad!*
	Curiosity	*How did Luísa get there?*
	Astonishment	*Such a horror!*
	Identification	*My compatriot!*
	Hoping	*Luísa, I hope you will be very happy in your new home.*
	Welcoming	*Welcome to Nex, Luísa.*
Engagement	Financial support	*I made a donation today!*
	Divulgation	*I will share it on my Facebook.*
	Aid offering	*Count on me!*
	Following media	*I am following the story and waiting for the next chapters!*
	Suggestion of actions	*We need to make a national campaign of consciousness.*
	Defense of the institution	*Take a look in the previous posts to understand NEX's work, instead of comparing it with another one.*
Perception	Negative perception	*Unfortunately, she is one more victim of men's destructive actions.*
	Positive perception	*What a wonderful story!*
Criticism	Criticism	*It makes no sense keeping her in captivity.*
Information	Information	*The jaguars of caatinga are the smallest of the species.*

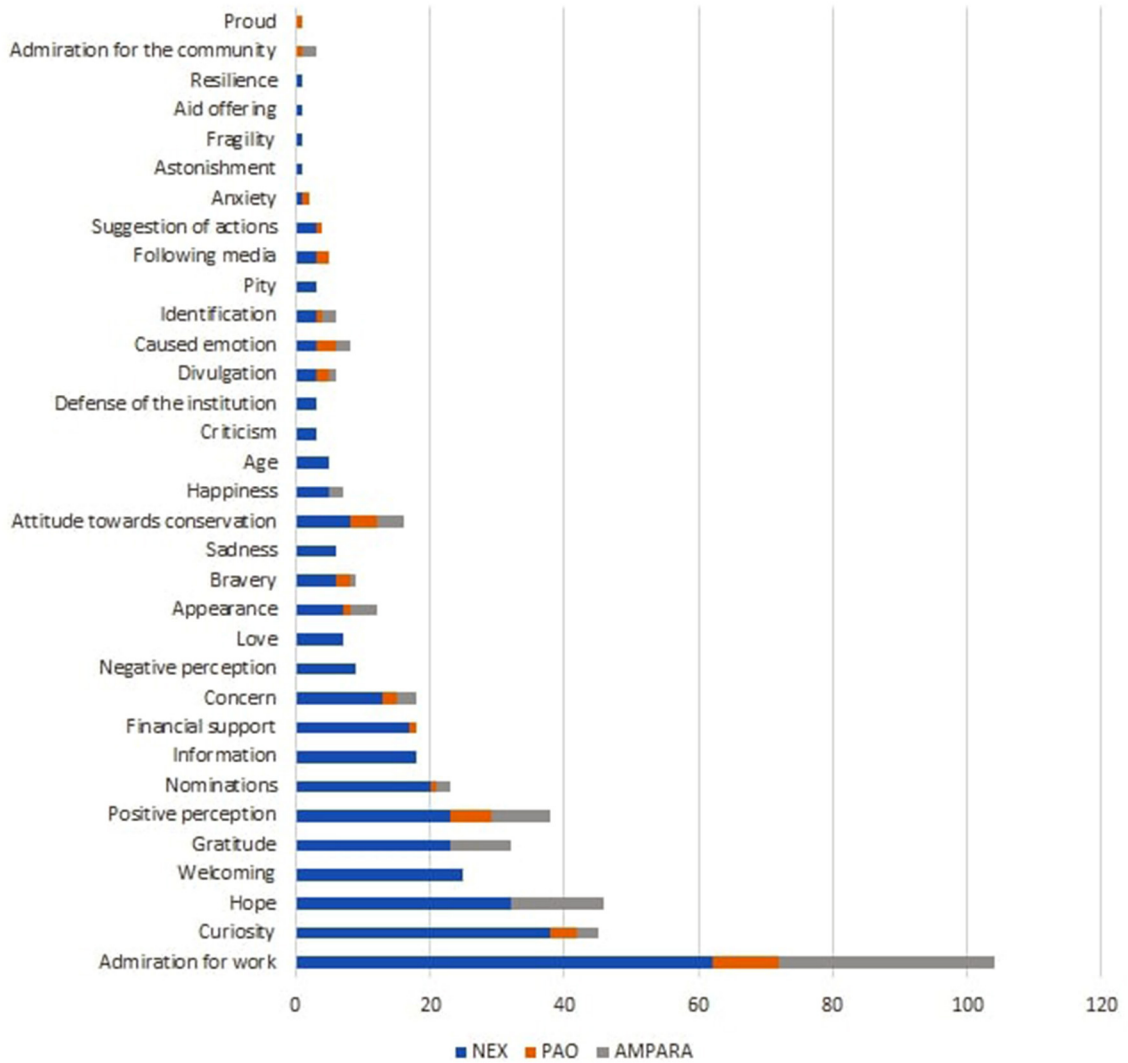

FIGURE 1 | The comparison of the frequency of all codes (number of citations) attributed to the Instagram comments of NEX, AMPARA, and PAO.

to spread the jaguar's story ("Divulgation"—six citations) and making themselves available for anything ("aid offering"—one citation in NEX). The engagement of people was noticed also by their interest in following the institutions, to keep informed about the jaguar's situation ("following media"—five citations) and by their answers to other followers' critics, defending especially the NEX institution ("defense of the institution"—three citations). This theme did not occur in the other two institutions.

Comparing the frequency of the codes between the three institutions (**Figure 1**), we found that "admiration for work" was the most frequent in all of them. NEX received this code 62 times, AMPARA 32 times and PAO, 10 times. "Curiosity" was the second most frequent code in NEX (38 citations). Considering PAO, the second most frequent code in this institution was "positive perception" (six citations). This code had a large frequency also in NEX (23 citations) and AMPARA (nine citations). Regarding AMPARA, "hope" was its second most frequent code (14 citations). This code did not appear in PAO whereas was the third most frequent in NEX.

In PAO we noticed two codes that received the same frequency in the third position: "curiosity" and "attitude toward conservation" had four citations. In AMPARA, there were also two codes that came third: "gratitude" and "positive perception." The code "gratitude" also had an expressive frequency in NEX (23 citations, the fifth most frequent), and did not appear in PAO. "Welcoming," the fourth most frequent code in NEX, was not mentioned neither in PAO nor in AMPARA. We noticed that all the comments that were coded as "attitude toward conservation" were related to a positive attitude, like people saying that nature is perfect, that all animals deserve love and respect and that it is

necessary to protect them. This code also occurred five times in AMPARA and seven times in NEX.

The relationships between all topics that appeared in public comments are shown in the Sankey diagram (**Figure 2**), a graphic representation of the co-occurrence of all codes. It shows how the most frequent coded item, "admiration for work," is related to various other topics, especially "nominations," positive perception," "appearance," "hope," "gratitude," "financial support," "attitude toward conservation," "concern," and "defense of the institution." That means that there were two or more codes occurring in the same sentence, as seen in: "Her story is so sad, but I'm glad she will be well-cared for! Congratulations for your work and thanks for your existence!"

The code "concern," with a high frequency, co-occurred with "curiosity," "happiness," and "information," e.g., some comments indicated that people were concerned about the jaguar's safety, and at the same time curious, asking for more information about its story and happy that it was safe. There were also some people who criticized the institution because they disagreed with the idea of captivity, or because they thought a human name for the jaguar could stimulate wildlife domestication, showing concern about the individual and the species.

The item "nominations" also co-occurred with many other topics, like "gratitude," "hope," "love," "attitude toward conservation," "pity," and "curiosity." We found that it was usually the comments in which people were thanking the institution, showing admiration for the work, expressing some feeling for the jaguar and using adjectives or substantives to refer to her, for instance. "Welcome Luísa! You will soon understand that people from NEX are just trying to help! Be very happy, big cat!" is an example.

"Attitude toward conservation" co-occurred with two codes related to engagement: "suggestion of actions" and "divulgation." We noticed that some people who had a positive attitude toward topics related to conservation and nature, revealed a willingness to do something, like sharing the posts in social media, or talking to authorities to protect the animals. This topic also co-occurred with "positive perception," "resilience," "identification," and "happiness." Here we noticed that people appreciated the jaguar's story, associating it with a resilient animal, because of its suffering and persistence, and expressed happiness because it was alive, despite all the challenges it had to face. In addition, some comments indicated that the jaguar Luísa changed into a symbol, representing the struggle of all jaguars from Caatinga.

DISCUSSION

In this study, we investigated how followers and supporters of three organizations that were responsible for solving a case of human-jaguar conflict perceived the translocation process of the so-called problem-animal and its removal from the wild. We used social media as a first approach to analyse a sensitive subject (i.e., human-jaguar conflict in the Brazilian Caatinga) that is still little known by the general public. This translocation is unique, considering circumstances such as the double rescue of the same individual, captured, and trapped in a cave twice for the same farmer, who in turn, warned a representative of the regional program of jaguar and puma conservation twice; thus, indicating willingness to solve the problem without eliminating the animal. Aware of the commotion surrounding the story of this female jaguar, this article is pioneering the investigation of stakeholder's perceptions toward the jaguar's translocation. More specifically, we assessed the perceptions of a stakeholder that was not directly involved with the conflict nor the translocations, but that have the power to influence conservation efforts by either voicing their views and concerns on social media (Greenspan et al., 2021), or donating money to the organizations involved.

While translocating wildlife from a conflict zone back to the wild tends to be socially acceptable (Linnell et al., 1997), results have shown that removing the jaguar from its natural habitat and placing it in captivity for the rest of its life caused

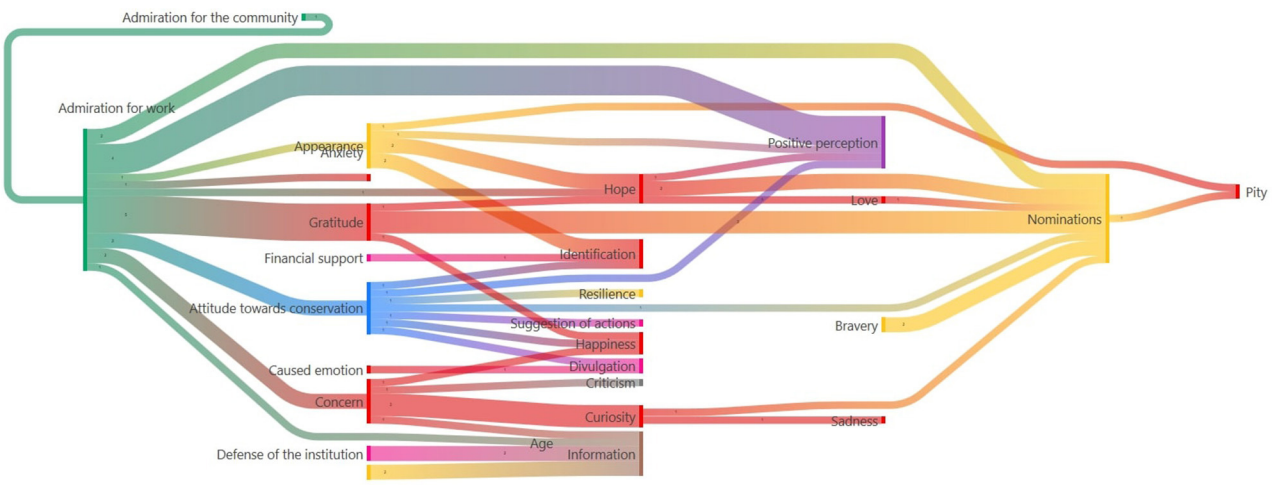

FIGURE 2 | The Sankey diagram shows the co-occurrence of all citations that were coded in the posts of NEX, AMPARA, and PAO.

discomfort among people. Oftentimes people are not fully aware of the role of *true* wildlife sanctuaries in caring for wild animals that cannot remain free in their natural habitat (Doyle, 2017). This lack of understanding and differentiation between ethical or unethical sanctuaries and other wildlife enclosures that use animals to attract people, may be causing people to feel uncomfortable (Doyle, 2017). Our findings indicate that this feeling of discomfort relates to a negative perception toward humankind, more specifically, toward people who kill jaguars as retaliation for livestock depredation. Furthermore, a positive attitude toward conservation seems to indicate a relation between concern toward the jaguar and concern with both the individual and the species. The opposite attitude and the discomfort with keeping the jaguar in captivity may also be linked with a lack of knowledge about the role of translocation and the removal of an animal from the wild as a means to solve a conflict situation with humans. It may even be related to a lack of knowledge about HWC itself as pity and compassion were turned to the predator and rage and intolerance were turned to humans. The code related to the institutions showed that admiration prevailed among other variables assessed. Although PAO is the institution closest to the jaguar and most familiar with the local context, with representatives leading every step of the operational interventions, it received less recognition than the other two other institutions. This may have happened due to the different strategies used by the institutions. For instance, while PAO uses its Instagram profile to disseminate information and knowledge about conservation more broadly (not specific to a single individual), AMPARA and NEX use their profiles more with an emotional appeal to leverage funds for their organizations and raise awareness (typically focusing on single individuals).

Cemafauna, the rescue center closer to where the conflict took place and the organization that performed a key role in the rescue and recovery of the jaguar, was not acknowledged in any reactive comments, despite being mentioned by PAO posts as a partner in the operation. Our data and analyses do not allow for an in-depth examination of the reasons for this disparity of reactions, but we wonder if it was a matter of AMPARA and NEX having more followers and supporters, or because AMPARA and NEX were simply more aware than PAO on how to engage the public on social media. Inevitably two questions arise, (1) what is the relation between trust and credibility of institutions in general, their mediatic prominence and their ecological relevance in the conservation of wildlife, and (2) institutional reputation turned the spotlight to jaguar (individual and species) conservation, or the uniqueness of this jaguar's story added credibility and trust to the institutions?

Our findings showed a high number of messages coded as "welcoming" (25 citations) and as "nominations" (23 citations). Both were addressed to the jaguar, as if it could read the comments in its own Instagram profile. Several "nominations" given to the jaguar correspond to human attributes and some "welcoming" citations cut the link to the jaguar's natural habitat. The borderline between caring for an individual unable to remain in the wild, and the distorted or exacerbated feelings that may pave the way for attempts (or willingness) of domestication (or undue proximity to humans), is too tenuous and may be counterproductive in terms of wildlife conservation. Some comments shared this concern when people criticized the choice of a human name for the jaguar and the option for its captivity.

Using social media to analyze people's perceptions toward wildlife has limitations like any other analytical tool. However, given the rise of these platforms, like Instagram, it has become an advantageous means of investigating discussions on wildlife (Wu et al., 2018), shedding light on some important remarks. Although we were unable to assess perceptions toward the translocation from the public at-large or from those directly impacted by the human-jaguar conflict, our investigation allowed us to obtain enough data to have a sense of how the target public (i.e., social media followers) perceived the translocation of a charismatic and endangered species. People far from HWC zones are important for wildlife conservation and a key stakeholder. Those Instagram followers tend to cooperate with conservation efforts by donating money used for infrastructure needed for the animals, food, and by disseminating information related to HWC. Thus, institutions already reliable for their values, norms and operational efforts, must take into account that any communication has to be accurate and transparent. Knowledge is one of the first human dimensions assessed in HWC. Although institutions like AMPARA, NEX, or PAO are not educational institutions, their visibility and wide range along with the relevance of their role as maintainers of wild species, mostly charismatic species (AMPARA, NEX) and as conservationists (researchers and practitioners) (PAO), increase their commitment in providing precise biological and ecological information accessible to specialists and the public in general. As pointed out by Wu et al. (2018), social media can be a powerful tool to strengthen public awareness of wildlife conservation.

Many comments started by responding to the content of the post and then changed its focus to more general and complex discussions about human-nature relations. This change in the discourse suggests that the case of the jaguar acted as a catalyst of broader reflections of wildlife management and conservation, thus showing the power social media has on generating debate among the public. What human dimensions of HWC and wildlife management would arise with the repetition of the analysis? Our results indicate that the studied public is likely to embrace Luísa as an ambassador for jaguar (and maybe even puma) conservation in the Caatinga. Therefore, the case of Luísa may become a showcase for strengths and weaknesses of conflict mitigation measures in order to help management agencies, and a symbol of what are the final outcomes if governance of natural resources is weak or absent, for both men and beast. Once people learn better with storytelling (Bogner, 1999), the potential of fostering knowledge and enhancing pro-conservation behaviors increases with an individual that stimulates the human dimensions beyond cognitive aspects. Therefore, this individual would have fulfilled a purpose to science as valuable as the genetic pool within it.

We acknowledge that there are other stakeholders involved in the translocation event described here (e.g., conservationists, governmental authorities, the local community). Therefore, future research should investigate the views, concerns and attitudes of all stakeholders who were involved in the

translocation so as to have a better picture of the implications of this effort for the conservation of jaguars in the Brazilian Caatinga and beyond. Furthermore, it would be beneficial to encourage the organizations AMPARA, NEX, and PAO to bring the subject (translocation and the jaguar) back to their social media accounts in a coordinated and cooperatively way, to repeat the methodology of this study and investigate other dimensions like engagement, leveling of concepts and transparency, for example. Based on our findings, we recommend that wildlife management agencies and institutions that keep captive animals align their posture and speech to establish a good foundation for continuous and savvy public engagement with *in situ* conservation.

CONCLUSION

The success of the translocation started where the conflict arose: the farmer that was affected by the jaguar's depredation trapped the animal in the cave and contacted the regional representative for jaguar and puma conservation program (PAO). The animal was old and unable to feed on natural prey and the farmer was exposed to the conflict with a predator. Several institutions collaborated and the translocation to the captivity at NEX was done successfully, being reported on social media, engaging an external public.

Our results showed that people cared, were concerned and engaged with interventions involving charismatic species. This finding is of particular importance for wildlife conservation as it motivates people to financially support projects and institutions committed to *ex situ* conservation. Furthermore, it provides a window of opportunity for education for conservation and behavior change programs, either for those impacted by the HWC or for those who watch from afar. People looked after the welfare of a single animal and gave their help and support. But people also cared for the species and the wildlife in general. That awareness must encourage institutions and wildlife management agencies to improve their communication objectives, content and skills, to go beyond the survival and welfare of an individual that will be kept in captivity to the end of its life and effectively promote coexistence, through conservation *in situ* of endangered species and their habitats and improvement of quality of human life within its traditional livelihoods.

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/s.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

FS organized the database. RP, FS, and MG analyzed the data. CE, FS, RP, ME, MG, and CM wrote the previous and current version of the document. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcosc.2021.788641/full#supplementary-material

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Paradox of Success-Mediated Conflicts: Analysing Attitudes of Local Communities Towards Successfully Reintroduced Tigers in India

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Conservation programs such as reintroductions are pivotal for the survival and proliferation of endangered species like tigers. However, restoring a carnivore population may create unforeseen problems for communities by fuelling human-wildlife conflict. The long-term persistence of tigers can only be ensured when the support of these local communities is garnered for conservation efforts, especially in release sites from where they were initially eliminated due to anthropogenic causes. The first step to gaining support for tigers and their reintroduction programs is to understand how local communities perceive these large carnivores. This study thus assessed the attitudes of local communities towards the reintroduced tigers of India, in the Panna and Sariska Tiger Reserves, and examined the socio-economic factors that potentially shape their attitudes. Questionnaire surveys were conducted in 330 households across 25 villages in Panna, and 361 households across 32 villages in Sariska. Decision tree and multinomial logistic regression analyses were employed to identify the explanatory variables associated with attitudes. In Panna, more respondents (52.12%) expressed negative opinions about tigers, as compared to positive (24.55%). Whereas in Sariska, more respondents had positive opinions (47.92%) than negative (34.90%). In both the sites, the most frequent reason given by the respondents for their negative attitude towards tigers was "fear." Regression modelling suggests that gender and education are key factors associated with the attitude of local communities towards reintroduced tigers. Other factors, specific to the reserves, were the age of the respondent, age of lost livestock, compensation received, and value of fodder obtained from the reserve. Community engagement must be integrated into conservation projects with a focus on educating women and the elderly about carnivores, protecting the traditional rights of local communities, and compensating for their losses.

Keywords: gender, education, human-tiger conflict, Panna, Sariska

INTRODUCTION

In the 21st century, "reintroduction" is frequently used as a tool for large carnivore conservation (Hayward and Somers, 2009), however, the human dimensions of such conservation programs are often overlooked, even though most of these carnivores were exterminated by humans or anthropogenic activities in the first place (Hartman, 1995). Moreover, reintroduced and revived populations of carnivores frequently get into conflict with humans (Stahl et al., 2001; Bangs et al., 2005). Making local communities the primary bearers of the cost of conservation in form of not only livestock loss due to conflict but also livelihood loss due to suspension of their traditional forest rights in the release sites (Green et al., 2018).

In India, after the original tiger population in two important "tiger reserves" was lost to poaching, from Sariska Tiger Reserve in 2005 and from Panna Tiger Reserve in 2009 (Narain et al., 2005; Wildlife Institute of India, 2009), a high-level committee convened by the Government of India recommended the reintroduction of tigers from other neighbouring reserves (Narain et al., 2005). Following this, reintroduction programs were launched in both the reserves and have been largely successful, especially in Panna (Sankar et al., 2013; Sarkar et al., 2016). The communities residing within and around these tiger reserves are highly dependent on the reserves for their subsistence, including for grazing their livestock (Jain and Sajjad, 2016; Malviya et al., 2018). The resultant high overlap of habitat use by humans and tigers in these reserves often results in human-tiger conflict (Sekhar, 1998; Kolipaka et al., 2017). The first tiger reintroduced at Sariska became a victim of this conflict when it was poisoned by a few villagers as retaliation for livestock loss (Sankar et al., 2013). Even before the reintroduction, the loss of the original tiger population in Sariska was also linked to human-wildlife conflict. The *Bawarias* (a nomadic hunting tribe) were hired by villagers to protect their crops against raiding by wildlife, in turn, indulged in poaching tigers and were given protection by the villagers (Dutt, 2004; Narain et al., 2005). A few cases have also been reported wherein tigers were killed to retaliate against cattle losses by local communities and then their parts were traded to these nomadic tribes who then supplied them to national and international smugglers (Shankar, 2007; Sansar Chand v. State of Rajasthan, 2010). In Panna also, nomadic hunting tribes like the *Pardhis* and *Bawarias* were identified as the primary reason for the local extinction of tigers (Srivastava, 2010). Thus, the persistence of tigers in these reserves is closely linked to how local communities perceive them.

As recently observed in the Satkosia Tiger Reserve in India, failure to ensure the support of local communities in areas where tigers are being translocated jeopardises the entire reintroduction program (Vasudeva et al., 2021). Therefore, for tiger conservation to succeed, whether it be at the individual tiger reserve level, like the Sariska and Panna Tiger Reserves, or at the national or global levels, it is imperative to have the support of local communities. To garner local support for conservation, it is crucial to understand the attitude of local communities towards these large carnivores.

Tolerance is often defined as acceptance of loss caused by a wild species (Kansky et al., 2014). However, experiencing first-hand loss by wildlife is not the only reason for negative attitudes towards them; people who have never experienced loss also express negative attitudes towards wildlife (Marchini and MacDonald, 2018). Studies have related attitude and the resulting tolerance of people towards large carnivores to a myriad of reasons. The reasons vary from socio-economic factors like age, gender, education level, occupation, community, household wealth, dependence on livestock for livelihood, number of livestock owned, livestock loss due to depredation/magnitude of loss, change in traditional practises, and the severity of effect that loss has on livelihood (Marchini and Macdonald, 2012; Kansky et al., 2014, 2016; Gebresenbet et al., 2018; Margulies and Karanth, 2018), to psychosocial factors like traditional or religious beliefs, inherent/cultural value, social trust and norms, fear, risk perception, past experiences, and hazard acceptance/acceptance capacity (Carter et al., 2012; Marchini and Macdonald, 2012; Banerjee et al., 2013; Bruskotter and Wilson, 2014; Browne-Nuñez et al., 2015; Gebresenbet et al., 2018; Struebig et al., 2018). The protection status of carnivores, protected area management strategies, relationship or trust towards forest management/authorities or government agencies, and compensation to mitigate loss or other monetary incentives, also influences people's opinions about carnivores (Mishra et al., 2003; Karlsson and Sjöström, 2011; Banerjee et al., 2013; Browne-Nuñez et al., 2015; Margulies and Karanth, 2018; Struebig et al., 2018). People are more accepting of problems caused by wild animals that they appreciate (Kaltenborn et al., 2006). Thus, their positive or negative opinions eventually dictate how tolerant people would be towards loss-causing wildlife, making it important to understand the attitudes people hold towards these large carnivores. Gaining an insight into the factors that determine these attitudes better equips us to design participatory tools to mitigate conflicts and accomplish lasting conservation goals.

Thus, through this study, we wanted to examine the attitude of local communities towards conflict causing large carnivores in sites where they have been reintroduced, and highlight the factors that explain these attitudes. Although qualitative studies have been conducted in Sariska and Panna to assess perceptions towards reintroduced tigers (Kolipaka et al., 2015; Doubleday, 2018), no quantitative study has been done in these reserves to identify the drivers of attitudes towards reintroduced tigers, which may help managers develop effective strategies to ameliorate attitudes and engage communities in tiger conservation. Therefore, we have modelled various socio-economic factors against the attitudes of people towards reintroduced tigers in the Sariska and Panna Tiger Reserves and discussed the explanatory factors that may have far-reaching conservation implications.

METHODS

Study Area

Sariska Tiger Reserve (27°5′N to 27°33′N and 76°17′E to 76°34′E) is situated in the Alwar district of the state of

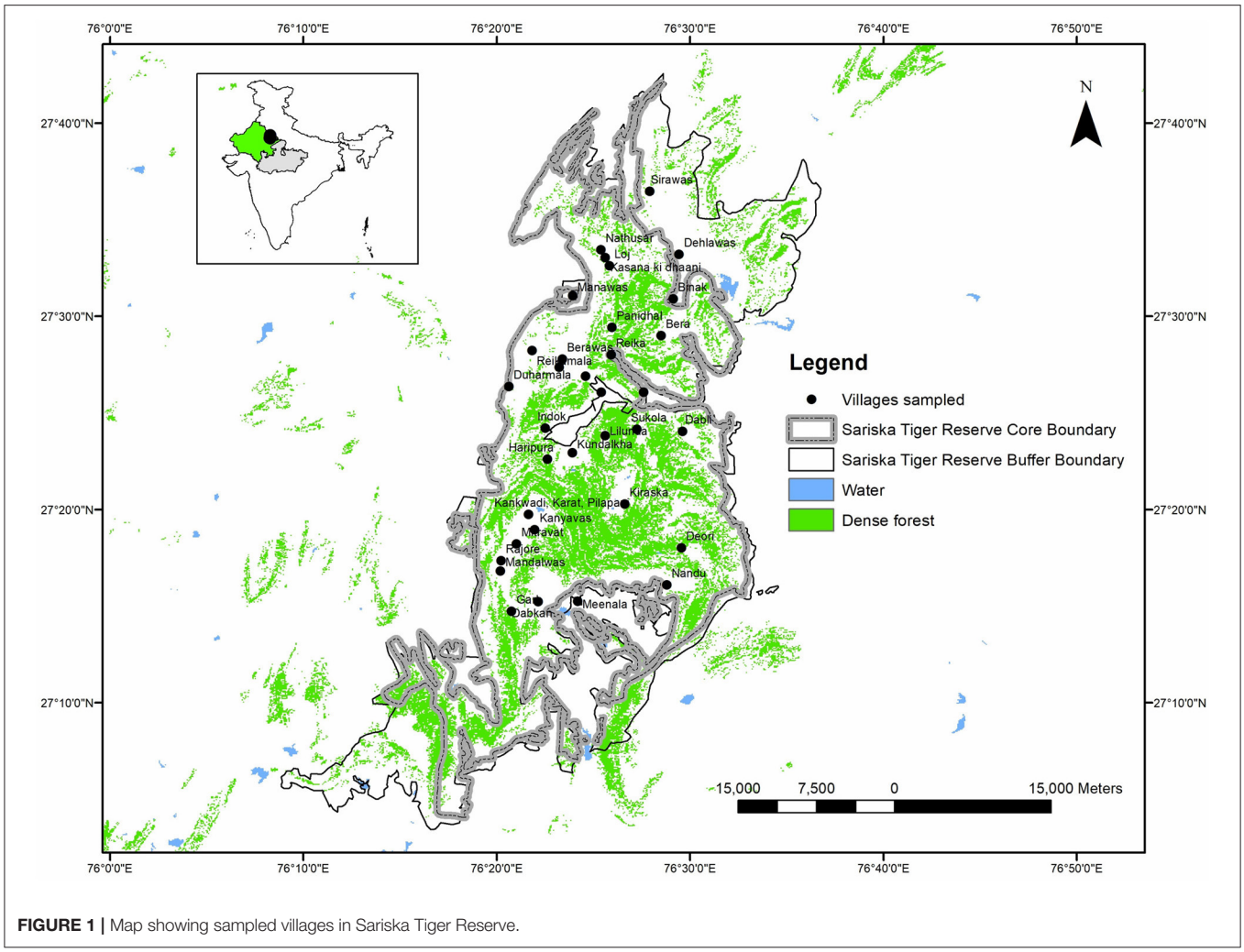

FIGURE 1 | Map showing sampled villages in Sariska Tiger Reserve.

Rajasthan in western India (**Figure 1**). The Critical Tiger Habitat (CTH) of Sariska Tiger Reserve covers an area of 881 km^2, of which 400.14 km^2 has been preliminarily notified as a national park. The buffer of the reserve is 334 km^2. There are 26 villages inside CTH, nine of which are within the notified national park area. The buffer of the reserve has 146 villages. The entire reserve is exploited by the local communities for fuelwood and fodder, putting it under a lot of anthropogenic pressure (Malviya et al., 2018).

Panna Tiger Reserve (24°27′N to 24°46′N and 79°45′E to 80°9′E) is situated in the Panna and Chhatarpur districts of the state of Madhya Pradesh in central India. The CTH or core of Panna Tiger Reserve is composed of Panna National Park and Gangau Wildlife Sanctuary covering an area of 576 km^2, and the buffer covers an area of about 1,022 km^2 (**Figure 2**). There are only four villages in the national park area and seven in Gangau Wildlife Sanctuary; hence, as compared to Sariska, there is large inviolate space available for tigers in the CTH (Malviya et al., 2018). However, 49 villages within the buffer of Panna Tiger Reserve are also dependent upon the fringes of the CTH.

Survey Design

Questionnaire surveys were carried out in selected villages within and around the reserves, in 2016–2017 (Oppenheim, 2000). Village list and locations were obtained from the forest department of both the reserves, along with livestock compensation data (2009–2015 for Panna and 2011–2016 for Sariska). In the case of Sariska, all 27 villages within the CTH were sampled; additionally, 20% (n = 5) of the conflict-facing villages outside the CTH were randomly sampled (**Supplementary Table 1**). In Panna, all villages inside the national park area plus two villages on the national park boundary were sampled (n = 6). Additionally, villages within a 2 km buffer of the national park were stratified into high (>10 cases of livestock loss), low (1–10 cases of livestock loss), and no conflict (0 cases of livestock loss) villages on the basis of compensation data, and then randomly sampled (n = 19) (**Supplementary Table 2**). Within villages, households were selected randomly.

Thus, a total of 361 households across 32 villages were sampled in Sariska and 330 households from 25 villages were sampled in Panna. The semi-structured questionnaire was aimed at

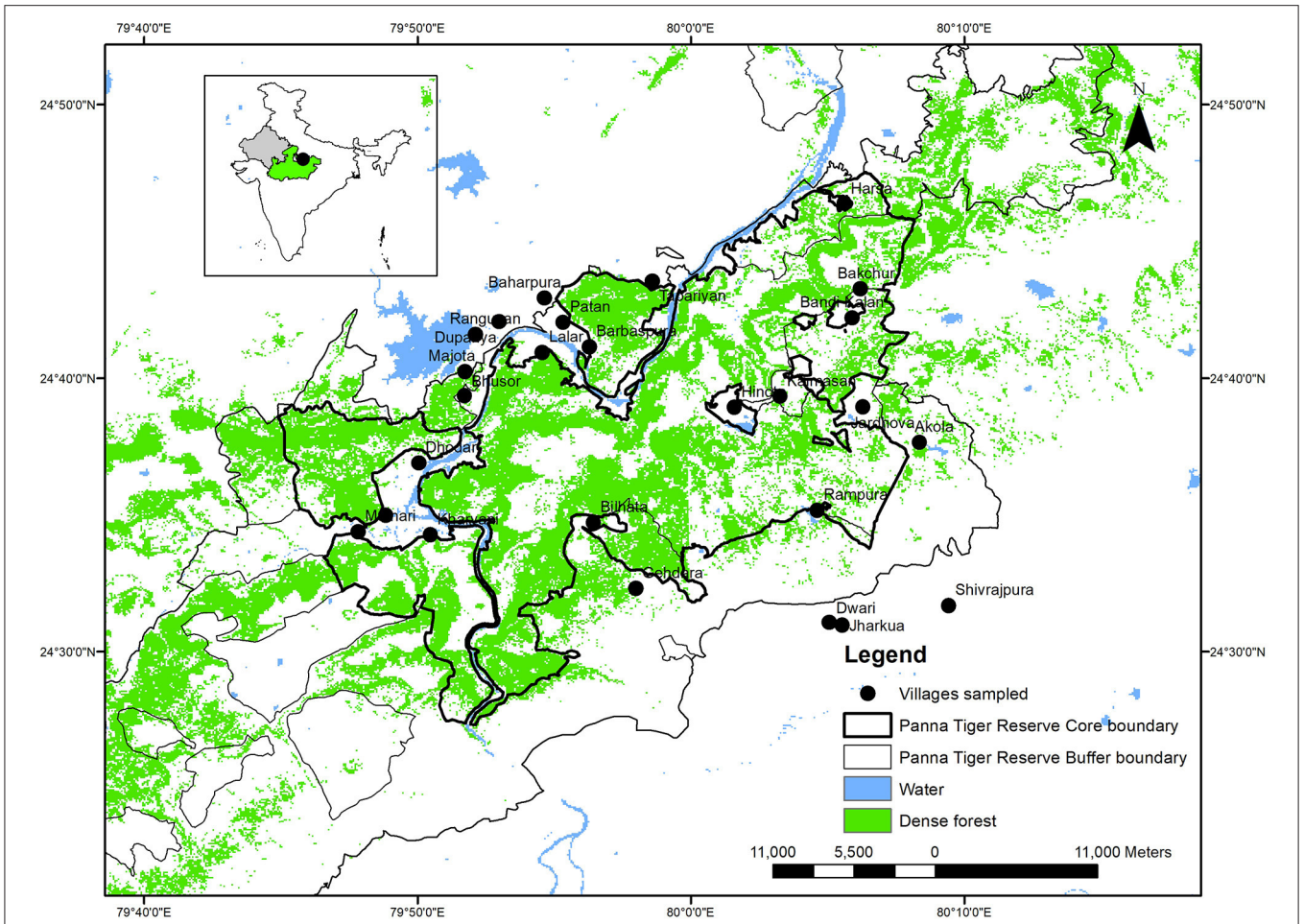

FIGURE 2 | Map showing sampled villages in Panna Tiger Reserve.

understanding demography, livelihood strategies and household economics, resource dependencies, livestock loss due to tigers, crop damage by herbivores, and, the attitude of people towards reintroduced tigers.

Respondents were asked about their opinion of reintroduced tigers. In case they could not comprehend the question, they were prompted whether they liked tigers or disliked them and why. Their answers were then dubbed as positive, negative, mixed, and neutral. "Negative" opinion meant people stated that they "dislike tiger" and/or made negative statements such as "tigers are a threat to their life and livelihood." While "positive" opinion meant people stated that they "like tigers" and/or expressed positive views, such as "tigers are beautiful" or "tigers should be present in the jungle." Others who made such statements as "tiger are beautiful, but they also inflict harm" were treated as "mixed." People who expressed no opinion about the tiger, citing that they "did not know anything about tiger" or "have never seen a tiger and never had to do anything with one," were dubbed as "neutral." The interviews were conducted by the first author, thus maintaining consistency and avoiding observer bias.

Statistical Modelling

To understand the factors that were shaping the attitudes of people towards reintroduced tigers, at the inception we employed decision tree analyses (Kohavi and Quinlan, 2002), to see how the variables were interacting and get an initial idea as to which variables might be important. Following which we employed multinomial logistic regression to identify the factors associated with attitudes (Böhning, 1992). This we did for both Sariska and Panna. Since we believed that the attitudes might be different for the general populace, and for those who have faced direct losses due to the species, we ran a separate analysis for all the sampled households and households having faced direct loss, within both reserves. The explanatory variables tested were village location (inside or outside the core of the reserve) of the respondent, respondent's age, sex, education level, community, economic status (household income), livestock holding, and livestock loss suffered due to tiger, last livestock species lost, and its age, compensation received, compensation satisfaction levels, the value of fodder obtained from reserve forest, profits from non-timber forest produce (NTFP) collection and crop loss due

to wild herbivores. Analysis was done in the statistical package for the social sciences (SPSS) version 27 (IBM Corp., 2020).

For decision tree analyses, CRT (Classification and Regression Tree) was selected as the growing method, and model validation was done using the 10-fold cross-validation method (Borovicka et al., 2012). Stopping criteria were predefined, maximum tree depth was set at five and a minimum number of cases for parent and child nodes in the case of Sariska were set as 50 and 25, respectively (IBM Corp., 2020). For Panna, due to the smaller sample size when analysing all the cases, parent and child nodes were set as 30 and 15, respectively. Plus, since conflict-only data set was even smaller, parent and child nodes were set as 18 and 9, respectively.

Since, attitudes were recorded as multiple categorical variables, i.e., positive, negative, mixed, and neutral, we employed multinomial logistic regression after checking for its assumptions i.e., linearity of independent variables and log odds, and multicollinearity (Peng et al., 2002; Stoltzfus, 2011; Park, 2013). Based on the correlation results, highly correlated variables were not used together in a model (**Supplementary Table 3**). Stepwise backward model selection was based on partial *p*-values and final model selection was based on pseudo R^2 and discrimination ability (classification accuracy and area under the curve (AUC) value of the receiver operating characteristic (ROC) curve).

RESULTS

Demography and Social System

In Panna, of the 330 respondents, 68.79% were men and 31.21% were women. The average age of the respondents was 43.52 ± 16.20. Most (52.42%) of the sampled household belonged to the other backward class (OBC) category, of which *Yadavs* (predominantly agro-pastoralists) comprised the largest proportion, followed by Scheduled Tribe (ST) category (32.12%), dominated by *Gonds* (a forest-dwelling tribe). In Sariska, of the 361 respondents, 66.76% were men and 33.24% were women. The average age of the respondents was 41.80 ± 16.04 years. *Gujjar* (predominantly pastoralists), classified as OBC, was the dominant community (62.33%), followed by *Meena* (an agro-pastoralist tribe) (16.07%) (classified as ST), and 15 others.

Education

Most of the respondents were illiterate, in both Panna (57.88%) and Sariska (66.48%). Illiteracy was higher among women in both the reserves, 75.73% and 86.66% of women were illiterate as compared to 50.66% and 56.43% of men, in Panna and Sariska, respectively.

Livelihood, Forest Dependence, and Household Economics

In Panna, most of the households were involved in agriculture (77.81%), manual labour (54.41%), selling NTFPs (42.25%), and livestock husbandry (36.78%), often in combination with each other. In total 66.06% ($n = 218$) of the sampled households, owned livestock. Of these 218 households, 66.97% ($n = 146$) depend upon the forest for fodder and graze their livestock in the tiger reserve. In Sariska, most of the households were involved in both livestock rearing and agriculture (52.63%), followed by only livestock rearing (20.78%), and, livestock rearing and agriculture plus manual labour (6.09%). It was found that 97.5% ($n = 352$) of all the sampled households owned livestock, 96% of which depend upon tiger reserve for fodder.

Based on the number of cattle owned and dependence upon the forest for fodder (partial or complete and total number of days for which they depend upon forest), the value/cost of fodder collected from reserve forest by each household was estimated, the average being INR 44,038 (USD 584.03) per year per household for Panna, and INR 2,75,757.5 (USD 3,657.09) per year per household for Sariska.

Crop Loss due to Herbivores

In Panna, 70% ($n = 231$) of sampled households were reportedly facing crop loss due mostly to wild pig and nilgai, followed by chital, monkey, jackal, porcupine, hare, bear, civet, and chinkara, in that order. In Sariska, 67.6% ($n = 244$) of sampled households were facing crop loss due to mostly wild pig and nilgai, followed by sambar, peafowl, monkey, porcupine, and hare, in that order.

Human-Tiger Conflict and Compensation

In Panna, of the 330 respondents, 27.27% ($n = 90$) reported livestock loss by reintroduced tigers (between 2009 and 2016), of which 57.78% ($n = 52$) applied for compensation; of these 59.62% ($n = 31$) received compensation. In Sariska, 29.64% ($n = 107$) of sampled households reported loss by reintroduced tigers (between 2009 and 2017), of which 71.03% ($n = 76$) applied for compensation; of these 53.95% ($n = 41$) received compensation.

Attitude of Local Communities Towards Tigers

Among the 330 respondents we interviewed in Panna, 24.55% ($n = 81$) had positive attitudes towards tigers, 52.12% ($n = 172$) had negative attitudes, 2.12% ($n = 7$) had mixed, 17.27% ($n = 57$) had neutral responses while 3.93% ($n = 13$) said they "don't know." Irrespective of whether respondents perceived themselves to be facing a loss or not, they were more negative towards tigers ($\chi 2 = 0.202$; $p = 0.653$) (**Table 1**). Women gave more neutral responses as compared to men, while men gave more positive responses as compared to women (**Table 2**). In total 31 communities were sampled in Panna, of which 11 were more positive and 16 were more negative, notably, the two dominant communities of Gonds and Yadavs had more respondents with negative attitudes towards tigers, as compared to positive. Of

TABLE 1 | Attitude of interviewees that have faced livestock loss due to tiger, towards tiger, in Panna and Sariska Tiger Reserve.

Loss suffered	Attitude			
	Panna Tiger Reserve		Sariska Tiger Reserve	
	Positive (%)	Negative (%)	Positive (%)	Negative (%)
Yes	23	54	44	39
No	25	51	50	33

TABLE 2 | Gender-wise attitude of local communities towards tigers in Panna and Sariska Tiger Reserve.

Attitude	Gender			
	Panna Tiger Reserve		Sariska Tiger Reserve	
	Male (%) (*N* = 227)	Female (%) (*N* = 103)	Male (%) (*N* = 241)	Female (%) (*N* = 120)
Like/positive	28.19	16.50	60.17	23.33
Dislike/negative	52.86	50.49	26.97	50.83
Can't tell/don't have any opinion/neutral	13.22	26.21	8.30	21.67
Don't know	2.64	6.80	1.24	2.50

all the sampled respondents, only 105 were able to articulate specific reasons for why they liked or disliked tigers. The reason stated by people who had negative attitudes ($n = 80$) were, most frequently (35%), fear for their life and livestock, closely followed by losses (28.75 %) caused by tigers. Some respondents (15%) expressed negative opinions about tigers because they had negative sentiments towards the forest department. At the same time, some respondents ($n = 6$) expressed a positive opinion of tigers because they were employed by the forest department.

Among the 361 respondents we interviewed in Sariska, 47.92% ($n = 173$) had positive attitudes towards tigers, 34.90% ($n = 126$) had negative attitudes, while four respondents gave mixed responses; 12.74% ($n = 46$) gave neutral responses, while 1.66% ($n = 6$) said they "don't know." Irrespective of whether respondents perceived to be facing loss or not, they were more positive towards tigers ($\chi 2 = 1.326$; $p = 0.249$) (**Table 1**). The attitudes of female respondents were more likely to be either neutral or negative as compared to men (**Table 2**). A total of 17 communities were sampled in Sariska, of which nine were more positive and seven were more negative, notably, the dominant communities of *Gujjars* and *Meenas*, had more respondents with positive attitudes towards tigers, as compared to negative. Among the respondents, only 40 were able to articulate the reasons for why they liked or disliked tigers. Respondents who expressed a positive opinion of tigers ($n = 13$) mostly (38.46%) believed that "tigers are king/pride of jungle." The reason stated by people who had negative attitudes ($n = 27$) were, most frequently (44.44%), fear for their life and livestock, and negative sentiments towards the forest department (29.63%).

Our results show that the attitude of respondents varied significantly between the two study sites, with a significant difference between the number of respondents having a negative attitude towards tigers, as compared to positive, in Sariska and Panna ($\chi 2 = 36.85$; $p < 0.001$).

Factors Associated With the Attitude of Local Communities Towards Tigers

Panna Tiger Reserve

All Sampled Households

Decision tree analyses revealed that education was the most important classifier but due to the small dataset the tree did not split any further. Close examination of the classification reveals that people who have received education higher than high school were more positive (59.1%) while people who were less educated

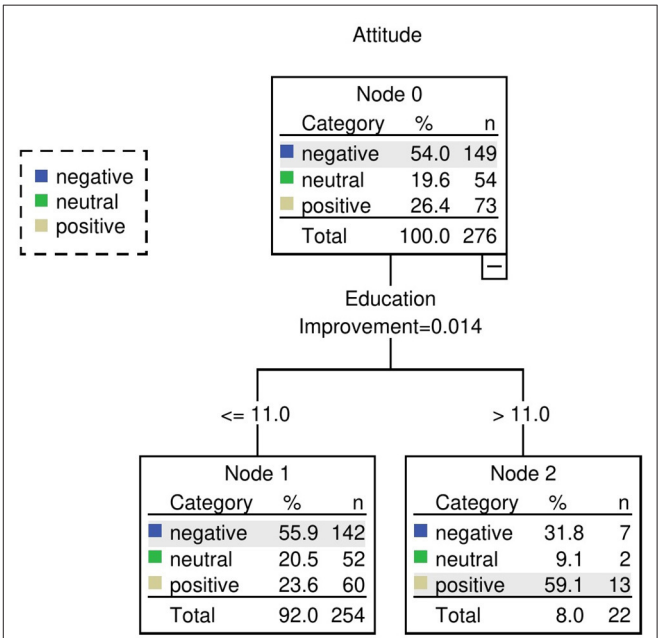

FIGURE 3 | Decision tree of attitudes of local communities towards tiger in Panna Tiger Reserve.

were more negative (55.9%) (**Figure 3**). Overall classification accuracy of the model was 56.2% (Risk = 0.457).

While constructing multinomial logistic regression models we considered the results of the decision tree and kept education as a key explanatory variable. The multinomial logistic regression model with seven predictor variables, viz. education ($p = 0.019$), total livestock ($p = 0.127$), total household income ($p = 0.369$), total income from forest products ($p = 0.533$), gender ($p = 0.006$), village location ($p = 0.276$), and crop loss due to wild herbivores ($p = 0.414$), was selected ($p = 0.001$). The Nagelkerke R-square indicated that 17.2% of the total variations in attitudes occurred due to the variations among the seven predictor variables. The classification accuracy of the model was 53.71%. The AUC of the ROC curve for the model was 0.62 (positive actual state as negative opinion), which means the model has class separation capacity.

Attitude towards tiger was influenced by gender and education of the respondent (**Table 3**). An overall neutral opinion

TABLE 3 | Multinomial logistic regression model explaining the attitude of people towards tiger in Panna Tiger Reserve: parameter estimates.

Attitude[a]	Parameters	B	Std. Error	Wald	df	*p*-value	Exp(B)
Neutral	Intercept	−0.101	0.704	0.021	1	0.886	
	Education	−0.056	0.046	1.467	1	0.226	0.946
	Total livestock	0.013	0.047	0.071	1	0.790	1.013
	Household income	−0.100	0.157	0.404	1	0.525	0.905
	Income FP	0.000	0.000	0.004	1	0.949	1.000
	Gender = M	1.161	0.411	7.968	1	0.005	3.194
	Gender = F	0[b]	0.0	0.0	0	0.0	0.0
	Village = in	0.759	0.496	2.340	1	0.126	2.135
	Village = out	0[b]	0.0	0.0	0	0.0	0.0
	Crop loss = 0	−0.700	0.436	2.581	1	0.108	0.496
	Crop loss = 1	0[b]	0.0	0.0	0	0.0	0.0
Negative	Intercept	1.411	0.556	6.429	1	0.011	
	Education	−0.079	0.036	4.739	1	0.029	0.924
	Total livestock	0.065	0.036	3.272	1	0.070	1.067
	Household income	−0.218	0.126	3.008	1	0.083	0.804
	Income FP	0.000	0.000	0.556	1	0.456	1.000
	Gender = M	0.438	0.353	1.539	1	0.215	1.550
	Gender = F	0[b]	0.0	0.0	0	0.0	0.0
	Village = in	0.720	0.402	3.196	1	0.074	2.053
	Village = out	0[b]	0.0	0.0	0	0.0	0.0
	Crop loss = 0	−0.412	0.332	1.544	1	0.214	0.662
	Crop loss = 1	0[b]	0.0	0.0	0	0.0	0.0

[a] *The reference category is: positive.*
[b] *This parameter is set to zero because it is redundant.*

is influenced by the gender of the respondent, with odds of women expressing a neutral opinion rather than a positive one being 3.19 times higher than that of men ($p = 0.005$) (**Table 3**). For the logistic regression model of negative opinion vs. positive, the odds of a more educated person to have a negative opinion rather than a positive one are 0.92 times than those of a less educated person ($p = 0.029$), meaning education is inversely related to negative opinion (**Table 3**).

Household Facing Loss

Decision tree analyses revealed that community was the most important classifier. Close examination of the classification reveals that respondents who were *Brahman, Serare,* and *Mehtar* were more positive (66.7%) than negative (0%), while all the other communities such as *Gonds, Yadavs*, etc., were more negative (61.4%) than positive (25%) (**Figure 4**). Overall classification accuracy of the model was 62.3% (Risk = 0.5).

Even though the decision tree suggested that community was an important explanatory variable, it was not possible to use community as an explanatory variable in the multinomial model due to high SE associated (as a result of a large number of communities and a small dataset). Thus, the multinomial model with seven predictor variables, viz. value of fodder obtained from forest ($p = 0.034$), age ($p = 0.032$), total livestock owned ($p = 0.071$), total livestock lost ($p = 0.007$), age of last livestock lost ($p = 0.023$), species of last livestock lost ($p = 0.061$), and compensation received ($p = 0.020$), was selected ($p = 0.003$). The Nagelkerke R-square was 47.5%. The classification accuracy of the model was 72.46%. The AUC of the ROC curve for the model was 0.54 (positive actual state as negative opinion). Attitudes towards tigers among households facing direct loss were influenced by age of the respondent, age of the last livestock lost to a tiger, and compensation received (**Table 4**). The odds for older respondents to have a negative opinion rather than a positive one is 1.074 times higher than a younger person ($p = 0.034$), i.e., older people are more likely to have negative opinions about tigers. The odds for respondents that have received compensation to have a negative opinion rather than a positive one is 0.21 times than a respondent that has not received compensation ($p = 0.042$), meaning people who have received compensation are less likely to have a negative opinion towards tigers (and more likely to have a positive opinion), as compared to a person who has not received compensation. The odds for respondents losing mature cattle to a tiger having a negative opinion rather than a positive one is, 91.52 times higher than a respondent losing immature cattle ($p = 0.015$), i.e., people losing mature productive cattle are much more likely to have negative opinions about tigers (**Table 4**).

Sariska Tiger Reserve

All Sampled Households

Decision tree analyses revealed that sex (gender) was the most important classifier, followed by cost (value) of fodder obtained from the forest. Close examination of the splits reveals that female respondents were more negative (54.5%) than positive (22.2%)

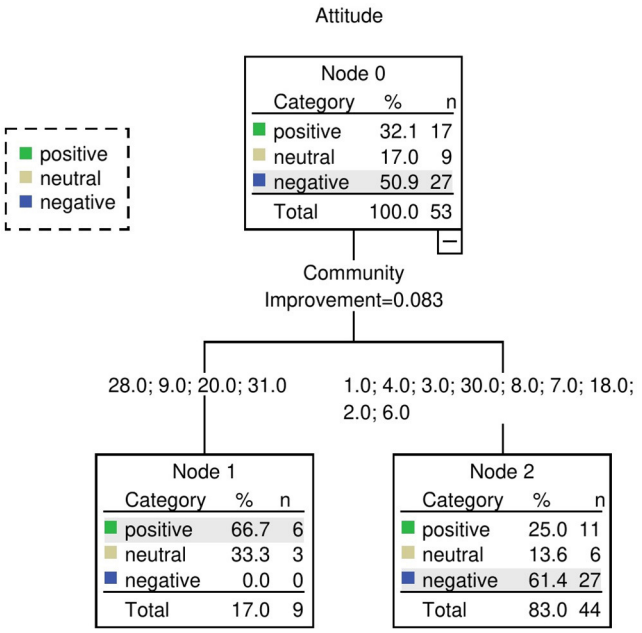

FIGURE 4 | Decision tree of attitudes of households that have faced livestock loss due to tiger in Panna Tiger Reserve.

or neutral (23.2%) while male respondents were more positive (63.5%) than negative (27.4%) or neutral (9.1%). The next split reveals that women who are drawing greater benefits from the reserve in form of a higher value of fodder obtained from the forest were more positive as compared to women who obtained less fodder from the forest, even though women were more negative in general (**Figure 5**). Overall classification accuracy of the model was 60.6% (Risk = 0.39).

While constructing multinomial logistic regression models we considered the results of the decision tree and kept gender and value of fodder obtained from the forest as a key explanatory variable. The multinomial logistic regression model with three predictor variables, viz. education ($p = 0.024$), gender ($p < 0.001$), and value of fodder obtained from the forest ($p = 0.028$), was selected ($p < 0.001$). The Nagelkerke R-square was 22.2%. The classification accuracy of the model was 60%. The AUC of the ROC curve for the model was 0.69 (positive actual state as positive opinion). Attitude towards tigers among local communities was influenced by the gender and education of the respondent, as well as the value of the fodder collected from the forest (**Table 5**).

Neutral opinion is influenced by the education of the respondent, with odds of a more educated person expressing a neutral opinion rather than a positive one being 0.86 times than a less educated person ($p = 0.011$). The odds of women expressing a neutral opinion rather than a positive one are 5.07 times higher than those of men ($p < 0.001$) (**Table 5**). The odds of respondents that collect more fodder from the reserve forest expressing a neutral opinion rather than a positive one are 0.99 times higher than respondents that collect less fodder ($p = 0.010$).

For the logistic regression model of negative opinion vs. positive, the odds of women having a negative opinion rather than positive are 4.93 times higher than men ($p < 0.001$) (**Table 5**).

Household Facing Loss

Decision tree analyses again revealed that sex (gender) was the most important classifier. Female respondents were more negative (52.9%) than positive (23.5%) or neutral (23.5%) while male respondents were more positive (60.4%) than negative (30.2%) or neutral (9.4%) (**Figure 6**). Overall classification accuracy of the model was 57.5% (Risk = 0.471).

While constructing multinomial logistic regression models we considered the results of the decision tree and kept gender as a key explanatory variable. The multinomial logistic regression model with three predictor variables, viz. gender ($p = 0.005$), species of last livestock lost ($p = 0.108$), and value of fodder obtained from forest ($p = 0.169$), was selected ($p = 0.003$). The Nagelkerke R-square was 23.9%. The classification accuracy of the model was 62.07%. The AUC of the ROC curve for the model was 0.61 (positive actual state as positive opinion).

Attitude towards tigers among households facing direct loss is influenced by the gender of the respondent, with odds of women expressing a neutral opinion rather than a positive one being 6.01 times than those of men ($p = 0.012$) and a negative opinion rather than a positive one being 4.23 times than those of men ($p = 0.007$) (**Table 6**).

DISCUSSION

Retaliatory killing is driving large carnivore populations to extinction in many countries (Inskip and Zimmermann, 2009). However, killing a large carnivore is not only retaliatory in nature but driven by multiple psychosocial factors (Bruskotter and Wilson, 2014; Inskip et al., 2014). Sometimes it is not socioeconomic status or the intensity of loss but the negative attitude stemming from general beliefs towards the carnivores that makes them vulnerable to being killed by people (Carter et al., 2012; Inskip et al., 2014). Attitude is, thus, the most important predictor of the acceptance of large carnivores like tigers by local communities, with a general attitude towards tigers along with other socio-psychological factors translating to tiger killing and its societal acceptance (Inskip et al., 2014).

Both Sariska and Panna present a unique case in the form of being the only two tiger populations in India that were reintroduced back into a habitat from which they were poached out of existence recently, with local communities likely playing a part in the initial extinction (Narain et al., 2005). Thus, we expected the attitudes towards reintroduced tigers to be largely negative in both these reserves. However, we found that in Sariska, more respondents had positive opinions towards tigers, as compared to negative. Although in Panna, the trend was inverse, with more respondents expressing negative opinions towards tigers as compared to positive.

It is to be noted that an earlier study done in Panna by Kolipaka et al. (2015) found that people are tolerant

TABLE 4 | Multinomial logistic regression model explaining the attitude of people facing loss, towards tiger in Panna Tiger Reserve: parameter estimates.

Attitude[a]	Parameter	B	Std. Error	Wald	df	*p*-value	Exp(B)
Neutral	Intercept	11.154	3.353	11.065	1	0.001	
	Value of fodder obtained from forest	0.000	0.000	0.021	1	0.885	0.999
	Total livestock lost	−19.320	0.000	0.0	1	0.0	4.067E-9
	Age	0.088	0.040	4.802	1	0.028	1.092
	Total livestock owned	0.223	0.143	2.443	1	0.118	1.250
	(Age of last livestock lost = mature)	2.789	1.961	2.022	1	0.155	16.259
	(Age of last livestock lost = immature)	0[b]	0.0	0.0	0	0.0	0.0
	(Compensation received = Yes)	−3.088	1.388	4.953	1	0.026	0.046
	(Compensation received = No)	0[b]	0.0	0.0	0	0.0	0.0
	(Species of last livestock lost = Cow)	2.226	1.392	2.557	1	0.110	9.259
	(Species of last livestock lost = Buffalo)	2.615	2.079	1.582	1	0.208	13.673
	(Species of last livestock lost = Bullock)	0[b]	0.0	0.0	0	0.0	0.0
Negative	Intercept	−5.439	2.532	4.615	1	0.032	
	Value of fodder obtained from forest	0.000	0.000	3.394	1	0.065	0.985
	Total livestock lost	−0.841	0.543	2.400	1	0.121	0.431
	Age	0.072	0.034	4.475	1	0.034	1.074
	Total livestock owned	0.231	0.127	3.302	1	0.069	1.259
	(Age of last livestock lost = mature)	4.517	1.851	5.955	1	0.015	91.518
	(Age of last livestock lost = immature)	0[b]	0.0	0.0	0	0.0	0.0
	(Compensation received = Yes)	−1.541	0.758	4.133	1	0.042	0.214
	(Compensation received = No)	0[b]	0.0	0.0	0	0.0	0.0
	(Species of last livestock lost = Cow)	0.331	0.746	0.196	1	0.658	1.392
	(Species of last livestock lost = Buffalo)	2.782	1.468	3.591	1	0.058	16.157
	(Species of last livestock lost = Bullock)	0[b]	0.0	0.0	0	0.0	0.0

[a] *The reference category is: positive.*
[b] *This parameter is set to zero because it is redundant.*

of tigers in the area. It could be because as Kolipaka et al. (2015) also observed, the tiger presence was limited in the buffer area (in 2014), and livestock killing by tigers was occurring only in a few pockets, affecting only a few pastoralists. However, the range of the tigers has since increased, thus increasing the chances of people encountering tigers, which potentially increased the number of people that feel threatened.

In both Panna and Sariska, irrespective of whether the households were facing loss or not, the proportions of positive and negative attitudes were the same, indicating that direct cost does not explain attitudes towards reintroduced tigers in India (Inskip et al., 2016; Kansky et al., 2016). Loss faced by households was also not selected as the explanatory variable for the attitudes of people in our modelling. Therefore, merely reducing livestock loss may not automatically bring about change in the attitude of the people. Social, cultural, and environmental factors are likely to play a bigger role in determining the attitude of people as compared to economic loss (Struebig et al., 2018). Thus, unravelling these factors will be crucial in managing conservation attitudes. It was found that attitudes towards reintroduced tigers in India were guided by the gender and education level of the respondents. "Fear for life and livestock" and "conflict with reserve management" were the most oft-stated reason by the respondents expressing negative opinions towards tigers. Apart from these common factors, there were site-specific factors that were also explaining the attitude of people towards tigers in the two reserves. In the successive paragraphs we shall first discuss the factors common across populations, and then briefly discuss site-specific factors.

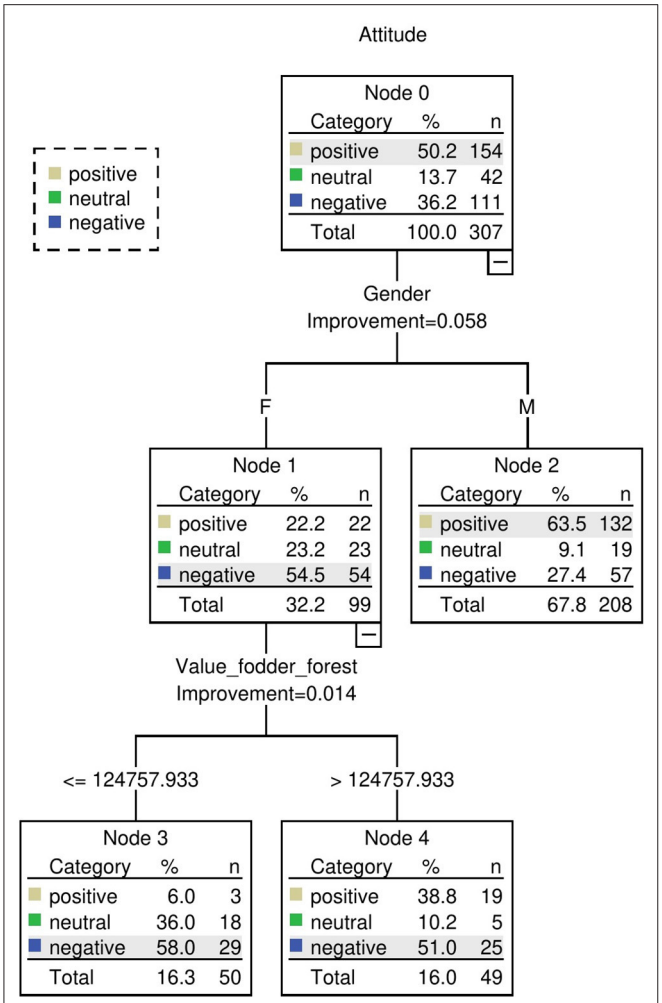

FIGURE 5 | Decision tree of attitudes of local communities towards tiger in Sariska Tiger Reserve.

We have also attempted to explicate how these factors are likely intertwined.

Major Factors

Gender

In both Sariska (23%) and Panna (17%) very few women expressed positive opinion towards tigers as compared to men, which resonates with earlier studies that not only does gender influence attitudes towards wildlife, women are more negative towards large carnivores as compared to men (Kaltenborn et al., 2006; Mir et al., 2015; Marchini and MacDonald, 2018; Karanth et al., 2019; Meena et al., 2021). An earlier study undertaken in Sariska also found that women had negative perceptions of tigers (Doubleday and Adams, 2020). It could be because men and women perceive risk differently (Gore and Kahler, 2012). It could be a construct of their different social roles, trust in authorities, and even how empowered they feel (Ogra, 2008; Gore and Kahler, 2012). Women bear a disproportionate burden of conflict costs but are often not included in decision-making processes, much less in conservation-related discussions, and hence might more readily express negative opinions (Ogra, 2008; Doubleday and Adams, 2020).

Education

Women in rural India also have fewer opportunities to gain formal education as compared to men, and thus are not exposed to the modern idea of conservation. In both Sariska and Panna, more women were uneducated as compared to men. It is known that education plays a crucial role in shaping attitudes towards wildlife, with educated people being more positive (Gebresenbet et al., 2018; Karanth et al., 2019). Education has been found to have a bearing on an individual's acceptance of carnivores and the success of conservation programs, more educated people being more pro-conservation (Hazzah, 2007; Karlsson and Sjöström, 2011; Pinheiro et al., 2016). In both Sariska and Panna, it was found that the more educated a person, the less likely they were to express negative opinions of tigers.

Fear

The major reason for disliking tigers as given by respondents in our study, in both Panna and Sariska, was 'fear' for their life and livestock. Many studies have found that women are more negative or less tolerant than men towards "fear" inducing concerning species such as large carnivores or megaherbivores (Gadd, 2005). This was found to be even more so in forest-dwelling communities, as in the case of Sariska and Panna, where women are the ones going into the forest for water or the collection of forest produce and hence are more vulnerable (Gadd, 2005; Ogra, 2008; Rubino and Doubleday, 2021). Thus, negative attitudes towards predators, especially in the case of women, often stem from fear of the species (Kaltenborn et al., 2006; Marchini and Macdonald, 2012). Furthermore, a recent study done in Sariska has shown that this fear towards tigers is augmented by the vulnerable position of women in the patriarchal Indian household (Doubleday and Adams, 2020).

Relationship With Reserve Management

Negative interactions of local communities with forest management that may have aggressive conservation strategies can also result in a decline of tolerance for wildlife (Bond and Mkutu, 2018; Margulies and Karanth, 2018). In fact, behind much human-wildlife conflict is human-human conflict (Bond and Mkutu, 2018) seated in class divides and public-government standoffs (Skogen and Krange, 2003). In Panna, people expressed negative sentiments towards the forest department, and because they termed tigers as "their (the forest department's) tigers," and by extension of association people did not like the tigers as well. They felt that in the olden days, they would be compensated for losses caused due to wildlife by collecting profitable NTFPs, but now citing the protected status of these forests, they have been incapacitated to do so by the forest department. Thus, feeling less empowered makes them feel more frustrated over their present circumstances. It has led to a buildup of negative sentiments towards the forest department. Although forest department-supported eco-development committees have been active in these forests, providing people with gas connections

TABLE 5 | Multinomial logistic regression model explaining the attitude of people towards tiger in Sariska Tiger Reserve: parameter estimates.

Attitude[a]	Parameters	B	Std. Error	Wald	df	*p*-value	Exp (B)
Neutral	Intercept	−0.938	0.342	7.531	1	0.006	
	Education	−0.003	0.001	6.573	1	0.010	0.997
	Fodder from forest	−0.153	0.061	6.401	1	0.011	0.858
	Gender = F	1.624	0.404	16.174	1	0.000	5.072
	Gender = M	0[b]	0.0	0.0	0	0.0	0.0
Negative	Intercept	−0.430	0.249	2.997	1	0.083	
	Education	−0.001	0.001	2.310	1	0.129	0.999
	Fodder from forest	−0.052	0.032	2.685	1	0.101	0.949
	Gender = F	1.595	0.309	26.713	1	0.000	4.930
	Gender = M	0[b]	0.0	0.0	0	0.0	0.0

[a] *The reference category is: positive.*
[b] *This parameter is set to zero because it is redundant.*

and employment, most people are disengaged from these committees, not aware of their activities, and distrusting of the department. The distrust at both Panna and Sariska has been fuelled by inadequate relocation attempts (Shahabuddin et al., 2007). Traditional forest dwellers find it difficult to relocate outside of forest reserves and resent conservation programs or forest departments/governments that ask them to relocate, and the resultant negative sentiment spills over to the very species that the program seeks to conserve (Hazzah, 2007).

Site-Specific Factors

Panna Tiger Reserve

Age

Older people are more negative towards large carnivores as compared to younger people (Zimmermann et al., 2005; Kretser et al., 2009; Blekesaune and Rønningen, 2010; Cavalcanti et al., 2010; Marchini and Macdonald, 2012), with younger people being more pro-conservation (Arjunan et al., 2006; Hazzah, 2007; Karlsson and Sjöström, 2011; Consorte-McCrea et al., 2017; Meena et al., 2021). Similar results were obtained from Panna, where among the respondents that have faced direct loss due to tigers, older people were more likely to have negative opinions as compared to positive or neutral opinions, than younger people.

Community

The beliefs of an individual about right and wrong are shaped by the society they live in. It has been found that societal factors influence tolerance, perception, and eventually poaching of large carnivores more than the sentiment of an individual regarding retaliation or threat to life (Treves and Bruskotter, 2014). So, the community to which a person belongs shapes their opinion towards loss-causing wildlife (Kretser et al., 2009). Certain communities in Panna, owing to their high resource dependency on the reserve forest (such as the *Yadavs*), have also suffered higher losses due to tigers, and hence harbour more negative sentiments towards tigers.

Age of Last Livestock Lost

People who lost mature and more costly cattle were more likely to be negative towards tigers as compared to people who lost immature and less costly cattle. Indicating that among the people facing direct losses due to tigers, those experiencing higher economic loss may become more intolerant towards them (Rocha and Fortes, 2015).

Compensation Received

In Panna, households that have faced loss and were compensated for it were more positive towards tigers than households that have faced loss and not been compensated. Compensating people for their losses can significantly decrease their killing of carnivores (Hazzah et al., 2014). It has been observed that when local communities are benefitted by the presence of large carnivores either in the form of tourism benefits or compensation for loss, coupled with benefits from the forest in the form of free fodder (Naughton-Treves et al., 2003; Hazzah, 2007; Banerjee et al., 2013) people are more tolerant and in favour of conservation.

Sariska Tiger Reserve

Forest Dependence and Community Beliefs

Sometimes communities have been found to be highly tolerant of a large carnivore, even in face of high loss, because of their inherent values and the financial capability to bear the losses (Zimmermann et al., 2005). Unlike Panna, people in Sariska do not sell NTFP, but by depending on forest for fodder, they make considerable savings. This dependence of people on fodder plays a critical role in shaping their opinions. It has been observed that forest dwellers that enjoy grazing rights inside protected areas are more likely to coexist with large carnivores (Banerjee et al., 2013). In Sariska, local communities make a huge profit from selling milk products, the economics of which are sustained by free fodder and fuelwood from reserve forest, therefore, people who were drawing more benefit from the forest were also more positive towards the tigers. Moreover, in Sariska tigers are an important part of their legends and faith, and the people in general are very religious. In cultures across the world, tolerance towards carnivores is linked to their cultural and religious beliefs (Meena et al., 2021) because of which they see some carnivores as beneficial (Baynes-Rock, 2013) or revere them (Banerjee et al., 2013) even in the face of HWC (Can and Macdonald, 2018). In several cases, tolerance stemming from culture and beliefs has

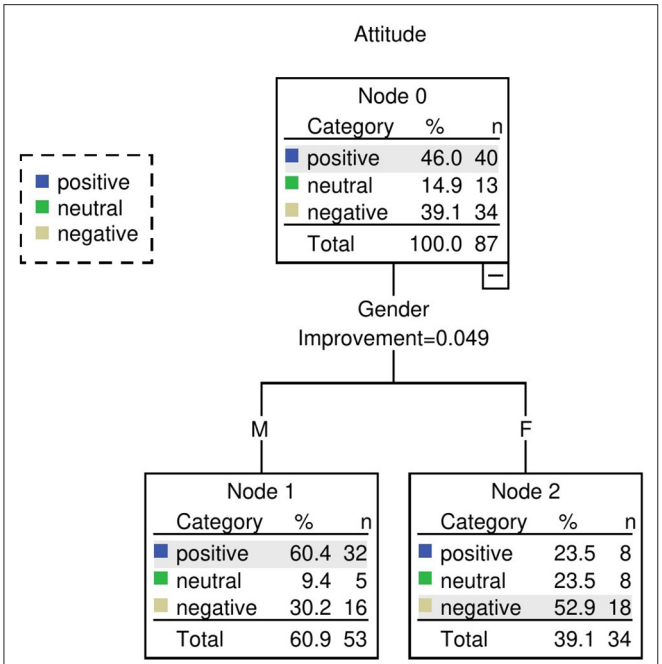

FIGURE 6 | Decision tree of attitudes of households that have faced livestock loss due to tiger in Sariska Tiger Reserve.

led to the long-term coexistence of carnivores such as Ethiopian hyenas and Gir lions with human beings (Banerjee et al., 2013; Baynes-Rock, 2013). Religion helps rural uneducated people rationalise risk (Inskip et al., 2016), thereby increasing the coping capacity of people towards loss-causing wildlife (Gogoi, 2018).

Tourism

Some people in Sariska were also positive towards tigers because they are involved in tourism activities as either vehicle owners, drivers, or guides. Eco-tourism is advocated to counter the losses faced by communities due to wildlife, because it incentivizes them for living in close proximity to wildlife, hence reducing negative attitudes (Hemson et al., 2009). However, in Sariska, even though some were being benefited by tiger safaris, benefits were largely limited to only two villages out of the 28 residing within the CTH. As also highlighted by other studies, communities often perceive tourism to be profitable for "government" and not them, because the profits from tourism are shared by very few in the community (Hemson et al., 2009).

Recommended Strategies for Management of Attitudes

Cost and Benefit

Contrary to what might be expected, allowing people to eliminate conflict-causing carnivores does not change their attitude towards the carnivore or improve tolerance (Browne-Nuñez et al., 2015). However, reducing tangible costs through compensation and increasing tangible benefits through ecotourism might be a good strategy (Kansky et al., 2016). People should be compensated for their losses immediately and the compensation process needs to be simplified. In the case of Sariska, benefits from tourism have been found to be correlated with support for the reserve in the past (Sekhar, 2003). Benefits incurred by tiger tourism should be spread out by encouraging local stakeholders over outsiders, in both of the reserves. At the same time letting forest-dwelling communities retain grazing or NTFP collection rights may be crucial in fashioning attitudes towards reserve management and wildlife. In Sariska, respondents who were getting more benefits from the forest were more positive towards tigers. This is because people make substantial profits from their dairy business, such that a few losses incurred by tigers may not make them negative. However, if they are not allowed to graze in the forest, and that in turn affects their capability to keep large livestock holdings, resulting in less profit, then the same number of livestock lost to tigers may invoke negative emotions.

Monetary incentives, therefore, are effective in the immediate alleviation of negative attitudes. However, incentives may work better if they are paired with social norms and educating people about the risk and benefit of the carnivore as well as, improving relationship with reserve management (de Pinho et al., 2014; Harvey et al., 2017).

Education and Gender

Since the level of education and knowledge about species influence attitudes towards wildlife (Pinheiro et al., 2016; Karanth et al., 2019; Meena et al., 2021), when people are educated about the benefits of the species, they become more tolerant (Bruskotter and Wilson, 2014). Poor knowledge about the species itself can lead to people attributing their loss to carnivores (Marchini and MacDonald, 2018). Thus, educating people about carnivores may decrease their sense of loss. Moreover, when people have correct knowledge about a carnivore, they also fear them less (Marchini and Macdonald, 2012) and will respond appropriately to conflict situations. Therefore, educating people can make them more positive towards carnivores, especially women, by allaying their fears and encouraging conservation values.

Receiving formal education and especially higher education inclines individuals towards conserving the environment (GEM Report, 2015). In both our study areas where formal education levels are low, and there are no regular programs for spreading awareness about conservation among the local communities; a multi-pronged approach is required, which firstly, focuses on ensuring formal education for both children, as well as, adults, especially women. Secondly, conducting conservation education and awareness programs, to reach the masses not covered by formal education. Lastly, sharing indigenous knowledge to promote traditional conservation values [Global Education Monitoring (GEM) Report Team, 2016]. Conservation education programs that take advantage of traditional beliefs and highlight the benefits of carnivores in a manner that is relatable to the target communities may make people more accepting of large carnivores and pro-conservation (Carter et al., 2012; Gebresenbet et al., 2018). Studies have suggested involving religious leaders in places where attitudes towards carnivores are guided by religious sentiment (Hazzah, 2007). Therefore, roping in local religious leaders for promoting tiger conservation may make attitudes

TABLE 6 | Multinomial logistic regression model explaining the attitude of people facing loss towards tiger in Sariska Tiger Reserve: Parameter estimates.

Attitude[a]	Parameters	B	Std. Error	Wald	df	*p*-value	Exp(B)
Neutral	Intercept	−1.324	0.884	2.243	1	0.134	
	Value of fodder obtained from forest	0.000	0.000	2.786	1	0.095	1.000
	(Gender = F)	1.793	0.711	6.354	1	0.012	6.010
	(Gender = M)	0[b]	0.0	0.0	0	0.0	0.0
	(Species of last livestock lost = Buffalo)	0.298	0.792	0.141	1	0.707	1.347
	(Species of last livestock lost = Cow)	0[b]	0.0	0.0	0	0.0	0.0
Negative	Intercept	0.024	0.550	0.002	1	0.965	
	Value of fodder obtained from forest	0.000	0.000	0.210	1	0.647	1.000
	(Gender = F)	1.442	0.535	7.274	1	0.007	4.228
	(Gender = M)	0[b]	0.0	0.0	0	0.0	0.0
	(Species of last livestock lost = Buffalo)	−0.898	0.519	2.991	1	0.084	0.407
	(Species of last livestock lost = Cow)	0[b]	0.0	0.0	0	0.0	0.0

[a] *The reference category is: positive.*
[b] *This parameter is set to zero because it is redundant.*

more positive in both of the reserves, especially in the case of the elderly, who might respond to religious values more than conservation ethics.

Women have responded very positively to environmental education in the past, which has resulted in them supporting the conservation of endangered species (WWF TAL Project, n.d.). They have further turned into educators themselves, teaching their children and larger community the conservation value of a species and even employing this knowledge for income generation (Hausheer and Waters, 2016). Arjunan et al. (2006) found that in the Kalakad-Mudanthurai Tiger Reserve in India, women were more positive towards the tiger and its conservation than men. The positive opinion was a result of an eco-development project that was benefiting women more than men were. Similar efforts can be made in Sariska and Panna, by strengthening eco-development committees and ensuring women's participation in them, so that women not only become aware of conservation issues but also become active participants in natural resource management decision-making at the household and village levels.

Summary

Understanding the attitude of people towards tigers and factors that help formulate these attitudes is critical to ensure the long-term persistence of tigers in India, especially in habitats where they have been reintroduced. We found gender and education to be important determinants of attitudes towards reintroduced tigers. Encouraging education, particularly that of rural women, should thus be aimed at, to ensure people's participation in the conservation of large carnivores. If people do not feel safe and secure, it creates challenges for the protection of large carnivores, especially in the human interface areas. The best way forward would be to ensure a shared vision and integrate both livelihood and conservation aspects into the governance and management actions. Consultation with local communities should thus be an integral part of the planning and implementation process for any conservation program. More so, in the case of costly conservation programs like translocation/reintroduction, which directly impact the lives and livelihoods of the forest-dwelling communities.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for this study in accordance with the local legislation and institutional requirements.

AUTHOR CONTRIBUTIONS

Material preparation, data collection, and analysis were performed by MM. Funds for the study, and requisite approvals from the forest departments of Madhya Pradesh and Rajasthan, were obtained by RK and SK. The first draft of the manuscript was written by MM. All authors commented on previous versions of the manuscript, contributed to the study's conception and design, read and approved the final manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcosc.2021.783467/full#supplementary-material

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Human Dimensions of the Reintroduction of Brazilian Birds

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People's acceptability for wildlife, stakeholders' engagement and involvement are acknowledged as key factors for the success of wildlife reintroduction projects. We analyzed the main National Action Plans (NAPs) (the Brazilian management participatory instrument for the conservation of endangered species) for eight bird species and conducted an online questionnaire with researchers and practitioners involved in those species reintroduction programs. The assessment of the main Brazilian bird's reintroduction programs showed that, in general, efforts have been made to integrate local people into it. Nevertheless, the actions were disconnected, isolated and fragmented. A formal protocol, designed, discussed and approved by experts aiming to address the human dimensions (HD) of human-bird interactions (HBI), preferably to be used in each stage of the reintroduction programs, was not found. Actions considered related to human dimensions are mainly under the umbrella of environmental education interventions or campaigns, more directed to children and youth; correspond to activities performed by locals with the birds and/or captive birds facilities; or, fostering artcraft production or bird watching activities. The weak or sometimes absent human dimensions approach to this important conservation tool may indicate either the novelty for Brazilian researchers and managers of the science of human dimensions within the field of wildlife management or the lack of dialogue between natural and social sciences when wildlife conservation is at stake. Reintroductions are expensive, sensitive, and labor-intensive processes. It becomes necessary due the conservation status of the species and its implementation follows a careful research of biological, ecological and socio-institutional regional background that identifies the drivers of species extinction and plans according to it. Understanding and predicting people's behaviors and its triggers are paramount to successful reintroduction projects. Thus, making use of well-planned HD studies in HBI may be the watershed between success or failure of reintroduction programs. This study was a pioneer initiative of its kind and it aimed to provide sound recommendations for managers, researchers and practitioners to acknowledge the relevance of HD and its core role in the reintroduction of endangered bird species.

Keywords: conservation, endangered species, engagement, human-bird interaction, bird's release

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INTRODUCTION

Human population growth and the increasing use of natural resources have promoted significant modification on terrestrial and aquatic ecosystems, resulting in habitat loss, ecosystem's fragmentation, pollution and environmental degradation of soils and aquatic systems, overexploitation of species and introduction of exotic species (WWF, 2020). As a main consequence of these impacts, the biodiversity loss accelerates (Sodhi and Ehrlich, 2010; Galetti and Dirzo, 2013). Dirzo et al. (2014) describe the defaunation of the Anthropocene as the sixth big mass extinction in our planet. Amongst the vertebrates it is estimated that most species had reduced their abundance by 25% and among the invertebrates this number is greater, reaching about 45 in 67% of the species assessed. It is estimated that among bird species, 187 were extinct by the year 1500 (Butchart et al., 2018) and currently about 14% of bird species are under some level of threat (IUCN, 2021). Brazil is one of the countries with the greatest and most threatened bird diversity in the world (Develey, 2021). The high vulnerability of wild species loss in Brazil is evident (Scheffers et al., 2012) and threats include deforestation, fragmentation, and habitat loss (Sodhi and Ehrlich, 2010). The extinction of bird species is also related to the introduction of exotic and invasive species, poaching and illegal trade (Butchart et al., 2018). On average, 36 thousand birds are confiscated per year and taken to Brazilian Wild Animals Rehabilitation Centers (Destro et al., 2012). Beyond the ethical right to exist, assessing the causes of bird's extinction also matters for ecological reasons; many species are pollinators, others are scavengers, and all perform ecological roles and services in the ecosystems they inhabit (Whelan et al., 2008).

Conservation programs of threatened species in general have three stages: (I) Recognition and identification of the endangered species; (II) Implementation of immediate and short-term protection measures to species conservation; and (III) Reestablishment (recuperation) of species population through long term measures (Wilcove, 2010). The establishment of Protected Areas through private initiatives from landowners of important areas for conservation and the management focused on specific species has contributed to the conservation of many Brazilian birds (Develey, 2021).

In Brazil, among the 166 endangered birds' species, two are considered extinct, *Numenius borealis* and *Anodorhynchus glaucus;* and two are already extinct in nature, *Pauxi mitu* (Alagoas curassow) and *Cyanopsitta spixii* (Spix's macaw) (Pacheco et al., 2021). The conservation of these species depends on reintroduction efforts (White et al., 2012). On a global level, at least 25 bird species changed their conservation status because of conservation actions such as reintroduction. Some of these species are Brazilian examples: *Crax blumenbachii* and *Anodorhynchus leari* (BirdLife International, 2018). The process of reintroduction is defined as the intentional release of individuals from one species in a place that comprehends part of its natural distribution before the species disappears or becomes extinct (Armstrong and Seddon, 2008; Sutherland et al., 2010).

The success and effectiveness of conservation programs rely on local people's engagement (Dayer et al., 2020; Develey, 2021). The difficulties and limitations of reintroduction programs have been historically attached to the inefficiency of modifying the scenario that caused the threats to the species, and human actions have often been determinant to cause the vicious circle, keeping the same scenario time after time (Gama et al., 2016). Seddon et al. (2007) reviewed articles published between 1990 and 2005 involving wildlife reintroduction and found that only 4% considered certain aspects of human dimensions (HD), such as people's attitudes toward reintroductions. Watkins et al. (2021) highlight that besides the growing actions for species reintroduction, the human dimensions of human-birds interactions and the reintroduction implications for the communities are still little known and explored.

Research in HD intends to identify, describe, understand, predict, and influence human thoughts, actions, and behaviors toward wildlife (Manfredo and Dayer, 2004). In Brazil, besides the operational difficulties, the low socioeconomic indexes among rural communities complicates the efforts to restrain illegal captures and wildlife trade (Barbosa et al., 2010). Thus, law enforcement alone is inefficient to minimize these practices (Bezerra et al., 2012). More suitable strategies are needed such as planning education for tolerance toward wildlife, and wildlife management aligned with the improvement of social and economic indexes of vulnerable human populations that co-occur with wild species. The guidelines, discussed by the working group in human and wildlife interactions (Consorte-McCrea and Bath, 2020) for reintroduction programs of wild species involve listening to and learning from local populations, before, during and after any action of reintroduction and translocation of animal species.

The overarching goal of this research is to analyze how the main projects of bird's reintroduction in Brazil approach the human dimensions of human-bird interactions in their different stages. The study intends to answer four questions: (1) How many actions within the project have human dimensions in their objectives? (2) What actions are these? (3) How detailed and clear are they? (4) How do people who plan and implement reintroduction efforts perceive the human dimensions within the projects?

MATERIALS AND METHODS

Bird Reintroduction Projects

Data were collected from eight bird reintroduction projects in Brazil. These projects have as focal species and its conservation status: *Aburria jacutinga*—EN (endangered) (ICMBio, 2018a; IUCN, 2021); *Crax blumenbachii*—CR (critically endangered) (ICMBio, 2018a), EN (IUCN, 2021); *Pauxi mitu*—EW (extinct in the wild) (ICMBio, 2018a); *Amazona vinacea*—VU (vulnerable) (ICMBio, 2018a), EN (IUCN, 2021); *Anodorhynchus leari*—EN (ICMBio, 2018a; IUCN, 2021); *Cyanopsitta spixii*—CR (ICMBio, 2018a); EW (IUCN, 2021); *Guarouba guarouba*—VU (ICMBio, 2018a; IUCN, 2021) and *Sporophila maximiliani*—CR (ICMBio, 2018a); EN (IUCN, 2021). These projects were chosen because they represent the main and most prominent projects currently known for bird reintroduction in Brazil.

Three of the species (*P. mitu*, *A. jacutinga* and *C. blumenbachii*) belong to the Cracidae family. They are large frugivorous birds that require large areas with more preserved vegetation and are hunted in large numbers. Traditional communities in the Brazilian Amazon often interact with these species, hunting them in large numbers (Peres, 2000).

Pauxi mitu has just 120 individuals living in captivity (ICMBio, 2008). The "Alagoas Curassow" Reintroduction Project, coordinated by the 4th Prosecutor of Maceió, the Capital of Alagoas state, resulted in the release of three pairs of the species in September 2019. Since then, the individuals released have been monitored, and two males and one female were found dead for unknown reasons (Francisco et al., 2021). The same project planned the release of more individuals in 2021 and 2022. Before the *P. mitu* reintroduction, in 2014, Gama et al. (2016) interviewed 402 people from the hinterland communities in a 5 kms radius from the reintroduction site and found that most people were favorable to the *P. mitu* reintroduction. Also, the acceptability of the program was positively related to the age and level of formal education of interviewees (Gama et al., 2016).

Aburria jacutinga is a species that depends on forested areas with a good conservation status in the Atlantic Forest domain and has different conservation status in its occurrence area (See details in Endangered Galliformes National Action Plan). Where this species forms populations, it must share territory with traditional communities and tourists, facing habitat loss, anthropic perturbations and poaching. Bernardo et al. (2011) estimated that in 11 areas in São Paulo state, this species density varied between 1.2 and 2.2 individuals/km^2, and poaching represented its main threat. The *A. jacutinga* reintroduction project has been coordinated by the NGO SAVE Brazil since 2010. In 2016 some individuals started to be released in different areas, up to 30 releases. Since then, post-release monitoring has registered reproductive activities among individuals (Phalan et al., 2020). The SAVE Brazil produced several educational materials focused on jacutinga conservation such as "Guia de Práticas e Saberes com a Natureza—Projeto Jacutinga" (available in: https://savebr-site.s3.amazonaws.com/guia_ativ_web.pdf).

Crax blumenbachii is a species with native populations only in the states of Bahia and Espírito Santo, Brazil (ICMBio, 2012). The largest population is on Vale Natural Reserve, Espírito Santo state, and was estimated at 325 individuals (Alves et al., 2015). Rocha et al. (2019) studied three vegetation fragments in Bahia state, finding between 0.13 and 0.29 sightings/10 km. Phalan et al. (2020) estimate 200 individuals living in captivity, totaling about 500 individuals in nature and captivity. From 2006 to 2008, 53 individuals were reintroduced in a protected area in Rio de Janeiro state (Bernardo, 2012; Bernardo and Locke, 2014). Despite the reproduction evidence among the individuals in the releasing site (Bernardo and Locke, 2014), there is no assurance to maintain a minimum viable population of the species in the state, especially considering the presence of poaching in the area (Bernardo et al., 2014). The "Project Mutum" developed by CENIBRA Company (Celulose Nipo-brasileira S.A.) and CRAX Foundation (Society for Research, Management and Reproduction of Wild Fauna), released a total of 480 birds from 1990 and 2018, and some of these species were the *A. jacutinga* (180 individuals) and *C. blumenbachii* (Phalan et al., 2020), both analyzed in this research. Of the 251 *C. blumenbachii* individuals that were reintroduced, 44 died and 116 were born from the new population (ICMBio, 2012).

Amongst the Psittacidae family, the reintroduction projects analyzed represented four species (*C. spixii, A. leari*, *A. vinacea* and *G. guarouba*). This birds' family is the one with the largest number of endangered species in the world (White et al., 2012). *Cyanopsitta spixii* has 129 individuals estimated to be living in captivity (ICMBio, 2018b). In June 2019, the ICMBio approved the second stage of the National Action Plan for the conservation of *C. spixii* that plans the reintroduction of the species individuals up to the year 2024. To achieve this goal, 52 individuals of *C. spixii* were brought from a private breeding center in Germany to the city of Curaçá, Bahia state, northeastern Brazil (Marcuk et al., 2020). A socioeconomic assessment in the region of Curaçá was done immediately before the creation of a polygon of protected areas under the management of ICMBio and redone as part of an Interamerican Bank of Development request as sponsor of a project for degraded areas restoration, to confirm the safeguards of the protected areas's creation. A pioneer participatory rural appraisal (PRA) (Newing et al., 2011) and a short-term' research within the area where the specimens will be released were conducted to correlate socioeconomic factors with community and children and youths' knowledge and perceptions about wild birds' species and the use values given by the community to them (Martins, in preparation).

Anodorhynchus leari is an endemic species from Caatinga, restricted to a small area in Bahia state (Lugarini et al., 2012). There is a population of the species in the ecoregion called "Raso da Catarina," where population surveys, undertaken from 2001 to 2012 by the National Center of Research and Conservation of Wild Birds (CEMAVE) have shown a population increase from 228 to 1263 individuals (Lugarini et al., 2012). Because of this increase, the species conservation status was updated from Critically Endangered to Endangered in 2008 by the IUCN (BirdLife International, 2018). The reintroduction project of the species ("Lear's Macaw: Research and Conservation"), has been developed by Loro Parque Fundación, in partnership with "Arara Azul" Institute, SAVE Brazil and ICMBio. According to the project's coordinator, in 2018 six individuals were brought from Loro Parque Fundación to "Boqueirão da Onça," a polygon of federal protected areas located in the northeastern of Bahia state, where the species was locally extinct, and released in January 2019; the second release occurred in 2021, with another six individuals released and monitored. Apart from the potential birdwatching as an alternative source of income to the region of "Raso da Catarina," other activities to generate income to the local communities include handicraft and artisanal products from "licuri," a regional palm tree (*Syagrus coronata*), valuable to people and food source for the birds (Andrade et al., 2015).

Amazona vinacea inhabits the Atlantic Forest domain, mainly in higher altitudes (from 500 to 1,700 m) (Schunck et al., 2011). It is estimated that there are between 1,000 and 2,500 individuals in the wild (Kanaan, 2016), but it is hard to assess a real number because this species makes seasonal displacements (Schunck et al., 2011). In the region of Curitiba,

Paraná state, the species population is estimated by 1,000 individuals and in Rio Grande do Sul state this number reaches 911 individuals (Schunck et al., 2011). The *A. vinacea* Reintroduction Project is coordinated by the "Espaço Silvestre" Institute, launched in 2010. The Institute website informs that from 2011 to 2021 in the state of Santa Catarina, 222 individuals were introduced at the protected area "Araucárias" National Park (available in: https://www.espacosilvestre.org.br/papagaiodepeitoroxo). Environmental actions and educational material were produced by "Espaço Silvestre" Institute and distributed at local schools, aiming to promote species' conservation. Furthermore, a group of local artisans popularly known as little purple's friends make and sell different products inspired by *A. vinacea*, generating income to the community.

Guarouba guarouba is endemic from the Amazon region and has an estimated population of 500 individuals in the west of Pará state (Laranjeiras, 2011). The same author estimates that the global species population is about 10,000 individuals and it is common to find the species in captivity (Vilarta et al., 2021). The "Ararajubas" (*G. guarouba*) Reintroduction and Monitoring Program is coordinated by the Forest Development and Biodiversity Institute from Pará state (acronym in Portuguese Ideflor-bio), in partnership with the Lymington Foundation, and developed within protected areas in the Metropolitan region of Belém, the capital of Pará state. Through this program, 14 individuals arrived at the reintroduction site in 2017 and 10 individuals in 2018. About 20 individuals were released in two different moments; the authors do not specify the dates (Vilarta et al., 2021).

Finally, the unique Passeriformes project assessed was the *Sporophila maximiliani* project. *Sporophila maximiliani* population in captivity, registered at the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), is estimated at 180,000 individuals (Machado et al., 2020). The species is rare in the wild (Ubaid et al., 2018) and is locally extinct in several areas of its original distribution area. Ubaid et al. (2018) highlighted that the main threat to the species is poaching and capture to illegal trade. The reintroduction project of this species in key areas of the Cerrado biome is developed by the "Ariramba" Nature Conservation Institute. The project plans the reintroduction of individuals from 2017 to 2021 at the protected areas of "Grande Sertão Veredas" National Park and "Cajueiro" Private Reserve of Natural Heritage, in the states of Minas Gerais and Bahia (available in: http://cepfcerrado.iieb.org.br/projetos/reintroducao-do-bicudo-em-areas-chave-para-conservacao-do-cerrado/). Ubaid et al. (2021) reported the release of 12 pairs of this species since 2018 in this region. Another project that plans this species reintroduction is the "*Sporophila maximiliani* Biology and Conservation Project in Minas Gerais: the return of the species," developed by Waita Institute for Research and Conservation, since 2016, but it is in prior phases to the releases (available in: https://waita.org/projetos-waita/2018/06/08/projeto-bicudos).

Data Collection and Analyses

We analyzed the Conservation National Action Plans (NAPs) related to the reintroduction projects of eight bird species through a systematic reading of their planning matrix. The NAP is a management tool for public policies used by the Brazilian central government, namely 'Chico Mendes' Institute for Biodiversity Conservation (acronym in Portuguese ICMBio). The instrument is built through a participatory process including different stakeholders, and aims to organize and prioritize effective strategies of conservation for Brazilian endangered species (ICMBio, 2018c). Given that the effectiveness of reintroduction projects depends on the agreement with public policies related to species conservation, we choose to analyze how human dimensions are present (or not) in these documents.

The planning matrix brings the objectives and strategic actions to promote improvements on endangered species conservation status. We examined the integration of a human dimensions' approach, either directly or indirectly, within the various actions in the most recent bird NAPs. Actions considered related to human dimensions were those that depend on the local community directly (e.g., changing behavior) or indirectly (e.g., land use restrictions). The NAPs are planned and evaluated every 5 years and they are based on methods used by IUCN (ICMBio, 2018c), thus we searched for the most recent NAPs that addressed the eight bird species focus of the reintroduction projects analyzed.

Additional data were collected through an online questionnaire targeting the reintroduction project's coordinators or researchers directly involved in these projects. These individuals were contacted by email or phone to be firstly presented to the main objectives of this study and its possible implications in future reintroduction programs. Prior to conducting interviews, the study was submitted and approved by the Ethical Committee of Research Involving Human Beings of University of Pernambuco (protocol number CAAE: 46639421.9.0000.5191). We used Qualtrics XM to collect data. Questionnaires had a total of 26 questions divided into four categories: (I) researcher involvement in the reintroduction program (five questions); (II) basic information about the reintroduction project (three questions); (III) how human dimensions were approached and investigated in the reintroduction project (13 questions); and (IV) personal information (five questions) (**Supplementary Material 1**).

RESULTS

Respondents Profile

Invitations to participate in the research were sent to 23 individuals involved in eight different projects. Fifteen agreed to participate (65.3% response rate), yet only nine completed the entire questionnaire. Among the 15 respondents, five were coordinators (33%), three were project collaborators (20%), one was an operational person from staff (7%), and six had other form of involvement (40%). Respondents worked with the reintroduction of six species: *C. blumenbachii* (n = 1), *C. spixii* (n = 3), *A. leari* (n = 2), *S. maximiliani* (n = 2), *A. jacutinga* (n = 1), and *G. guarouba* (n = 2). No participants from *A. vinacea* and *P. mitu* projects answered the questionnaire. One of the projects has already ended (carried out between 2006 and 2010; *C. blumenbachii*), and another one (*C. spixii)* has the birds in an

"adaptation to the habitat" phase before the reintroduction begin. The other four projects were ongoing by the time this research was carried out.

How Many Actions Within the Project Are Aimed at Human Dimensions?

We analyzed eight National Action Plans (NAP) (**Supplementary Table 1**). Four of the eight focal species (*P. mitu*, *C. blumenbachii*, *C. spixii*, *A. leari*) had a specific NAP. Currently, only *C. spixii* has its own NAP. *Pauxi mitu*, *C. blumenbachii* and *S. maximiliani* were included in the general NAP of the Atlantic Forest Bird Species, *A. vinacea* was included in the NAP of Parrots' Conservation, and *G. guarouba* was included in the NAP of Amazonian Bird Species.

A total of 327 actions were analyzed. Of those, 109 (30%) related to human dimensions (**Supplementary Table 1**). Actions listed in the NAPs were mainly related to managing birds in captivity, release sites, and post-release monitoring. Most of the human dimension actions were found in the *A. leari* (48%), and in the *C. spixii* (37%) NAPs; the *P. mitu* NAP only accounted for 22% of the human dimension related actions (**Figure 1**).

What Actions Were Identified? How Detailed Were They?

The 109 human dimension actions were divided into seven categories: (1) Environmental Education and Awareness; (2) Public administration/wildlife management (e.g., protected areas, compensation); (3) Law enforcement; (4) Infrastructure (e.g., visitor center); (5) Communication and information dissemination; (6) Sustainable livelihoods (e.g., birdwatching, training); and (7) Research involving Human Dimensions. Category two has the higher number of actions listed in NAPs (44), followed by Category one (26) (**Figure 2**). Category four has just a single action (**Figure 2**).

Actions within Category two, related to land use and natural resources management concerning public administration are mainly land demarcation, creation and establishment of protected areas, habitat conservation and restoration of degraded areas, and ecological corridors (with people living within and surrounding protected areas). The actions in Category one, environmental education and awareness, had a low level of detail compared to actions within objectives related to the management of captive birds or to study of bird ecology; these actions are described as "To promote environmental education programs" (see **Supplementary Table 1**). Actions related to improving socioeconomic context refers to the promotion of sustainable livelihoods and fostering and diversifying local economic activities with artisanal honey production, birdwatching, and crafts using the bird as a symbol. These actions were found in the *A. leari, C. spixii* and *A. vinacea* NAPs, corresponding to 13% of those 109 actions (**Figure 2**). Actions that foster bird watching activities are also determined in the NAP of Atlantic Forest Bird Species.

The *A. leari* NAP was the only one mentioning conflict between people and the threatened bird species, which occurs when birds feed on corn plantations causing economic loss to farmers. A compensation scheme is anticipated to mitigate the conflict. Concerning mitigation or compensation schemes given by development projects causing environmental impacts, the resource would go to bird conservation efforts, and do not include the local communities.

From the questionnaires we found that six of the eight reintroduction projects (with the exception of *P. mitu* and *A. vinacea* which representatives did not answer to this question) performed actions designed to include a human dimension approach, namely: offering public visits to the project facilities; providing information about the species and the importance to preserve it through lectures and booklets predominantly at schools; opening job opportunities in activities linked directly (e.g., research assistant) or indirectly (e.g., park ranger, art craft) to projects' activities; conducting interviews and informal conversations to gather information about the species; facilitating direct participation in the projects' activities (e.g., training on birds' release, participatory monitoring), and citizen science. One respondent stressed the importance of these participatory monitoring activities in the *A. leari* project during the COVID-19 pandemic when local communities were essential in the absence of researchers in the field conducting work.

Other actions, cited by the researchers in the *C. spixii* project, included the creation of the management board of protected areas where the project happens; call for and social participation in the protected areas management; socio-environmental planning and professional training. These last actions brought a different perception of local communities' participation, availing them the chance of being stakeholders, listening, speaking, and taking decisions. In the *A. jacutinga* project it was mentioned the effort to establish a sense of pride among the local communities to promote species conservation.

In Which Phases of the Projects Did Actions Take Place?

Data from the questionnaires showed that the *C. spixii* project adopted a human dimension approach only during the pre-release phase (they have not moved forward the next phases of the project). The *S. maximiliani* project developed activities within this approach close to the release and post-release phases. The other four projects worked with the local communities during all reintroduction phases.

How Did People who Plan and Carry out Reintroduction Projects Perceive Human Dimensions as Part of Their Projects?

Eight of the fifteen respondents (53.3%) strongly agreed and one agreed (6.7%) with involving communities as part of the reintroduction projects. One of the respondents (6.7%) neither agree nor disagree with community involvement.

A total of 19 answers about how people can positively impact the reintroduction projects were collected. These answers were ordered into four categories (**Figure 3**): (1) participating directly in the project (human resources and monitoring); (2) protecting the species (reporting illegal actions, being species guardians); (3) obtaining and disclosing important information (citizen science);

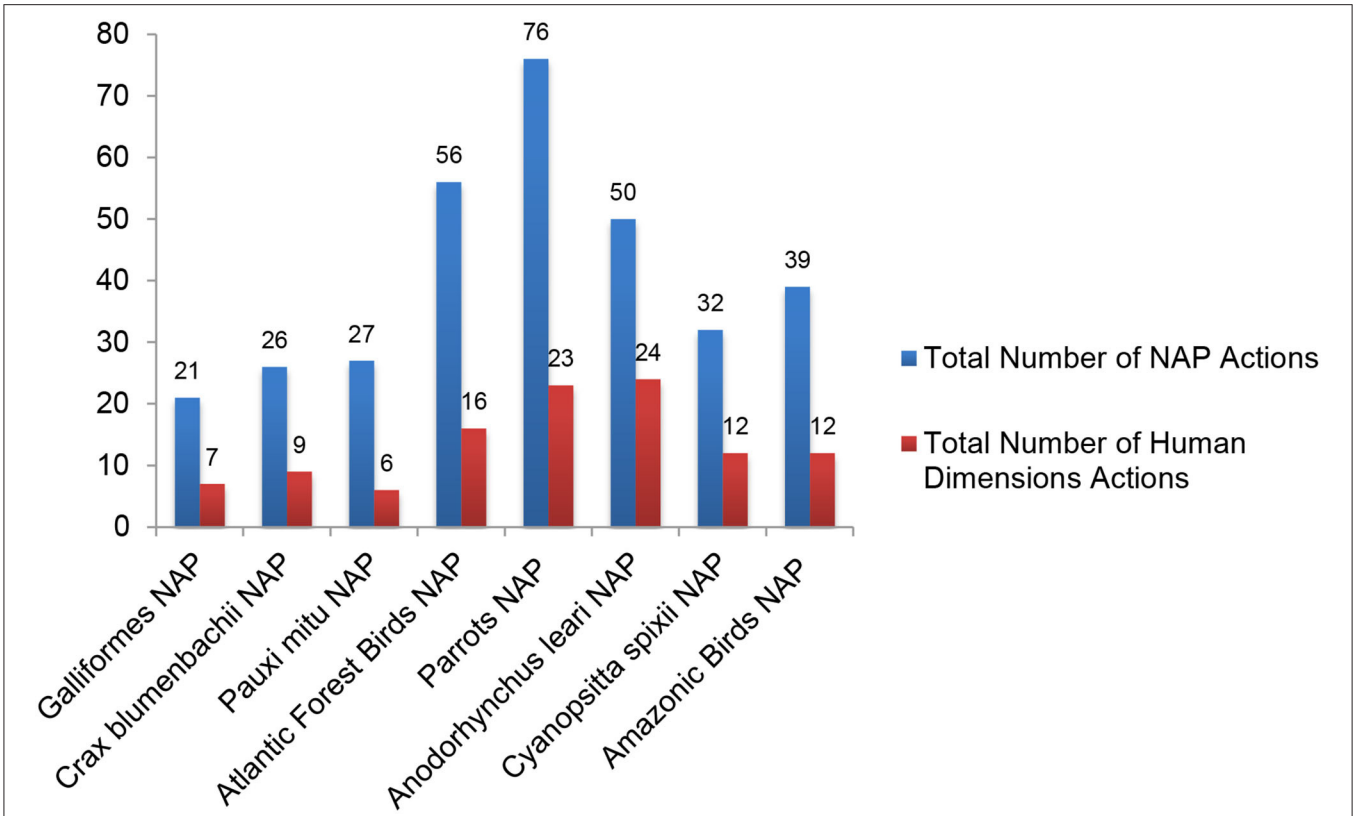

FIGURE 1 | Total number of National Action Plans actions in comparison with actions related to Human Dimensions found in the NAPs analysed.

and/or, (4) acting as co-responsible in the project (making individual and collective conscious choices; directly involved in some profitable activity related to the project; feeling of pride and species appreciation).

Although 21% of the answers referred to the fourth category, it corresponds to data provided only by two (13%) of the 15 interviewees. These individuals highlighted the active participation of local people to the conservation of the focal species by fostering community behavior changes, such as stopping captures. One respondent mentioned improving livelihoods through extra income coming from the species' conservation, such as birdwatching. Another respondent mentioned that the projects could be positively impacted if local people were proud of the fact that in their region the focal species is preserved.

Seven out of nine respondents pointed out that people in communities had the opportunity to share their appreciation toward, and knowledge about the focal species during the social engagement activities.

Participants were also asked how communities could negatively impact the reintroduction efforts. A total of four threats were indicated among 14 responses (respondents could cite more than one action). All respondents related poaching and illegal captures as negative impacts. Two respondents referred to artificial bird feeding, bird attraction and habitat destruction as threats to the projects. One respondent mentioned the resistance that some communities may have to cooperate with the dissemination of relevant conservation information and the lack of engagement in environmental education actions.

Finally, of the nine answers about the main challenges to birds' reintroduction in Brazil, four (44%) mentioned the availability of viable individuals to be reintroduced, three (33%) mentioned poaching and illegal capture of the species, the lack of financial sponsorship and post-release monitoring (**Figure 4**). Two respondents mentioned community engagement as a challenge, and one pointed to the socio-environmental development of communities in balance with species conservation. These points were not mutually exclusive. Participants of this research were asked to explain how interviews with locals were conducted, if it occurred. It is noteworthy that three projects conducted interviews based on public engagement protocols that were available from other reintroduction projects, whilst four created their own protocols.

DISCUSSION

Actions Using a Human Dimensions Approach and the Lack of Detail

The assessed NAPs of Brazilian endangered birds highlights the paradox of being a very-well conceived instrument for wildlife management within and surrounding protected areas and an indication that the human dimensions of human-bird

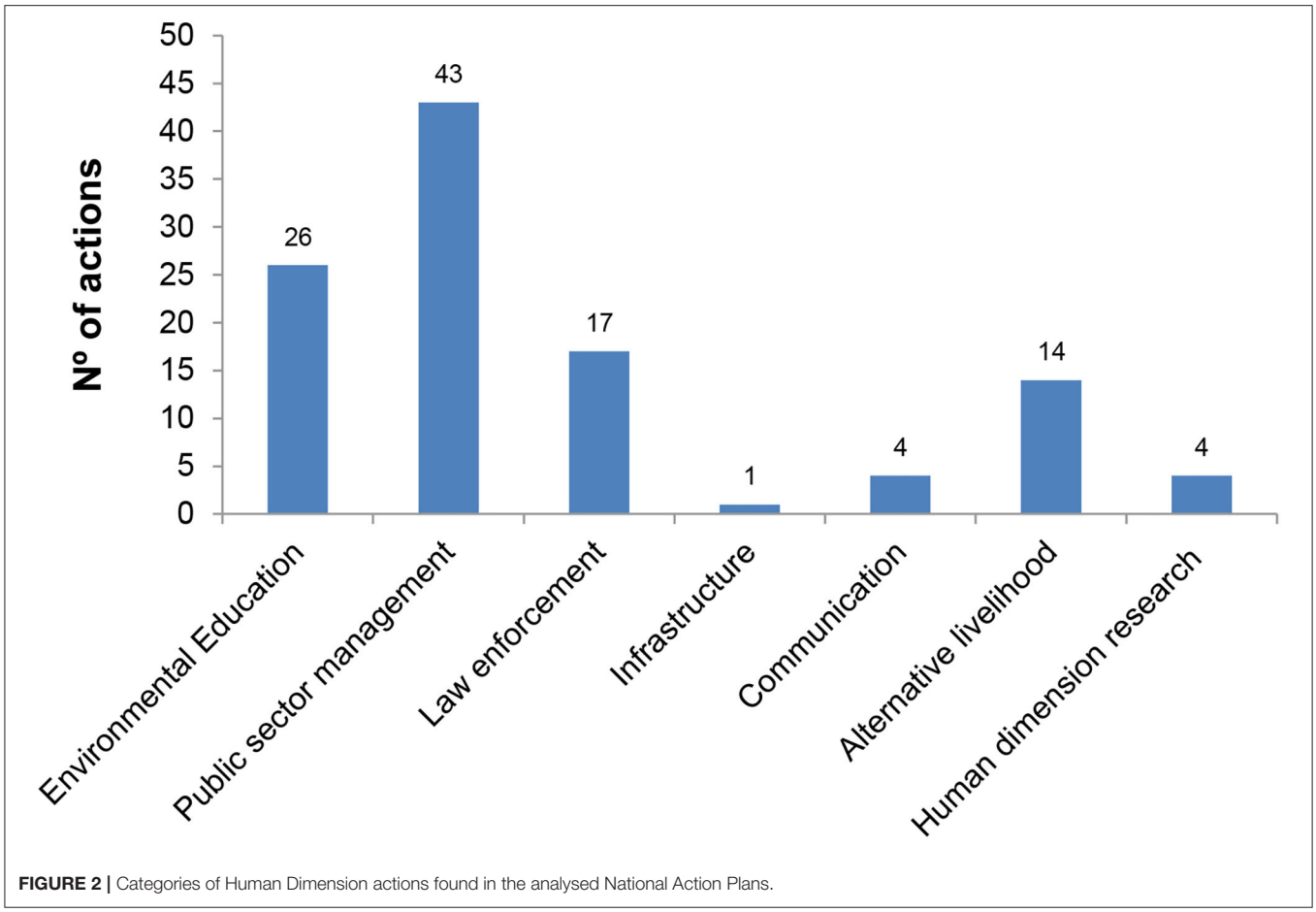

FIGURE 2 | Categories of Human Dimension actions found in the analysed National Action Plans.

interactions is in its infancy. The NAPs also point to the imbalance between goals and actions related to biology and ecology of birds and goals and actions related to variables of human behavior toward the birds and their determinants. The gap between how people are framed in the current NAPs and what people could perform in all stages of a life-cycle project of bird reintroduction weakens governance and compromises conservation of species and its habitats.

When looking at the conservation and reintroduction projects of birds in the world, compiled by IUCN SSC Conservation Translocation Specialist Group (CTSG) (Soorae, 2008, 2010, 2013, 2016, 2021), we see that editions from 2016 and 2021 have more projects with objectives related to human dimensions than in the previous years. The number of the projects with human dimensions objectives in 2016 (46% of the 13 case studies) was twice the number of 2008 (23% of the 17 case studies). The Conservation Project of *Vultur gryphus* in Argentina, developed by Jacome and Astore (2016) focused on three of four objectives related to human dimensions. The authors argued that educational and extension projects are essential to promote changes in behavior and perceptions in favor of focal species and environmental conservation. The *A. vinacea* reintroduction project (Kanaan, 2016) has as one of its goals to create sustainable socioeconomic opportunities to the local communities of species occurrence area. Ewen et al. (2018) highlight among the four main objectives of Hihi (*Notiomystis cincta*) Recovery Group, in New Zealand, to increase public appreciation. To work on this matter the group promotes public knowledge about the species and comprehension about the causes that threaten the species and how people can help to preserve it; they also encourage volunteer work (national and international). It is likely that because of greater inclusion of human dimensions factors in the early planning stage of the project, greater success was reported in community participation in all the project editions since 2013.

Actions with the objective of reducing and controlling illegal trade of birds covered aspects of improving enforcement and involved those vulnerable populations who are typically part of the hunting, capture and trade of birds. In these actions, some NAPs mention the possibility of changing the legislation to improve enforcement. Few actions mention behavior change *per se*, although they mention promoting environmental education to mitigate illegal trade. Actions aiming to develop scientific knowledge about the species did not include the opportunity of integrating social sciences. Research including cultural and socioeconomic context of local people and their interactions with bird species were absent as well as local population knowledge, values, and norms about the focal species. The only exception is the *C. spixii* NAP which acknowledges the need to know

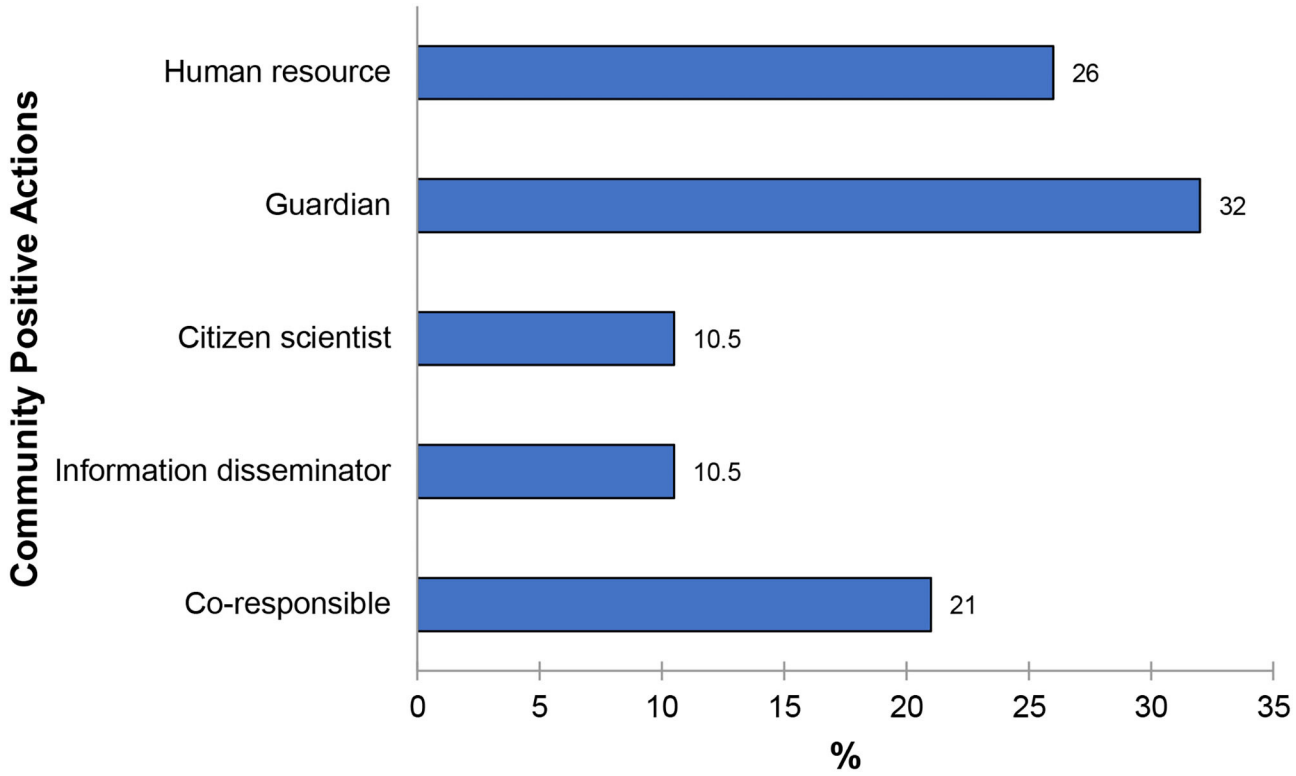

FIGURE 3 | Community positive actions toward reintroduction projects cited by the survey respondents.

the socioeconomic profile of the communities and the hunting activities eventually performed by locals.

Looking at the results from the interviews conducted with representatives of six reintroduction projects, it appears that most of them had a human dimension approach, which was expressed mainly through public presentations carried out in schools, and meetings with different stakeholders. Engagement with communities living close to release sites were sometimes promoted before the reintroduction, but for most of the projects, locals were involved in all phases, i.e., pre-release, during, and post-release. These findings indicate that, in general, efforts have been made to integrate local people to bird reintroduction projects. However, the actions were planned isolated, disconnected, and fragmented, involving more palliative actions, and less preventive and/or behavioral change actions. Approximately one quarter of the answers mentioned employment or volunteer work as ways to engage society in the reintroduction projects. This may be linked to the fact that this is the fastest and most effective way to integrate locals in project actions. The difficulties to maintain financial support to the projects interfere in its capacity to propose and maintain long-term educational programs focusing on species conservation.

Local people are seen especially as human resources and instruments to protect the focal species, but rarely as a real participatory tool to make decisions that would affect them directly and indirectly. Few researchers associated engagement with the projects as improvement for local quality of life, environment, and economic activities. This fact is also evident in the responses given about community participation in the projects, which were related to locals being recipients of education and information about focal species and local people monitoring and collecting scientific data about species. The same reasoning is displayed in the NAPs, where engaging local people comes restricted to their support to the already designed, and planned activities proposed, with no local participation during the early stages of objectives, aims and goals' conception.

Engagement means the active involvement and participation of others, as many and diverse as possible, spontaneously or attending a call for it, and it is one of the first steps to a "good" governance of natural resources, which in its turn, must consider norms, values, and principles that underpin a dialogical decision-making management (Borrini-Feyerabend et al., 2013). Values, norms, and principles are rooted in human dimensions beyond cognitive processes, and include psychological, emotional, and cultural aspects, embedded of complexity and emerging unpredictably during a project life cycle, not only while someone performs his role in some operational stage of the process. Being a reintroduction project a management strategy, the agencies, programs, and projects leading need to acknowledge its relevance, sensitivity, and time-consumption, to make it a routine, which conducted in a safe interpersonal and institutional environment promotes learning

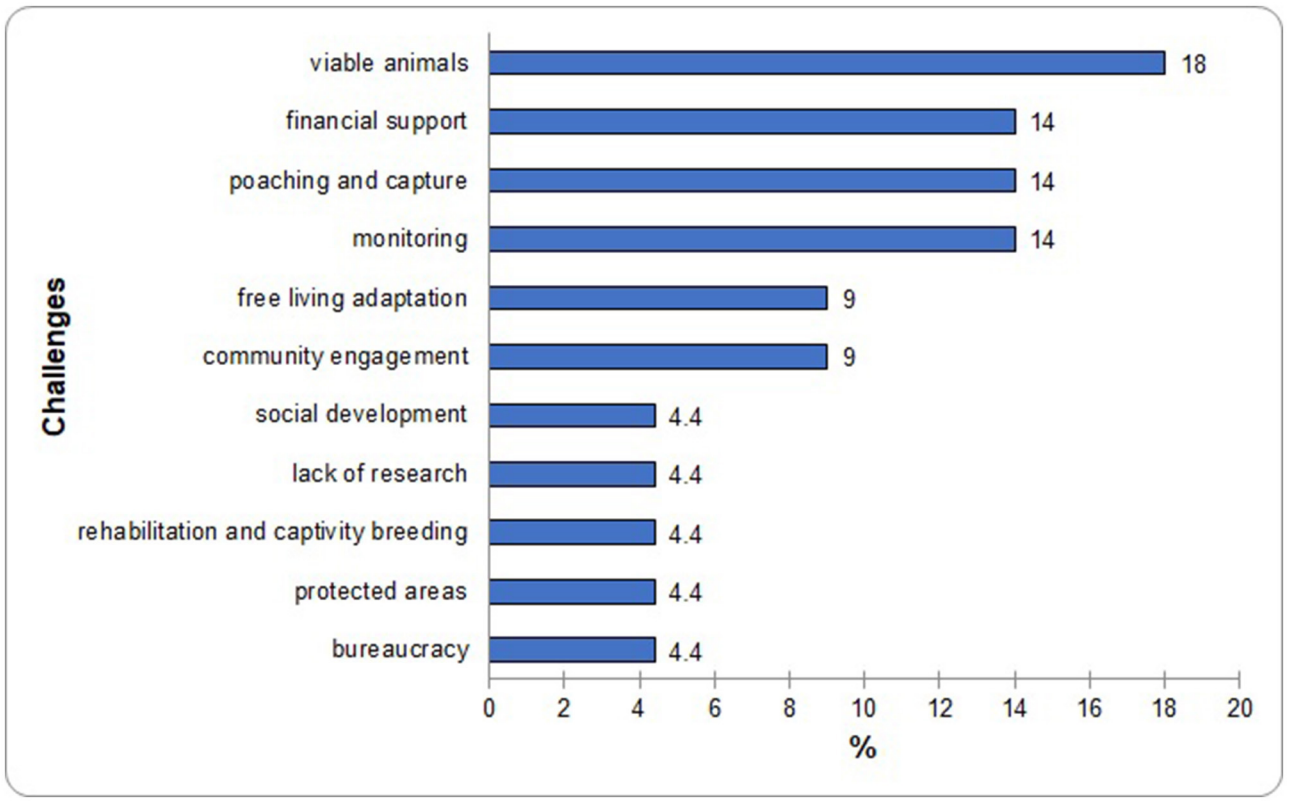

FIGURE 4 | Challenges for reintroduction programs mentioned by the survey respondents.

and trust among participants and prevents (reduces or mitigates) conflicts. Trust and confidence in management agencies are important to reduce risk perception and to gain support for reintroduction (Watkins et al., 2021).

To identify, describe, understand, and predict local people values, beliefs, norms, attitudes, and perceptions toward species reintroduced in the wild and the historical development of these interactions is important to understand the key factors that will influence people's attitudes and behaviors toward the reintroduction projects and toward the reintroduced species (Castillo-Huitrón et al., 2020; Dayer et al., 2020) and is crucial to the success of any reintroduction project (Owens, Consorte-McCrea, Kolipaka, Ruiz-Miranda and Waters, 2019). The code and guidance to reintroductions and conservation translocations in England (DEFRA, 2021) highlights the importance of not engaging the community, but to engage with community and other stakeholders since the planning stage of the program, creating and providing potential benefits, and consequently, reducing conflicts and possible local economic losses. The decisions must be shared, guaranteeing a listening, and speaking space to all stakeholders: people cannot cooperate with the reintroduction project if the decisions which affect them are not clearly shared with them (DEFRA, 2021).

The same pattern is observed in indicators related to HD goals--—46% and 45% of the indicators respectively, then in the previous year's programs (2008-—12%; 2010-—14% and 2013-—10%). Some of these indicators are not clear on operational variables such as good local awareness related to the program (Bernardo, 2008) or comprehension and cooperation from local communities promoting coexistence (Stoynov and Grozdanov, 2010). Some indicators are more specific, and therefore, have greater chances to be effective, monitored and measured as the indicators used in *Vultur gryphus* conservation program in Argentina: number of educational campaigns; communication strategies where the program is mentioned and associated; number of popular events and parties that the program participates; number of volunteers per year; and number of conservation partner certifications (Jacome and Astore, 2016). Kanaan (2016) defined the total indicator of socioeconomic opportunities according to the green (sustainable) economy. In the project of *Ara macao* (Williams and Haines, 2021) the success indicator is the number of local people, greater than 10 per year, who benefit directly from the program. Apparently, a perspective change is happening in the reintroduction programs worldwide, as in Brazil may be seen in the last NAPs. Currently the programs are more concerned about defining goals, actions and indicators that involve HD, since the planning phases. Thus, it is important to work with an interdisciplinary team to plan, execute and evaluate the HD aspects in the reintroduction programs (Consorte-McCrea and Bath, 2020).

It is noteworthy that difficulties related to human dimension factors frequently are listed among birds' conservation and reintroduction projects as compiled by Soorae (2008; 2010; 2013; 2016; 2021). These difficulties are related to poaching and bird's illegal captures (Mari et al., 2010; Cremades et al., 2016; Tritto, 2016; Ubaid et al., 2021); bird's poisoning by the use of pesticides and other toxic substances in the release sites (Swanepoel, 2013; Parish and Hunt, 2016; Kemp and Alexander, 2021; Reynolds, 2021); presence of semi-wild cats and dogs (Bernardo, 2008; Burbidge et al., 2010); frequent interactions with people who feed birds and make them vulnerable and dependent on humans (Kanaan, 2016); and fires, intentional or accidental (Burbidge et al., 2010; Menkhorst, 2010; Ubaid et al., 2021). All the difficulties named as key to achieve success in the reintroduction projects are hard to solve without changing paradigms. To restore biodiversity, it is essential to seek new ways of thinking and doing conservation, adding the coexistence perspective, where interactions between people and wildlife are managed to keep wild species population sharing space and resources with human communities in a socially fair way (Pascual et al., 2021; Pooley, 2021; Pooley et al., 2021).

The main lessons left by these projects are the need to identify and involve different stakeholders, to inform local populations about the project's aims and actions, to extend stakeholders participation and cooperation in the projects (Adams and Cash, 2010; Stoynov and Grozdanov, 2010; Saidenberg et al., 2013; Steiner et al., 2013; Bridge, 2016; Parish and Hunt, 2016; Tritto, 2016; Williams, 2021), that coexistence between people and wildlife requires a long-term and well-studied work plan, but if well performed it brings a strong impact and real awareness of people to the environment and species conservation (Cremades et al., 2016); and that citizen science perform great help to monitoring bird (Islam et al., 2010; Ingwersen and Johnson, 2016; Kanaan, 2016). The main reasons for the success of the reintroduction project, related to human dimension, are real engagement of local communities and the economic benefit generated to the communities in the areas of species reintroduction (Jacome and Astore, 2016; Kanaan, 2016; Williams and Haines, 2021; Woinarski et al., 2021).

After analyzing the Brazilian National Action Plans for the conservation of at least eight bird species, it is clear that the public policies are more focused on actions of surveillance, law enforcement and controlling illegal trade. Some NAPs bring actions involving the creation of the management board and the economic ecological zoning of the protected areas where the species are being reintroduced. The NAPs that went through recent review include more actions involving local communities in the planned actions as: important community assessment of human-bird interactions with the focal species; what people think, feel, perceive and know about the species; motivations to certain types of behaviors that can lead to conflict with focal species conservation; and socioeconomic variables that can affect the interactions with the focal species. An example of a NAP bringing these aspects is the *A. leari* NAP. It is important to say that this kind of research and practice must happen before, during and after the reintroduction of focal species.

CONCLUSIONS

National Action Plans for the conservation of threatened species are a valuable tool for conservation planning and management. Human dimensions of human-bird interactions are only implicitly present in the NAPs and starting to emerge, as seen from the data obtained through the questionnaire.

Despite the clarity about the common subject to the causes of threat for endangered bird species (e.g., people, directly or indirectly, through poaching, illegal trade, or habitat destruction, just to mention few), conflict is mentioned only related to *A. learii* (in NAP) and its rides on corn plantations, affecting small farmers livelihoods, thus proposing compensation schemes to increase tolerance toward co-occurrence with the species.

All the other aspects connected to human populations co-occurring with the species (before its local extinction in the wild or after its reintroduction) identify people either as a potential labor force in the reintroduction project or program; either as an artisan, beekeeper or guide for tourists and birdwatchers within or surrounding the area where birds are to be released; or as a "strange in the nest," as children or adults unaware of birds' biology and ecology or threats to its conservation and motifs underneath; either, and the worst category, as hunters or wildlife traders requesting surveillance and punishment, or as competitors for natural resources, in need to be taught on how to dwell in the territory they share with its wild neighbors. It lacks a leveling amidst stakeholders in understanding, acting, and communicating human-bird interactions, beyond conflicts, economy, and ecology. It remains a gap between scientific knowledge and real-world demands, focused on behavior change and researchers triggering that change.

Wildlife conservation includes wild species management, habitat conservation and habitat restoration, within or surrounding protected areas, research, education, and law enforcement. Coexistence of humans and wildlife requires that multi and interdisciplinary approach, assessing and influencing human dimensions of cognitive, psychological, cultural, social, and economic background. People are more prone to engage and involve with conservation if acknowledged as stakeholders, a step further of being subjects whose quality of life may be not a priority of conservation projects or whose traditions, knowledge, and voices are displayed as incompatible with biodiversity conservation. Especially while dealing with traditional communities within protected areas, management agencies and researchers will assure effectiveness depending on the fulfillment of governance principles, based on wide and democratic participatory processes, transparency and accessibility of information, distributive justice, and social equity together with biodiversity conservation. Instead

of labeling human populations co-occurring with wildlife based on the threats to its conservation status and/or its environment, and on potential ways to improve its conservation status, people will answer more positively to any initiative concerning biodiversity if they acknowledge a non-judgmental move toward their livelihoods, behaviors and motivations from wildlife management agencies, researchers, and organizations.

The contribution of this research includes the acknowledgment of the imbalance between biological and ecological assessments when threatened birds' species are to be reintroduced and the assessment of determinants of behaviors that led or ease their population decline or extinction (in the wild). This is displayed in the NAPs, which fail to detail objectives and actions on how to engage people, especially locals, from planning stages up to wildlife and its habitats managements, at the same level as objectives, actions, and indicators related to birds' biology and ecology.

Cyanopsitta spixii is an exception in several aspects, followed by *A. leari*, which reinforces the leadership of Caatinga biome in scientific research and practice related to HD in HBI. The timing of the study, especially the questionnaire application, amidst COVID-19 pandemic, provided an unforeseen but robust answer if any doubt remained about the relevant role of social engagement and communities' participation in conservation: in the absence of researchers, locals were close to the release sites and within and neighboring protected areas with reduced surveillance. Being stakeholders since the design of a birds' reintroduction project or program paves the path for the dialogue between scientific and traditional knowledge, for the establishment of trust and values gridlock conciliation that diminishes the resistance to spread conservation information and develops and strengthen the sense of pride for co-occurring with wildlife.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical Committee of Research Involving Human Beings of University of Pernambuco. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FM and FS organized the NAPs database. ME did the on-line questionnaire. FM analyzed the data. FM, ME, FS, and CM wrote the previous and current version of the document. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcosc.2022.791103/full#supplementary-material

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When Ecological Analysis Reveals Hidden Human Dimensions: Building on Long-Term Community Participation to Enable a Conservation Translocation of Mountain Bongo in Kenya

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Conservation translocations have traditionally focused on ecological aspects while overlooking or underestimating the importance of human dimensions. Here, we present a feasibility analysis for a conservation translocation that up front took a holistic approach by investigating both ecological and socio-economic suitability of reinforcing mountain bongo in Eburu National Forest, Kenya. From 2018 to 2019, we set up 50 cameras to detect mountain bongo and searched for secondary signs in a grid overlaying Eburu. We also conducted surveys with 200 households surrounding the forest and interviewed 300 students to understand local perceptions of and interactions with Eburu Forest and their desire for a mountain bongo translocation. We used data from camera trapping and secondary signs in a MaxEnt model to determine the amount and location of available habitat for a bongo conservation translocation. Camera traps recorded only five bongo events in the 2-year study, and MaxEnt models revealed that these antelopes were relegated to less than 2.5 km of available habitat. Socio-economic surveys indicated local support for the conservation of bongo and their habitat, and yet our camera traps uncovered threatening illicit activities that could jeopardize both bongo survival and any attempt at boosting the remnant population with captive-bred individuals. We report how we built on long-term community and stakeholder engagement to mitigate these threats and provide concrete recommendations for how to proceed with a conservation translocation in terms of both the biological aspects and continued efforts to integrate socio-economic needs and community engagement.

Keywords: poaching, reinforcement, endemic species, *Tragelaphus eurycerus isaaci*, local communities, household surveys, camera trapping, illegal activities

INTRODUCTION

Direct or indirect human-driven threats lie at the root of demise for the vast majority of imperiled species (IUCN, 2021). It follows that attempts to improve the conservation status of imperiled wildlife should carefully examine and address human interactions with individual species and their ecosystems. Moreover, a human-rights perspective and—more recently—the growing recognition, heightened by the COVID-19 pandemic, that societal well-being and biodiversity are interdependent, have fostered greater integration of human considerations in conservation (Corrigan et al., 2018; Corson et al., 2020; Schneider et al., 2021). Although nature reserves that largely exclude humans remain a valuable, contemporary tool (UNEP-WCMC, 2018; Lewis et al., 2019), emphasis on honoring the needs and rights of local communities in conservation efforts has been growing for decades (Berkes, 2010; Kothari et al., 2013). As a result, a growing number of protected areas and forests are now co-governed by diverse stakeholders or indeed community-led (Macura et al., 2015; Gilmour, 2016; Corrigan et al., 2018).

Despite this overarching trend, planning for specific, management-intensive conservation interventions, such as conservation translocations, has traditionally focused on ecological aspects of the conservation challenge, with implications by or for local communities often ignored or addressed as an after-thought (Brichieri-Colombi and Moehrenschlager, 2016; Rayne et al., 2020; Reed et al., 2021). Conservation translocations are the human-mediated release of organisms for conservation purposes, where source individuals may come from populations under human care or from populations elsewhere in the wild (IUCN, 2013). The feasibility of such programs needs to be carefully evaluated. Pre-eminent priorities include addressing potential threats that may have led to past declines, determining the status of threats currently, and taking mitigative actions that will increase the likelihood of the focal species' growth and sustainability at release sites over time (IUCN, 2013). Integrated planning will involve selection and support of potential release sites and specimen over time, but such planning should be founded within assessments that iteratively address ecological as well as human dimensions (IUCN, 2013; Rayne et al., 2020).

Fortunately, in some locations, conservation translocations are beginning to integrate community considerations, particularly when candidate species or sites are of important cultural or spiritual importance on lands that are co-managed with indigenous societies (McMurdo Hamilton et al., 2020). Particularly in protected areas, however, the perception may arise that consultation with communities is less important given restrictions on human access to such sites, implying limited human interference with ecological conditions required for conservation translocations and limited impact of released wildlife on humans (McMurdo Hamilton et al., 2020). Yet not all parks are created equal, with a wide variety of protected area models balancing ecological integrity with human use (Dudley, 2013). Moreover, implementation or enforcement of restrictions is often difficult, especially in resource-constrained developing economies. Protected area designation may hence not necessarily mean that habitat conditions are sufficiently protected, that ecological conditions would suffice for wildlife reintroductions, that interactions between reintroduced wildlife and humans are unlikely, or that the values and activities of local communities are well-aligned with a conservation translocation and vice versa.

In accordance with the IUCN Guidelines for Reintroductions and Other Conservation Translocations (IUCN, 2013), Kenya's National Recovery and Action Plan for Mountain Bongo (*Tragelaphus eurycerus isaaci*) identifies involvement of local communities in the conservation of this endemic antelope as a key objective (Kenya Wildlife Service, 2019). The plan recommends managing captive and wild mountain bongo as a global meta-population with the help of conservation translocations. Fewer than 100 mountain bongo survive in the wild, with small populations fragmented between four montane forest areas isolated from each other by 45–75 km wide stretches of farmed and settled lands (Svengren et al., 2017). In contrast, around 500 mountain bongo persist in captivity around the world, including approximately 52 at a captive breeding facility within Kenya (Kenya Wildlife Service, 2019; Mount Kenya Wildlife Conservancy, 2021).

Eburu National Forest, at 87 km^2, is the smallest of the remaining bongo-inhabited forests. Gazetted during colonial rule with little regard for local communities, Eburu originally formed part of the much larger Mau Forest Complex. Surrounding non-gazetted forest was lost over time, however, so that by the end of the twentieth century Eburu had become an isolated island of forest surrounded by crowded farms and pastures. By 2001, small-scale agriculture and logging were commonplace inside the forest reserve, resulting in considerable forest loss and degradation (Baldyga et al., 2008; Ministry of Environment Forestry, 2018). Evictions followed, but also considerable work to engage forest-adjacent communities in conservation, enable sustainable use, and foster restoration. Since November 2014, Eburu has been fully encircled by a 43.3 km electric conservation fence intended to protect human life, livestock, and agricultural crops in neighboring communities from wildlife and, conversely, protect the forests from intrusion by livestock, poachers, illegal farming, logging, and charcoal production (Kenya Forest Service, 2017). In combination, these measures have provided hope and evidence for effective protection of the montane forest ecosystem at Eburu.

In this context, Eburu has been identified as target for a captive-to-wild conservation translocation for mountain bongo with a working wild population target of 20 individuals (Kenya Wildlife Service, 2019). We therefore set out to explore biological feasibility via sign surveys and intensive camera trapping, and socio-economic feasibility via focus groups, household surveys, and interviews with school children.

Although our socio-economic surveys indicated a human context favorable to bongo rehabilitation, our camera-trapping revealed threatening illicit activities that astonished local stakeholders. The insights gained inspired a concerted effort to protect forest resources for both mountain bongo and local citizens. We here delineate the interplay between community exclusion and engagement that led Eburu to become suitable for consideration as a translocation site, report the results

of our socio-economic and ecological feasibility analysis, recount the events that brought illegal forest use to light, and describe the interventions sparked by the discovery. We conclude with concrete recommendations regarding a conservation translocation of captive-bred mountain bongo to Eburu National Forest.

MATERIALS AND METHODS

Focal Species

The mountain bongo is a critically endangered, nocturnal, or crepuscular antelope that used to occur in montane forests of Kenya and Uganda but is now endemic to Kenya with small populations surviving on Mt. Kenya, in the Aberdares, the Mau Forest complex, and Eburu Forest (Gibbon et al., 2015; IUCN SSC Antelope Specialist Group, 2017). Large-bodied and spiral-horned, mountain bongo were a popular target for trophy hunters in the past, with hunting licenses issued from 1910 onwards (Prettejohn, 2020). In the 1970s, mountain bongo additionally became the target of live capture for zoos and game parks worldwide (Prettejohn, 2020). Hunting pressure coupled with forest loss and degradation led to population declines and extirpation from various parts of the antelope's range (Mt. Elgon, Mt. Londiani, Cherangani Hills, and Chepalungu Hills; Gibbon et al., 2015; IUCN SSC Antelope Specialist Group, 2017; Kenya Wildlife Service, 2019). Where mountain bongo persist, they are found in rugged terrain with structurally complex vegetation (Estes et al., 2011), and are thought to consume bark, roots, and the leaves of various shrubs, herbs, climbers, and bamboo (Kenya Wildlife Service, 2019). Historic information provided by former hunters suggests that mature bulls are either solitary or lead herds with females, calves and young males, herd size ranging from 4 to 15 or more where browse was plentiful year-round. Out-group males range alone or in pairs (Sheppard et al., in prep.). The maximum number of mountain bongo thought to have existed in Eburu in the 1970s, when populations were still healthy, was 20–30 animals, with a ranging distance of 10 km or less. Like elephants (*Loxodonta africana*), bongo were observed to repeatedly follow the same trails, making them easy to track, hunt, and snare (Sheppard et al., in prep.).

Prior to this study, the most recent evidence of bongo presence in Eburu stemmed from continuous camera trapping 2006 through 2018 with between three and five cameras set by the Bongo Surveillance Project (BSP) (Prettejohn et al., 2020).

Study Area

Eburu National Forest, located between longitudes 36°07′ and 36°16′ East and latitudes 0°40′ and 0°37′ South in Kenya's Nakuru County, was originally gazetted in 1932 (Boy, 2017). Once an integral part of the much larger Mau Forest Complex, Eburu Forest is now a fenced island, surrounded by agricultural settlements on all sides (**Figure 1**). The forest is nestled in the rugged terrain of Mt. Eburu, a volcanic massif with two peaks. Indeed, the terrain is so hilly that while the planar area of Eburu Forest is only 87 km^2, the surface area increases to 92.6 km^2 when factoring in topography. Altitudes range from a low along the fence lines of 2,068 m to a high at Ososogum/Eastern Summit of 2,855 and drive an elevational vegetation gradient, with *Acacia* trees and leleshwa (*Tarchonathus camphoratus*) scrubland typical of lower areas, superseded by *Dombeya torrida* forests higher up that then give way to a mix of *Podocarpus* spp., *Crotalaria* spp. and highland bamboo, and finally open moorland. Precipitation averages 700–760 mm annually and generally falls during two seasons: long rains from March to May and short rains between October and November. Temperatures typically range from 24 to 29°C, with the hottest season occurring December to February (Kenya Forest Service, 2017).

Montane forests like Eburu act as critical water catchment areas and jointly supply millions of households with water. Rivers emanating from Eburu and the nearby Mau Forest Complex are also the lifeline of conservation and tourism areas downstream, including key lakes such as Lake Naivasha and Lake Nakuru (Albertazzi et al., 2018).

Human presence in Eburu dates to at least the late Middle and Upper Pleistocene 120,000 to 45,000 years ago (Van Baelen et al., 2019). Indigenous hunter-gather groups were largely assimilated or displaced by waves of pastoral immigrants approximately 3,000 and 2,000 years ago and finally the arrival of the Massai in the eighteenth century. Forest-dwelling hunter-gatherer groups that had persisted to this time became collectively known as Ogiek. Livestock diseases and smallpox introduced with the arrival of Europeans in the nineteenth century devastated Masaai communities and cleared Eburu for settlement by Europeans, who established large, sparsely settled farms in the area in the early twentieth century (Boy, 2017). Under British colonial rule, the Indigenous Ogiek were evicted from Eburu and the larger Mau Forest ecosystem on multiple occasions between 1911 and the 1930s (Sang, 2001) but continue to this day to engage in beekeeping and other forest activities on the land that their ancestors once walked. Post-independence in 1963, the de-colonization of the "White Highlands" of Kenya resulted in waves of in-migration of different tribal groups including Kikuyu, Kipsigis, Kamba, and Luhya, and further evictions of Ogiek from gazetted forests. Today the area surrounding the reserve is surrounded by densely packed farms and pastures (Boy, 2017).

In the late 1990s and early 2000s, Eburu Forest Reserve was on the verge of collapse, with a rampant red cedar harvest making way for cultivation (**Figure 2**). Smoke could be seen across the landscape as charcoal burning was rampant (E. Kihiu, pers. commun., 2021). Recurrent forest fires caused by human activities, including charcoal burning and beekeeping, destroyed extensive forest cover in the lower and middle forest belts. In the upper forest areas, illegal settlements led to the conversion of prime indigenous forest into cultivated areas with annual crops. Kiosks were established inside the reserve where customers could buy chapati, mandazi, and bush meat including mountain bongo (J. Kiruy, pers. commun., 2021). The crisis situation in Eburu Forest led the Government to carry out an eviction of the illegal settlers residing in the forest in 2006 (Centre on Housing Rights Eviction, 2007; Church, 2015).

In the 15 intervening years since then, community engagement has turned around the fate of the forest. We provide an overview of relevant events in **Figure 2**. Milestones across this time period include a policy change, with the Kenyan

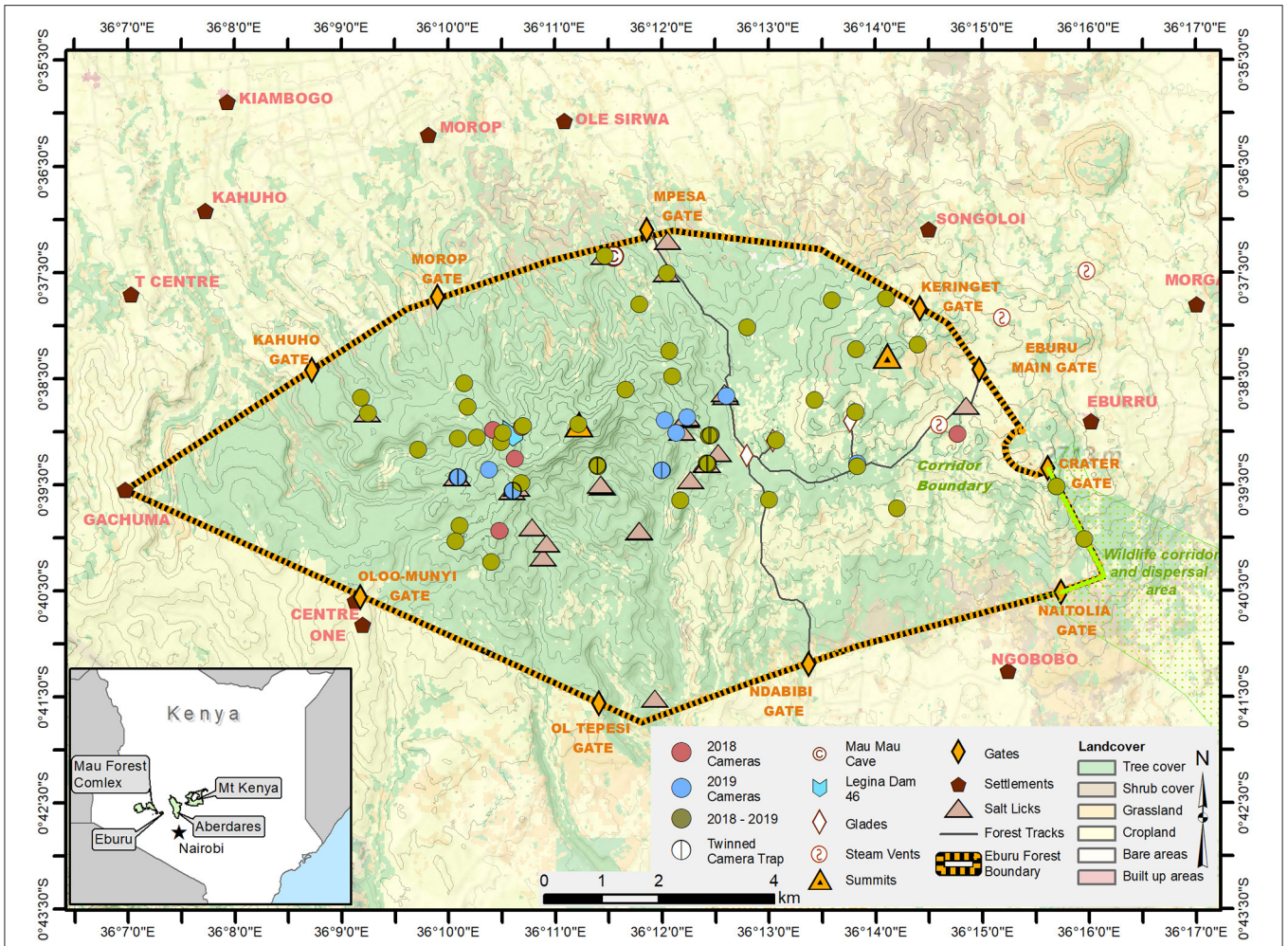

FIGURE 1 | Study area of Eburu National Forest, Kenya, and surrounding human settlements. Green, blue and mauve circles indicate the camera trap locations within the forest. The inset depicts Eburu's location relative to the other forests where mountain bongos still remain in Kenya.

government ushering in a forest co-management system in 2005 with the new Forest Act (No. 7 of 2005), which was entered into force on February 1, 2007. In line with the new Act, a 5-year Eburu Participatory Forest Management Plan (PFMP) was prepared in 2008 (Mutune et al., 2015). It was one of the first PFMPs prepared in the country. The PFMP coincided with the establishment of one of Kenya's earliest community forest associations at Eburu Forest (ECoFA) that same year (Mutune et al., 2015). Though the ECoFA started well, with strong financial backing, mismanagement and a lack of funds saw the association reduced to a skeleton structure until re-vitalization and capacity building activities commenced in 2019.

Beginning in 2007, the BSP, a Kenyan NGO, began to determine the status of bongo in Eburu by engaging a notorious local hunter to search for secondary signs of the species. In 2008, a camera trap unequivocally confirmed both male and female bongo presence in the forest (Prettejohn et al., 2020). The team grew to three local trackers by 2009, and two to five cameras were installed on a continuous basis until 2018 when the current study commenced. Starting in 2008, BSP also worked with local schools to establish bongo wildlife clubs that allowed school children to learn about this endemic species in their neighborhood (P. Munene, pers. commun., 2021).

Simultaneously, forest restoration had grown in the public conscience in Kenya through the work of The Greenbelt Movement, which commenced in 1977 and grew into a widespread movement after its founder, Wangari Maathai won a Nobel Peace Prize in 2004 (The Nobel Peace Prize, 2004). Growing nationwide awareness on the need to protect and rehabilitate indigenous forest led to a flagship project focused on Kenya's five most prominent water towers (montane water catchment areas), including the Mau Forest complex of which Eburu formally forms part, under the government's "First Medium Term Plan 2008–2012 of Vision 2030" (Government of Kenya, 2008). Two years later, the 2010 Constitution of Kenya set as an objective the attainment and maintenance of at least 10% tree cover in the nation. In Eburu Forest, rehabilitation efforts began in earnest in 2011 with the planting of seedlings thanks

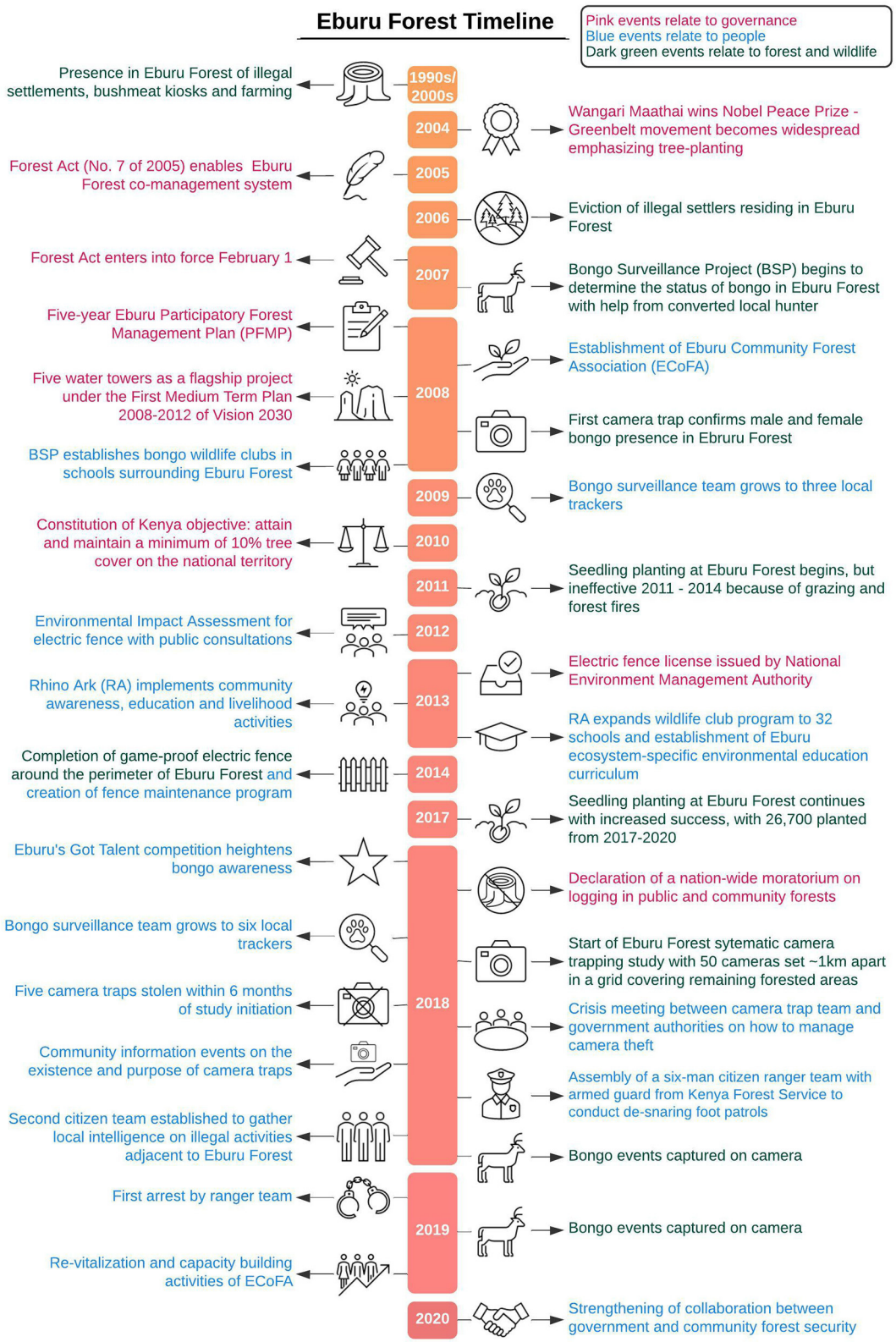

FIGURE 2 | Eburu forest timeline highlighting key conservation-relevant events from the 1990's to 2020. Events in pink relate to governance, events in blue to impacts on local people and events in dark green to impacts on the forest and wildlife.

to the Greenbelt Movement and other organizations with a reforestation mandate. Unfortunately, these efforts were initially largely unsuccessful due to poor seedling survival rates as a result of forest fires and cattle grazing (J. Kiruy, pers. commun., 2021).

Around this time, Rhino Ark Kenya Charitable Trust was invited by government institutions and forest-adjacent communities to commence a comprehensive stakeholder process for the establishment of a perimeter fence around Eburu Forest. An Environmental Impact Assessment (EIA) study that included extensive public consultations started in mid-2012. On August 14, 2012, an Eburu Leaders' Sensitization Workshop was held in Naivasha, followed by four community sensitization meetings held in locations adjacent to the forest, which saw the participation of 486 local community members. In addition, questionnaires were administered to 119 individuals from the local communities, private ranches, non-governmental organizations (NGOs), and government departments (Kenya Wildlife Service, 2012).

Following the submission of the EIA report, the National Environment Management Authority issued a license to build the proposed electric fence on February 18, 2013 (letter Ref. No. NEMA/EIA/5/2/927). The first fencing post was placed in March 2013 and the 43.3 km long electric fence was completed in November 2014. Fence construction was undertaken with labor contracted from the forest-adjacent communities to provide local job opportunities and build ownership of the fence. Once completed, a fence maintenance program was established. The most skillful and dedicated 12 community members involved in the fence construction were offered permanent jobs as fence attendants, whereby each of them is responsible for maintaining an approximately 4 km section of the fence (Kenya Wildlife Service, 2014).

Once the fence was in place, rehabilitation efforts became more effective: 26,700 seedlings planted 2017–2020 have enjoyed a survival rate of 20% (D. Chege, pers. commun., 2021).

Concurrently with the fence construction, Rhino Ark started implementing a wide-range of community awareness, education, and livelihood development activities including the rehabilitation of water sources and water projects; the promotion of conservation-based enterprises, such as beekeeping and the growing of fruit trees; and the promotion of more sustainable energy sources, such as biogas and the use of portable kilns to convert crop residue into charcoal (Rhino Ark, 2016).

Building on the bongo wildlife clubs established by BSP, Rhino Ark expanded the program to a total of 32 primary and secondary schools, and designed an environmental education curriculum specific to the Eburu ecosystem. The curriculum was soon adopted by the Kenya Institute of Curriculum Development (Rhino Ark, 2013). In 2018, bongo awareness was heightened when 28 wildlife clubs competed in a talent competition—"Eburu's Got Talent"—that saw them perform poems, songs, and dance routines about the mountain bongo, which subsequently featured on local radio shows.

2018 also saw the declaration of a nation-wide moratorium on logging in public and community forests to allow for a comprehensive review of forest resource management and illegal logging in Kenya (Tobiko, 2018). The moratorium, which to the general public signaled that they should stay out of gazetted forests, has remained in place ever since with limited concessions made in 2020 for mature and over-mature timber plantations (Tobiko, 2020). No timber plantations exist in Eburu (Boy, 2017), which since 2017 has been exclusively managed as a conservation area (Kenya Forest Service, 2017).

Feasibility Analysis

The design of our feasibility analysis, including biological survey methods and protocols for interviewing adults and children, was reviewed and approved in advance of implementation by Kenya's National Commission for Science, Technology and Innovation (NACOSTI). Implementation occurred under NACOSTI permit #17458 and in close, continued collaboration with the Kenya Forest Service, Kenya Wildlife Service, and Eburu's Community Forest Association. The study involved camera trapping and sign surveys targeted at capturing information about mountain bongo, and focus groups, household and student surveys to gain understanding of local ecological knowledge, forest use, and conservation attitudes. While NACOSTI did not require a formal ethics review, all interviews followed the University of Guelph (Canada) ethics guidelines. The Kenya Forest Service in partnership with the Eburu Community Forest Association (ECoFA), with mandated jurisdiction over the co-management of Eburu Forest, guided all interactions with the forest-adjacent communities. In line with the Nagoya Protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization to the convention on biological diversity (Secretiariat of the Convention on Biological Diversity, 2011), the Kenya Forest Service requires that a prior informed consent process is duly implemented with regard to community stakeholders surrounding forest resources nation-wide.

Camera Trapping and Sign Surveys

To document the remaining bongo population, its habitat preferences and threats to survival, an existing team of three trackers from the BSP was increased to six in 2018 and trained to undertake systematic camera trapping from 06 March 2018 to 27 November 2019. The trackers, all of them reformed poachers, were selected based on their abundant knowledge of the forest. Fifty camera traps were set to cover all remaining forested areas within the 43 km electric game-proof fence, at an average elevation of 2,548 m (± 113 m) (**Figure 1**). Although there was an attempt to set the cameras at approximately 1 km straight-line distance in a grid, the terrain made this challenging and, in many instances regular spacing could not be achieved. Non-baited cameras were attached to trees or posts around knee height of the trackers. However, due to the undulating terrain, some cameras set on steep slopes were placed very high or low on a standing tree, or the angle of the camera was tipped so that the field of view was angled toward the trail. At grid points where trackers detected secondary signs of bongo—including tracks, droppings, and scratching posts—cameras were twinned for increased capture success (Burton et al., 2011). Cameras were active 24 h/day with a 9 s delay for a 21-month period and regularly checked to switch SD cards and batteries. On the way to and from cameras, trackers also looked

for and mapped secondary signs of bongo and any evidence of human disturbance, including illegal logging, charcoal kilns, leg-traps, and neck snares. Kilns, traps, and snares were dismantled when found. The trackers were highly skilled and recorded only unambiguous secondary signs of mountain bongo. Six months into the study, concerns were raised about forest security after five cameras had been stolen. In response, six community information events (approximately 100–250 audience members per event) were completed in October 2018 on the existence and purpose of the camera traps.

Focus Groups

Four focus groups, each with approximately 10 men and 10 women, were conducted in March 2018 as an entry-level assessment tool with the aim of gaining a sense of locals' interactions with the forest, and of their beliefs, knowledge and attitudes regarding the forest, mountain bongo, and nature conservation. One settlement was selected from each of the four forest-adjacent Locations (sub-district administrative units) where larger settlements existed. Participants comprised community members with dwellings closest to the forest edge, and with an interest, history, or knowledge of forest issues, and were selected by local community conservation leaders. Although a set of guiding questions was at hand (**Supplementary Data Sheet 1**), the focus groups did not follow a rigorous structure. Instead, open discussion and information sharing among participants was encouraged. These discussions helped inform questions for a more detailed and structured household survey (see below). Focus groups also served to determine general features of the area, including gender relationships and other societal norms, by observing who was able to speak within each group, and the depth of information shared.

Household Surveys

Building on information gained in focus groups, we undertook a household survey via structured interviews with individuals from 200 households (male and female) near Eburu Forest from November to December 2018 (**Supplementary Data Sheet 2**). Questions addressed local residents' interactions with Eburu Forest before and since perimeter fencing, traditional and local ecological knowledge about the forest ecosystem and mountain bongo, and attitudes toward conservation and a potential conservation translocation. Clearance to conduct the household survey was first sought from the four administrative Location Chiefs that oversee communities surrounding Eburu Forest. Survey participants were selected using stratified random sampling based on distance from forest edge ($\leq$1, 1–2, $>$2 km), gender of respondent (male vs. female), and the relative population size of each of the four administrative units (known as "Locations") that neighbor Eburu Forest. Each participant was informed of the survey's purpose, that participation was voluntary, that they could decline answering any individual question, and how long the survey would take. Interviews were conducted in the respondent's preferred language (Kiswahili, English, Ma, or Kikuyu) and participants were given a bar of laundry soap as a token of appreciation upon completion.

Student Surveys

Because translocation efforts for large mammals generally require a decade or more of intensive management, we also involved future community leaders in the study by conducting a survey among school students (**Supplementary Data Sheet 3**). We first secured permission from the relevant administrative chiefs and reviewed the survey's purpose and questionnaire with the headmasters and teachers of all participating schools. We then conducted standardized interviews between March and April 2019 with 300 youths, half of whom were members in their school's wildlife club. At the time, 32 schools had a bongo wildlife club. Student respondents were representatively sampled from 37 schools (24 primary schools; 13 secondary schools) based on the size and gender composition of the school population, and were asked to answer a total of 16 questions that addressed general environmental knowledge and knowledge specific to mountain bongo.

Data Analysis

We reviewed all bongo images captured by camera traps to determine the number, sex, and age (adult vs. immature) of individuals. A new bongo camera event occurred when there were more than 60 min between pictures, or if a different bongo crossed in front of the camera, based on individual identifying features (stripe pattern, horns, age, sex, etc.). We also took note of camera captures of other antelope species to gain an idea of relative frequency of occurrence, of potential predators, and of wildlife overall to assess faunal biodiversity.

All bongo camera captures ($N = 5$) and data on secondary signs ($N = 40$) were combined ($N = 45$) to examine environmental suitability via a maximum entropy model (MaxEnt). MaxEnt uses presence vs. background data and biophysical covariates to predict the suitability of the area for species presence (Phillips et al., 2004). Given the low total number of presence observations and the possibility that they reflect the movements of only a few individuals, the modeling approach we used is equivalent to a resource selection function that contrasts use vs. availability (Boyce et al., 2002; Griffin et al., 2021).

We derived environmental variables from a cloud-free Sentinel 2 image, taken on December 20, 2019 (USGS, 2020), and a Digital Elevation Model (DEM) obtained from ASTERGTM (USGS, 2011). We used PCI Geomatica Software (PCI-Geomatica, 2017) and the *raster* package in R (Hijmans, 2020; R Core Team, 2020) to derive the following landscape variables from the Sentinel 2 image: Normalized Difference Vegetation Index (NDVI), Atmospheric Resistant Vegetation Index (ARVI), Brightness, Greenness, and Wetness values generated by a tasseled cap analysis, albedo, and NDVI homogeneity (a texture measure that relates to habitat structure) (Jensen, 2007); we used the DEM to derive elevation, slope, aspect and Terrain Roughness Index (TRI—mean of the absolute differences between the value of a cell and the value of its eight surrounding cells) (Wilson et al., 2007). We also used the RCMRD 2016 Land Use Land Cover map derived from Sentinel 2 Global Land Cover data (RCMRD-SERVIR, 2017) to calculate edge density (all landcover transitions in the landscape in relation to the

landscape area), as edge habitat has been identified as potentially important for bongo (Estes et al., 2011). Justifications for inclusion of the explanatory variables are provided in the **Supplementary Materials** (**Supplementary Table 1**).

Because the input raster data were collected at different resolutions (Sentinel2 = 10 m, vegetation = 20 m, and DEM = 30 m), we resampled the landscape variables to 30 m resolution using bi-linear resampling. Based on extensive surveys and local knowledge of the area, we also derived distance to seasonal and permanent water, distance to forest roads, and distance to salt licks. Before including environmental variables in our model, we ran variance inflation factor (VIF) tests using the "vif" function in the R package usdm to determine multicollinearity and included only variables with a VIF <2 (Naimi et al., 2014).

We ran the MaxEnt model using the "maxent" function (version 3.4.1) in the R package *dismo* (version 1.3.3) using the recommended settings (Phillips et al., 2004, 2005, 2006; Elith et al., 2011). By default, MaxEnt retains only one species record per grid cell, and thus reduced our sample size from 45 to 37 bongo evidence locations. MaxEnt selects background data at random and can provide internal model evaluation via a jackknife of calibration data, each time predicting probability of occurrence for the omitted calibration grid cells (Phillips et al., 2005). To additionally evaluate model accuracy more rigorously, we divided presence points and the search effort area from which absence points were drawn into two periods. The first two thirds of the mountain bongo presence points served as training data for our baseline model, which covered the period between 06 March 2018 and 18 April 2019 at 9:06 am. The last third of the bongo presence points served model testing, and covered the period from 18 April 2018 9:07 am to 27 November 2019. The precise time point for period separation was dictated by two secondary signs discovered (but not necessarily created) within 30 min of each other on the same day. Search effort polygons for each period where generated by buffering the trackers' search-associated movements and collected GPS points by 30 m. We then calibrated a baseline model with data from Period 1 and used it to predict the probability of bongo presence in the Period 2 search effort polygon for period 2 presence data (13 grid cells) and 130 randomly selected background grid cells. We then used the "evaluate" function in the R package *dismo* (Phillips et al., 2005; Hijmans et al., 2017) to compute the area under the curve (AUC) of the receiver operating characteristic (ROC), averaged over 30 model runs (each with a different random set of background calibration points). AUC provides a measure of prediction accuracy for presence-absence data that is independent of the threshold used to transform probabilistic into binary predictions of occurrence (Fielding and Bell, 1997). Although use of AUC in the context of presence-background models has been criticized (Li and Guo, 2021), it's use in our case seemed justified, as background data were limited to the search area and hence more likely to represent true absence than unconstrained background data.

We also compared the baseline model with a model calibrated using all combined presence points from Periods 1 and 2 and absences drawn from within the total search effort area across both periods. We then projected the combined model into the full study extent (the entire Eburu Forest rather than just search polygons) over 30 iterations. Next, we averaged the resulting probability of occurrence surfaces over the 30 individual model outcomes to obtain a final predictive surface of suitable habitat. We considered grid cells as suitable bongo habitat where the averaged probability of occurrence exceeded 0.6.

Because the primary aim of our model was prediction (to get a sense of the total area within Eburu Forest suitable for mountain bongo) rather than inference, we did not attempt to test for spatial autocorrelation in model residuals. We expected spatial structuring in the explanatory variables to account for the vast majority of spatial structure in bongo presence points. Any residual spatial autocorrelation, e.g., due to presence records reflecting movements of just a few individual mountain bongo, is not a major concern for prediction (Boyce, 2006; Hawkins et al., 2007). Indeed, attempts to account for such autocorrelation via, for example, inclusion of an autocovariate among explanatory variables often result in higher AUC values (Dormann et al., 2007; McPherson and Jetz, 2007), so our approach likely yields more conservative estimates of model accuracy.

To evaluate threats to bongo, we mapped all human disturbances in Eburu as recorded by the trackers. Threats were classified into two categories. Category 1 included direct threats to bongo, i.e., evidence of poaching such as leg traps and neck snares. Category 2 included threats to bongo habitat, such as evidence of charcoal production, logging, illegal camps, firewood collection, donkey tracks, and marijuana fields. Threats were mapped by year for 2018, 2019, and 2020. We also calculated the average distance of each threat category to the Eburu fence line as a proxy for the degree of forest penetration of the detected human threats, i.e., the greater distance from fence line means greater time spent (illegally) in the forest, and hence greater risk of detection.

Responses to the household survey were analyzed by determining the proportion of respondents who mentioned specific topics. Proportions were straightforward to derive for multiple choice questions. For open-ended questions, responses were manually classified into emerging themes (e.g., finance, culture/spirituality, ecosystem, security, education, etc.) or sentiments (e.g., pride, recognition, future benefits, management concerns, etc.) to then derive the frequency with which each was mentioned across respondents. We used two-sample Z-tests to determine if proportions differed between men and women (Quinn and Keough, 2002).

For student surveys, questions that had one or more correct answers were scored for each student based on the number of accurate responses given. For other questions, we again simply determined the proportion of students who mentioned specific topics. We then calculated a total score for each student as well as separate summary scores for questions pertaining to basic ecology (five questions), deeper ecological knowledge (three questions), nature's benefit to humans (two questions), conservation concepts (two questions), and knowledge of Eburu (four questions). To test for differences between students inside and outside of wildlife Clubs, we used two-sample *t*-tests for accuracy scores (Quinn and Keough, 2002).

RESULTS

Local Ecological Knowledge, Attitudes, and Forest Interactions

A total of 36 women and 45 men took part in focus group interviews, with each group reasonably gender-balanced. The focus group interviews offered perspective on the shared basis of knowledge about forest perceptions and usage, traditional and cultural forest relationships, conservation attitudes, and mountain bongo. Through the focus groups, we learned of widespread and sophisticated conservation attitudes, support for the perimeter fence surrounding the forest, and that many people claimed to be from other areas and, as such, did not have strong cultural ties to the forest. Those with the longest tenure in the area—the Ogiek and Kikuyu group members—spoke of prayer caves inside Eburu Forest, and of the harvest taboo of an endemic species, the Meru oak (*Vitex kenensis*). When asked how people felt about a bongo translocation, they immediately responded by clapping enthusiastically, or expressing profound support. We learned that the majority of citizens surrounding Eburu Forest were farmers and the issue universally mentioned for all four focus groups was the need for improved water supply to their farms.

Of the 200 people who participated in household surveys, there were 93 women and 107 men aged 14–82, with the mean, median, and mode of age equal to 40 (see **Supplementary Table 2A** for more demographic information on the respondents). When the participants were presented with a set of wildlife images (**Supplementary Data Sheet 4**), 68.5% were able to correctly identify a mountain bongo among other antelopes, although 74.5% had never seen one in person. Local people were largely in favor of increasing the mountain bongo forest population using captive-bred bongo (94.5%). Respondents identified several potential personal advantages of a bongo re-stocking event, including the opportunity to see and/or learn more about bongo (63%), additional employment (60%), and growth in tourism (54%). Responses diverged distinctly along gender lines, with women expressing more interest in the educational benefits (73% women vs. 59% men, $z = 2.113$, $p < 0.05$), and men more vocal about the economic benefits (31% men vs. 15% women, $z = 2.626$, $p < 0.05$).

Local residents' interactions with Eburu Forest were complex, which is noteworthy as few respondents had long-standing family roots in the area (only 4% of respondents came from families who had lived in the area for at least three generations). The forest had cultural importance for 76% of respondents, including for religious practices (41%), medicinal plants (25% but with significant difference by gender: men 31%, women 18%, $z = -2.046$, $p < 0.05$), traditional honey production (24%), and youth initiation practices (22%). Residents also commented on ecosystem services provided by Eburu Forest in the form of economic activities including logging for fuelwood (74%), timbers (59%—men 69%, women 47% $z = 3.133$, $p < 0.05$) and charcoal for cooking (50%—men 61%, women 38%, $z = -3.261$, $p < 0.05$), grazing areas for cattle (60%), as well as water provision (47%), improved farming (31%), and climate moderation (27%). The importance of a healthy ecosystem was an answer that eclipsed all others (75% of respondents). Under half (43%) observed changes to their forest-based activities since the completion of the electrified, game proof fence in 2014. By restricting residents' access to the forest, the fence had hindered access to fuelwood or charcoal for cooking (22%) and reduced cattle grazing (22%). Most residents, however, supported the fence (84%) and reported that the fence protects farms and livestock from wildlife damage (70%), protects the forest from being destroyed by logging or charcoal production (46%) and increases security or reduces theft (24%). Moreover, 38% of respondents stated that they were participating in forest recovery schemes through indigenous tree planting efforts.

The students interviewed (148 female, 152 male) ranged in age from 11 to 21 (mean age 15), had experienced 8–17 (mean 11) years of schooling and attained either Standard 8 (last year of primary school) or Form 4 (last year of secondary school) (**Supplementary Table 2B**). Among students, wildlife club members vs. non-members showed no noticeable difference in scores for knowledge on basic ecology ($t = 1.608$, $p = 0.109$), deeper ecological knowledge ($t = 1.047$, $p = 0.296$), nature's benefits for humans ($t = 0.958$, $p = 0.339$), or knowledge of Eburu ($t = 1.358$, $p = 0.175$), but differed significantly in scores for conservation concepts ($t = 3.460$, $p < 0.05$) and total scores ($t = 3.391$, $p < 0.05$); wildlife club members had higher average scores for conservation concepts (mean = 62.9%) and total scores (mean = 57.6%) than non-members (51 and 54%, respectively). More than half the students correctly defined mountain bongo as herbivores (54%) and described bongo as brown or red with white stripes (52.7%); many (45%) fittingly suggested that bongo live in forests. Overall, students had a good understanding of basic ecological knowledge (90% average score on these questions), an average understanding of conservation concepts (57%) and deeper ecological knowledge (51%), and a low understanding of the benefits of nature to humans (31%) or knowledge about Eburu (30%).

Hidden Human Dimensions

Given the fence, Kenya Forest Service guards and a national moratorium on logging, Eburu Forest was expected to be relatively devoid of human disturbance. As soon as the tracker team commenced installing camera traps within the forest, however, they began detecting signs of illegal hunting and logging. When reported to Kenya Forest Service and other forest security stakeholders, these observations were initially largely dismissed. The theft and destruction of five cameras within the first 6 months of the study, however, elevated attention by illustrating the scale of illegal activities, and led to stakeholder cohesion in forest security efforts. Over the course of 2018 and 2019, a total of 19 camera traps were stolen or destroyed by poachers (2018: 2 in May, 3 in July, 1 in December; 2019: 2 in January, 7 in February, 4 in March; **Figure 3**).

Strategic Intervention

Recognition of the presence of serious environmental crime inspired forest security stakeholders to disguise camera traps to evade poachers by wedging the cameras within chiseled recesses of upright, rotting logs, and the assembly of a six-man citizen

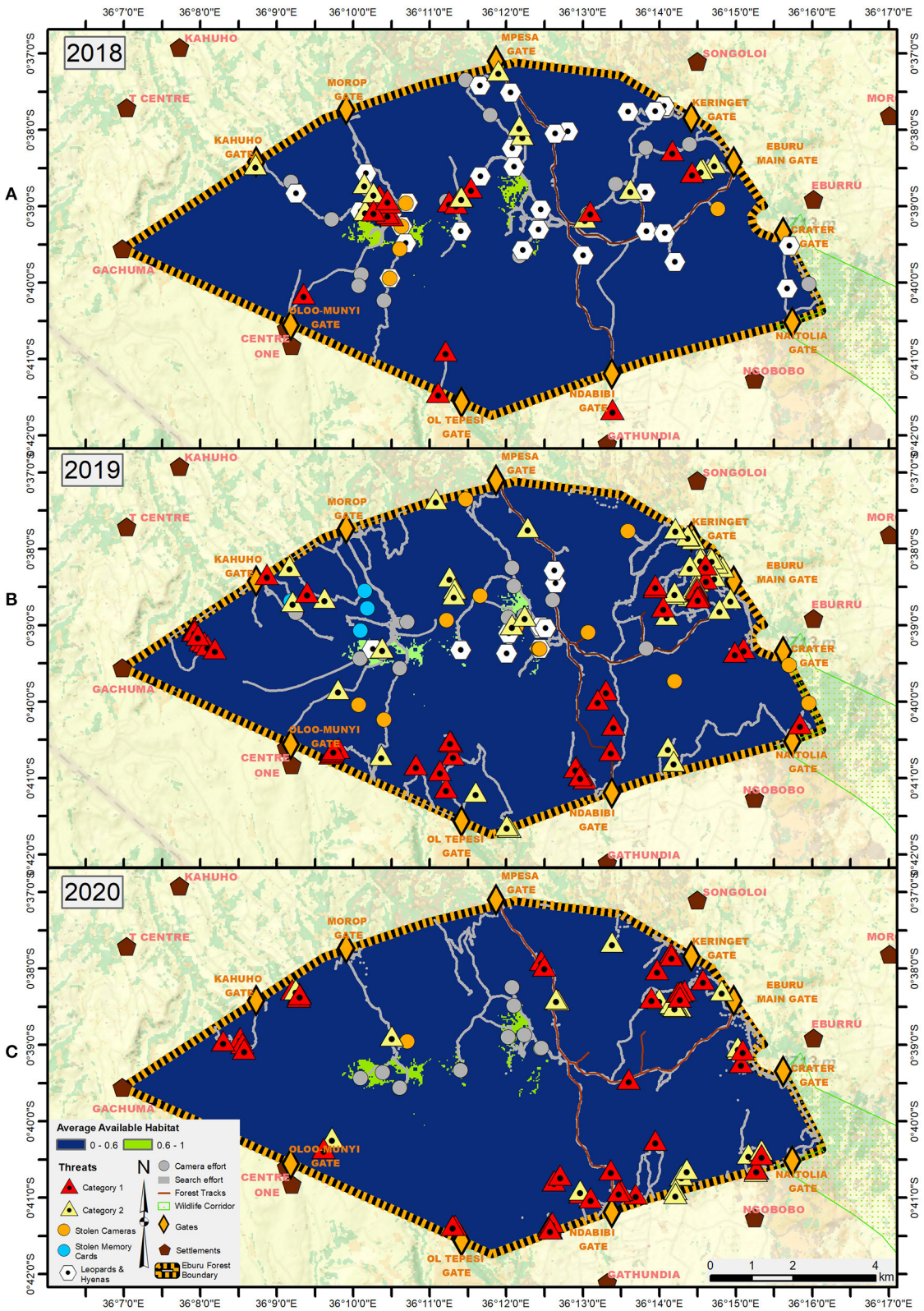

FIGURE 3 | Threats detected in Eburu forest in **(A)** 2018, **(B)** 2019, and **(C)** 2020, including direct threats to bongo (Threat Category 1: evidence of poaching such as leg traps and neck snares), threats to bongo habitat (Threat Category 2: evidence of charcoal production, logging, illegal camps, firewood collection, donkey tracks, and marijuana fields), interference with camera traps, and signs of potential predators (leopards, hyenas). In 2020, the impact of COVID-19 on field operations demanded focus on data for mountain bongo and human threats, so we do not have reliable predator data for 2020.

ranger team together with an armed guard from Kenya Forest Service to conduct de-snaring foot patrols (**Figure 2**). Beginning in mid-2018, the team conducted regular multi-day patrols over 10–15 days per month in the forest. Each day, the team walked for approximately 6–7 h covering different forest sections on a rotating basis to dismantle and record the location of any illegal items observed. In addition, another citizen team was established to gather local intelligence on illegal activities from their home settlements adjacent to the forest. The identities of the six men involved are kept confidential, with reports gathered at a command center by a neutral non-resident.

The community trackers and joint forest security patrols discovered more than 60 leg traps/neck snares, 15 charcoal kilns, and 25 firewood and timber cache sites over 2018/2019 (**Figures 3A,B**). As a result of these efforts, a retaliatory physical assault was carried out on one of the community trackers by four of his neighbors, angry at the constraints being placed on their illegal forest activities. The four men were arrested and charged (cases are before the courts at this time). Five other culprits caught on hidden cameras were cautioned or arrested by the wildlife authorities, and a notorious poaching gang disbanded toward the end of 2019. The collaboration between government and community forest security forces strengthened further in 2020 with 92 leg traps/neck snares, 35 charcoal kilns, 10 fuelwood collection sites, and 11 rafter harvesting sites detected and dismantled (**Figures 2**, **3C**). Ten joint forest security stakeholder meetings were held—roughly one per month.

Remaining Mountain Bongo at Eburu

Over the course of the 8972.79 days of camera trapping effort, camera traps recorded approximately 600,000 images, 182,781 of which were wildlife images, the remainder false triggers. Camera traps recorded only five bongo events, captured on three cameras, with all captures being of single adult males (**Figure 4**). Two bongo events were captured on Camera 29 on November 15, 2018 at 19:40 and November 16, 2018 at 04:34; one bongo event was captured on Camera 3a on April 1, 2019 at 19:33 h; and two bongo events were captured on Camera 33 on March 4, 2019 at 20:22, and April 21, 2019 at 23:16 (**Figure 2**). Cameras 3a, 33, and 29 were 1.5–2 km apart as the crow flies, separated by deep ravines (1.5 to 3.5 km apart considering the topography of the area). An additional 40 bongo secondary signs were observed during the study (11 in 2018, 29 in 2019).

Other antelope captured on camera traps in Eburu Forest in 2018 and 2019 were bushbuck (*Tragelaphus scriptus*; 143,994 images), red duiker (*Cephalophus harveyi*; 7,809 images), waterbuck (*Kobus ellipsiprymnus;* 96 images), and Kirk's dikdik (M*adoqua kirki;* 65 images). Bushbuck and red duiker were the most widespread antelope species, recorded on all and at 33 camera traps, respectively, including the three cameras at which bongo were recorded. Kirk's dikdik were recorded at six cameras and waterbuck at one. Additionally, 72 secondary antelope signs were observed: 54 bushbuck (29 in 2018, 25 in 2019), 13 duikers (4 in 2018, 9 in 2019), and 2 dikdik (both in 2019).

Potential bongo predators recorded on camera traps were leopards (*Panthera pardus*; 98 images) and spotted hyenas (*Crocuta crocuta*; 769 images). Between 2018 and 2019, leopards were found at 14 camera traps and hyenas at 21 cameras. Leopards were found on the same or twinned camera at all three locations were cameras recorded bongo; hyenas overlapped at two of the three locations. An additional 17 predator secondary signs were observed: 4 leopard (2 in 2018, 2 in 2019) and 11 hyenas (6 in 2018, 5 in 2019).

Along with the antelope and potential bongo predator species, a total of 33 mammal species were recorded on camera traps in Eburu Forest in 2018 and 2019, including 12 carnivore species, 3 non-human primates, 7 rodent, and 9 ungulate species, as well as domestic dogs and humans. The number of species recorded at each camera ranged from 3 to 22, with an average 10.7 mammal species per camera trap (SE $\pm$ 0.6). Waterbuck were the only mammal species recorded at a single camera trap site, and bushbuck were the only mammal species found at every camera trap site (**Supplementary Table 3**). Humans were recorded on 18 of the camera traps.

Environmental Suitability

The minimum elevation at which bongo evidence was recorded was 2321 m. All camera captures of mountain bongo occurred in dense forest (mixed montane forest including *Podocarpus* spp. and *Crotalaria* spp.) combined with highland bamboo (*Yushania alpina*) at an average elevation of 2,544 m (SE $\pm$ 45 m). Secondary bongo signs were also found in the same dense vegetation layer at an average elevation of 2,574 m (SE $\pm$ 105 m).

For the MaxEnt environmental suitability models, VIF analysis reduced the environmental variables retained to distance to roads, distance to salt licks, distance to forest roads, edge density, aspect, brightness, DEM, homogeneity of NDVI, and slope. Model accuracy was high with average AUC = 0.964 for the jackknifed calibration data and 0.942 ($\pm$0.014 standard deviation) for the Period 2 testing area. Individual explanatory variables ranked similarly in their contribution to model fit in both the base model and the model calibrated with combined data, as judged by gains and losses in jackknifed AUC. The MaxEnt output provides the permutation importance of each variable in the model, where for each variable, the values of that variable on training presence and background data are randomly permuted and the model re-evaluated on this permuted data to examine the resulting percentage drop in training AUC. In both models, permutation importance was highest for distance to salt licks (15.5 and 37.8% for the base and full model, respectively) and distance to seasonal and permanent water (38.8 and 35.2%, respectively). Other variables of importance were edge density and distance to roads (**Table 1**).

Figure 4 shows the final averaged habitat model for mountain bongo in Eburu. The amount of available habitat ($p > 0.6$) was small at 2.16 km^2 (2.3 km^2 when considering the hilly topography), with only 2.5% of Eburu Forest classified as suitable.

Human threats to bongo occurred in or close to suitable bongo habitat at the start of the study in 2018 (**Figure 3A**) with distance to the fence line averaging 2.2 km $\pm$ 0.8 for threat Category 1 and 1.8 km $\pm$ 1 for threat Category 2. Threats then gradually moved out toward the fence line in 2019 (**Figure 3B**) with average distances equaling 0.8 km $\pm$ 0.6 and 0.9 km $\pm$ 1, respectively. This

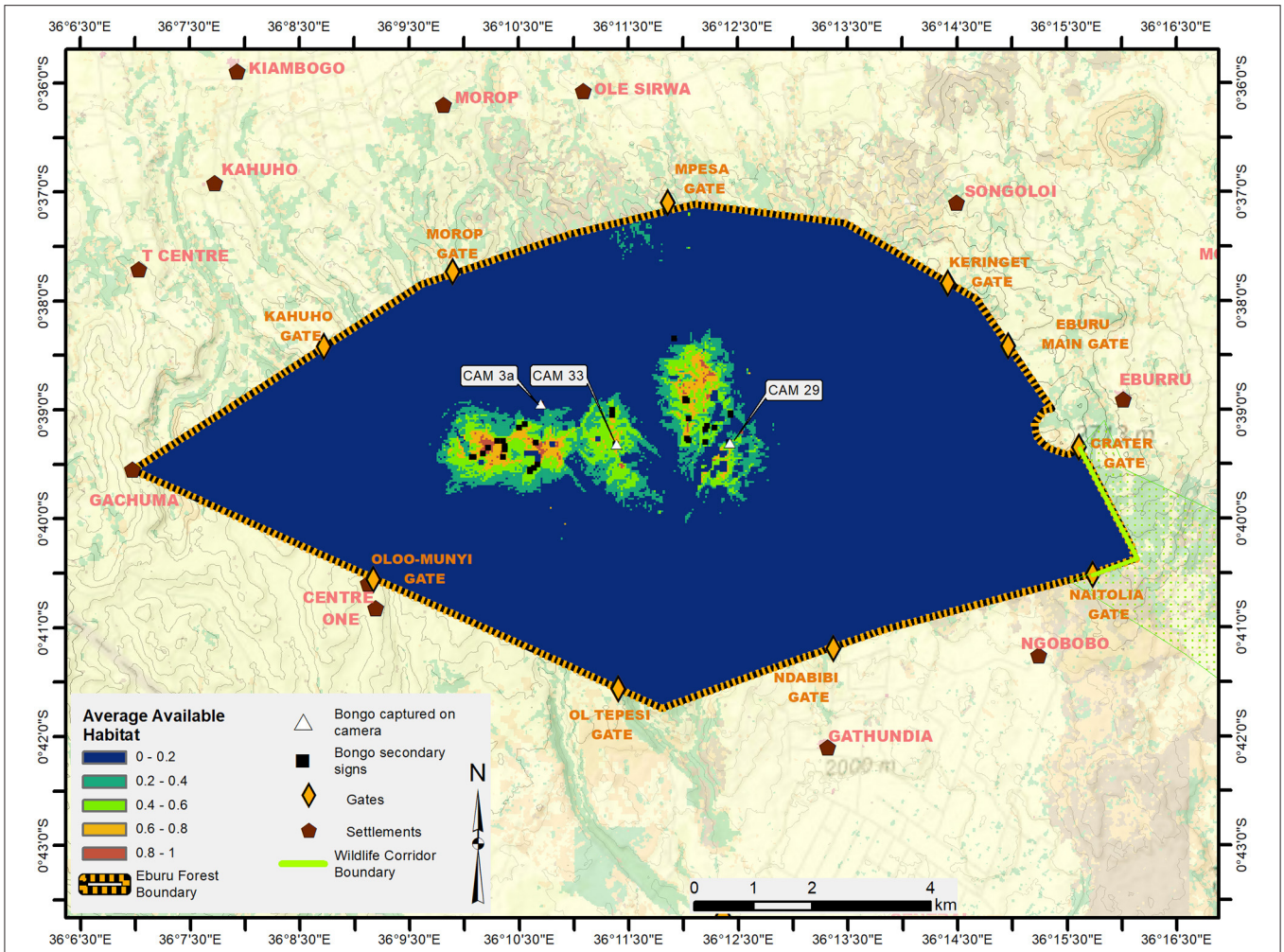

FIGURE 4 | Environmental suitability for mountain bongo in Eburu Forest based on MaxEnt modeling, with warmer colours representing higher suitability. The camera labels highlight the locations in which mountain bongo were detected on camera traps and the black squares indicate where secondary signs of bongo were observed.

TABLE 1 | Permutation importance (%) of model variables for the base model and full model.

Variable	Training model	Full model
Distance to salt licks	15.5	37.8
Distance to water	38.8	35.2
Edge density	20.9	10.6
Distance to forest roads	11.3	8.8
DEM	0.8	3.9
Slope	4.7	2.3
Aspect	4	1.3
Brightness	4.1	0
Homogeneity of NDVI	0	0

trend continued into 2020 (**Figure 3C**); with respective average distances at 0.6 km ± 0.5 and 0.8 km ± 0.7.

DISCUSSION

The frequency of conservation translocations has increased exponentially over the last 30 years, and projections suggest that such increases will continue in the future to prevent regional or global extinction of species, to restore faltering populations, or to improve the ecological function of ecosystems (Moehrenschlager et al., 2013; Armstrong et al., 2018; Swan et al., 2018). While conservation translocations may enjoy widespread public support where recovery entails proximate positive outcomes for local communities (Williams and Haines, 2021), situations where the species of interest, or their protection, threaten local livelihood can result in vehement opposition that precludes the initiation of conservation translocations or their long-term success (Vaske et al., 2013; Gray et al., 2017). While biological considerations are often the focus of conservation translocation studies, the viability of managed populations is frequently linked to socio-economic, political, or legal factors (Riley and Sandström, 2016).

Holistic feasibility assessments for conservation translocations that from the onset consider community context and perspectives alongside ecological parameters are explicitly recommended by the IUCN Guidelines for Reintroductions and Other Conservation Translocations (IUCN, 2013). Nonetheless they remain rare but are gaining momentum (Leiper et al., 2018; McMurdo Hamilton et al., 2020; Rayne et al., 2020). The analysis presented here provides a valuable case study that illustrates both the complexities and necessity of a holistic approach.

Focus group discussions and structured interviews with community members or key informants are common tools for gaining insights on the local populations' interaction with the environment and associated needs, wants, attitudes and aspirations (Bajracharya et al., 2005; Nyumba et al., 2018). While it is known that such tools may fail to reveal practices that are illegal or perceived to be so, this can be mitigated to a degree by assuring participants of their anonymity and that no incriminating information would be shared with government and law enforcement agencies (Gavin et al., 2010; Solomon et al., 2015). Even where confidences can be gained, however, illicit practices may not come to light if constrained to a small proportion of the population and conducted in sufficient secrecy that the general public is unaware.

In Eburu, the vast majority of survey participants supported conservation of the forest, the electrified fence with its dual purpose of protecting humans from wildlife and vice versa, and the idea of bolstering local mountain bongo numbers with the help of conservation translocations. Yet camera trapping and sign surveys, intended to collect ecological information for the feasibility study, quickly revealed that a small number of community members were actively undermining forest conservation efforts by illegally hunting and logging within the forest reserve.

Some illicit activity was to be expected: a previous study on resource-use conflict had noted that a small proportion of the forest-adjacent community extracted charcoal and timber from Eburu without permission, or had expressed disgruntlement vis-a-vis the fence and permit restrictions on firewood and life stock grazing (Makhanu, 2015). Interference of the fence with access to charcoal, fuel wood and grazing was also mentioned by 22% of participants in our study. Neither study, however, predicted poaching, nor the tenacity with which perpetrators would defend their illegal activities.

That the discovery of illegal activities was at first met by incredulity among the stakeholders responsible for forest security is undoubtedly not unique to Eburu Forest (see e.g., Dureuil et al., 2018; Sabuhoro et al., 2020). Although the concept of "paper parks" exists (officially gazetted protected areas that are not or are poorly enforced—Bruner et al., 2001), the presence of visible protective measures, such as Eburu's electric perimeter fence and eight Kenya Forestry Service stations manned by guards, can lull people into the belief that protective measures are effective. Any observations reported to the contrary are then dismissed as isolated incidents that pose no overall threat. In our study of Eburu, it took the consecutive theft of multiple pieces of expensive and, in Kenya, hard-to-come-by field equipment, to shake forest security stakeholders out of this complacency.

With multiple stakeholders involved, the resulting awareness might have descended into a mutual blame game. Thanks to a quick intervention that gathered all relevant agencies in an emergency meeting, the result instead has been the building of mutual trust, commitment and coordination, now reinforced monthly at joint forest security meetings. These meetings serve to remind the different stakeholders of their shared goals, exchange information and ideas, and closely coordinate efforts. They have given rise to two innovative approaches that involve citizens in mitigating conservation threats, have led to some of the illicit actors being successfully reprimanded, and have been effective at pushing potentially harmful activities away from primary mountain bongo habitat toward the vicinity of the fence.

Confidence in a joint ability to tackle the crisis and ideas to involve ordinary community members in the response would have been less forthcoming without the knowledge—gained during focus groups and household interviews—that the population at large is supportive of forest conservation. Hence while it was our ecological monitoring efforts that inadvertently revealed the problem, planned community consultation contributed to the solution. This illustrates the value of soliciting community perspectives up front alongside ecological investigations rather than as an afterthought.

Broad community support for forest conservation and mountain bongo likely reflects, at least in part, the diverse and durable efforts over the past two decades by various organizations to raise environmental awareness and engage the communities bordering Eburu in habitat restoration. Although intimate knowledge of and appreciation for an ecosystem and its gifts and services is common in communities that have a long-standing association with a particular landscape or environment (Pretty et al., 2009), the relatively recent arrival of much of the population surrounding Eburu might have made environmental respect less inherent. It is noteworthy, therefore, that when asked about the benefits of Eburu Forest, 75% of household survey respondents mentioned ecosystem health, and that the majority of adults and children knew what mountain bongo look like even though most had never seen one.

Similarly, the fact that a forest island, which seemed doomed by degradation just two decades ago (Church, 2015), was found to teem with a diversity of wildlife (33 mammal species documented through camera traps), including top predators, speaks to the success of protective measures taken. These measures combined legal barriers (official protected status), physical barriers (presence of guards, fence), and social barriers (community awareness and engagement). Any instrument on its own is unlikely to have been as effective. Protected status alone rarely is. Community engagement alone can be, particularly where community-wide cultural or spiritual ties align with a conservation ethic (Davies et al., 2013), a scenario not applicable to Eburu. Physical barriers on their own are also unlikely to suffice, as most can be overcome or circumvented. Guards cannot be everywhere, and Eburu's electric fence, for example, is game-proof rather than human-proof, not infrequently breached by short-circuiting, and under constant need for maintenance (Otungah et al., 2008). Seeing the fence built and maintained, however, helped signal to surrounding communities that talk

around the importance of conservation and around ensuring the community's' safety from wildlife was sincere, and that the organizations involved can be trusted to follow through on promises (McLeish, 2020). The health of Eburu Forest, and with it the prospects for a conservation translocation of mountain bongo being feasible, have hence benefitted from a long-term investment in readying both the ecosystem and surrounding human communities for the potential release of a critically endangered species.

Nonetheless, our ecological analysis determined that Eburu Forest holds only roughly 2.2 km^2 of suitable environment for mountain bongo. This is a fraction of the area typically used by mountain bongo herds given historic observations that 8-10 bongo might range over 10 km (Sheppard et al., in prep.). Assuming 10 km can be interpreted as a diameter, this translates to ∼78.5 km^2. At face value, this might suggest that reinforcement of the remaining bongo population at Eburu with captive-bred individuals is not feasible without first implementing extensive habitat restoration to expand the area suitable for release.

Our environmental suitability analysis, however, may be misleading. The rarity of camera captures (3 bongo events among 182,781 wildlife images), and the fact that each capture involved lone males suggests strongly that our observations of bongo habitat use are limited to the movements of at best 2–3 lonesome survivors. Remnant individuals or populations may not utilize the best or all available habitat, and may in fact be pushed into sub-optimal areas given human-induced threats (Namgail et al., 2007; Shanee, 2009; Fowler et al., 2012). Moreover, habitat selection by individuals does not necessarily reflect limiting factors relevant at population-scale (Germain and Arcese, 2014; Dunn and Angermeier, 2016), and this may be particularly pertinent for individuals that would ordinarily reside in herds. It therefore seems unwise to conclude that the environmental conditions that correspond to the locations currently frequented by the few individuals remaining in Eburu represent the best or only suitable habitat for bongos in this forest. In the Aberdares, for example, where the size of surviving forest is much larger than Eburu (225,224 vs. 8,715 ha), and provides a less human-penetrated core, the country's most intact mountain bongo population (with an estimated 40–50 individuals; Kenya Wildlife Service, 2019) resides at lower elevations, and in areas with reduced extremes in terrain (DSh, pers. observ.).

This is not to say that habitat restoration would not be helpful. Clearly, ongoing reforestation of denuded areas with native tree species is most welcome and should continue for multiple reasons, including forest health and regeneration, the benefits it may ultimately bring to bongo, increased resilience of ecosystem services, and continued engagement and pride of community members in conservation actions. The practice is well-established in Eburu, with 3,600 indigenous seedlings planted across 12.2 ha in 2019, and 4,250 seedlings across 16 ha in 2020 (J. Kiruy, pers. commun., August 18, 2021). For direct benefit to bongo in terms of both habitat and community support, it may be useful to specifically include plants favored by mountain bongo as forage among the those grown by school or community nurseries and planted during community events.

A conservation translocation of mountain bongo to Eburu, however, need not and likely should not wait until additional suitable habitat has been created. With so few mountain bongo left, and a likely lack of females, reinforcement is urgent. Reinforcing existing populations, even if very small, is generally considered easier than reintroducing species to locations from where they have vanished completely (Champagnon et al., 2012; Martin et al., 2012; Hardy et al., 2018). This is even more critical for translocations of captive-born individuals who are less likely to have the essential survival skills than animals that are sourced and translocated from other wild populations. The remaining wild individuals in Eburu can still serve to anchor released animals near release sites, to prevent dangerous post-release dispersal, and to illustrate key survival behaviors in terms of foraging, activity periods, and anti-predator behaviors (Moehrenschlager and Lloyd, 2016). Moreover, timing of reinforcements has been identified as an important factor in determining success, with earlier onset yielding better long-term results (Hardy et al., 2018).

We fully acknowledge that Eburu Forest in its current state, and even if fully restored within its fenced boundary, is too small to host a mountain bongo population of sufficient size to sustain itself in the long-term. The Mountain Bongo Task Force has set a tentative target size for the wild population at Eburu of 20 individuals (Kenya Wildlife Service, 2019), which is in line with historic population estimates for the area (Sheppard et al., in prep.). Populations of this size were likely viable in Eburu in the past thanks to connectivity with populations in the larger Mau Forest Complex. The insular nature of Eburu Forest as it exists today, however, means that a population that small would need to be carefully managed (as is planned) to avoid the detriments associated with small size, including demographic and environmental stochasticity, potential allele effects, genetic drift, and inbreeding depression (Caughley, 1994).

As the first reinforced wild population within an artificially managed mountain bongo meta-population, however, a small population at Eburu could be immensely valuable, particularly in terms of developing effective release strategies. Moreover, established populations could be seen as a potential "stepping stone" site which not only serves as a destination for naïve captive-born animals, but indeed as an eventual source for wild-born behaviorally superior animals that could be translocated to other protected areas (Lloyd et al., 2019).

Several aspects of the site render it favorable for a conservation translocation.

First, illegal activities within the forest, although still ongoing, are now understood and actively being managed with considerable success. Their increasing confinement toward the edge of the forest indicates that perpetrators fear the increased chance of detection associated with the longer time required to penetrate deeper into the forest and more pristine habitat. The electric fence and recently established Kenya Wildlife Service outpost, combined with citizen engagement in forest security, help deter all but the most tenacious minority of offenders.

Second, political will and stakeholder support exist, as illustrated by the considerable effort put into joint forest security

measures by both the Kenya Forest Service and Kenya Wildlife Service and earmarking of Eburu as a potential translocation site (Kenya Wildlife Service, 2019). The two government agencies are further supported in Eburu Forest by an engaged and organized Community Forest Association, plus technical and financial support from conservation NGOs including Rhino Ark, BSP, and Eburru Rafiki. Forest-adjacent communities are enthusiastic about a conservation translocation, with 94.5% of household heads interviewed in favor of bongo reinforcement. Although for some the enthusiasm is tied to expectations of economic benefits through tourism, many also recognize a more intrinsic, educational value to boosting bongo presence. Moreover, hopes for tourism might in fact materialize, as Eburu is not far from Lake Naivasha, which consistently attracts large numbers of visitors (Abiya, 1996; Njiru et al., 2017). Initial interest in Eburu might be enticed by tales of elusive bongo, and subsequent visits by the rugged, beautiful, volcanic habitat the bongo calls home.

Thirdly, despite the rugged terrain, Eburu also offers a more accessible site for a bongo conservation translocation than alternative locations. Excellent existing rural and forest roads provide access to areas in Eburu in close proximity to suitable habitat and so would facilitate transport of captive-bred individuals to soft-release pens.

Finally, much of Eburu's advantage lies precisely in being small. Conservation translocations aim for species or ecosystem benefits, but risks need to be considered not only for the released individuals but also remaining conspecifics, other species, or human communities. The limited size of Eburu Forest permits a conservation translocation here to effectively test and impact an entire but well-contained ecosystem, facilitating genuine insights on how a reinforced population interacts with other species, including predators and competitors, and thus providing room for adaptive management (Moehrenschlager and Lloyd, 2016). Moreover, reinforcements do carry risks for remaining wild individuals, such as pathogen transfers or maladaptive genetic swamping (Champagnon et al., 2012), although these very rarely manifest in conservation translocations (Novak et al., 2021). With clearly very few wild individuals remaining at Eburu, the overall risk to wild mountain bongo would be minimal should such unintended consequences occur, and mistakes could be rectified before undertaking reinforcements in the Aberdares, at Mt. Kenya or in the Mau Complex proper, where larger wild populations persist.

To avoid mistakes in the first place, however, careful consideration should be given to the selection of individuals for release with regards to behavioral suitability, genetic and physical health, including the absence of pathogens and parasites (Champagnon et al., 2012; IUCN, 2013). Given the apparent absence of female mountain bongo in Eburu and what is known about historic herd composition, we recommend that an initial release involve 3–6 females. We also recommend release of one mature and potentially one immature male, as lack of recent camera trap evidence could suggest that the previously observed male individual(s) have since died. Experience in zoos suggests that males can be paired (C. Magner, pers. commun., 2021), and age-differentiated pairs have been observed in the wild (Bosley, 2003).

The bongo individuals selected for release should be acclimatized to each other and to Eburu Forest in on-site soft release pens for a month or more. Once released, the individuals should be carefully monitored by an established network of approximately 20 camera traps serviced by the now experienced tracker team in habitat identified as most suitable. In addition, a tree hideout could be constructed near the release sight to facilitate unobtrusive, live observation, and feeding stations set up to gradually wean released animals off the diet they were accustomed to in captivity.

Subsequent releases of up to a total of 30 individuals over 3–5 years, depending on post-release mortality and availability of individuals for release, might aim to maintain the population at a sex-ratio of 3–4 females to 1 male of varying age and maturity, again carefully selected for health and behavioral aptitude. Once a herd has established and is actively reproducing, conservation translocations can be limited to the occasional transfer of individuals from and to either captive or stabilized wild populations for maintenance of genetic diversity. All releases should be followed by careful and long-term monitoring. Monitoring will be critical in determining if herd bonds form and last, if reproduction occurs, if young fall prey to opportunistic predators, and if poachers try to take advantage of tame or at least somewhat human-accustomed mountain bongo.

Monitoring should not, however, be limited to biological aspects. Although the IUCN Guidelines for Reintroductions and Other Conservation Translocations focus on monitoring biological goals (IUCN, 2013), it is equally important to monitor socio-economic aspects of a conservation translocation. Releases involve decisions regarding the selection and support of individuals and sites and these considerations should incorporate human dimensions iteratively in an adaptive management process. Monitoring not only includes ecological parameters, but also needs to assess human dimensions on an ongoing basis (Moehrenschlager and Lloyd, 2016). For success in re-establishing a small mountain bongo population in Eburu, community support will be critical for decades to come. Regular attitude checks via repeated household surveys every 2–3 years will be important, and note should be taken of any bongo-related comments that arise in discussion at the Community Forest Association or other community discussion fora.

Additionally, community spirit might need to be actively fostered. Community festivities, such as a repeat of the "Eburu's Got Talent" competition that allowed schools to showcase their knowledge about mountain bongo, are one option. Another is to ensure that community members experience tangible benefits from their conservation efforts. Assisting the Community Forest Association through capacity building, working toward facilitating a sustainable honey cooperative, and public recognition and support for local conservation champions are three initiatives we are currently pursuing. Helping to promote eco-tourism and providing teachers with additional material to encourage student knowledge about the Eburu ecosystem are two additional alternatives.

Implementing sustainable use of Eburu Forest compatible with a conservation translocation may initially require forest-internal zoning that combines a strictly protected bongo sanctuary off-limits to humans with a surrounding buffer zone

where honey harvesting, back-country camping, and leisure hikes are permitted. Such zoning might be seasonally dynamic and become unnecessary once a bongo population has become well-established and any threat of poaching minimized. Both formal and citizen-based patrols and data gathering will be key to continuously monitoring threats. Participatory monitoring might be encouraged via an ecosystem-specific citizen science monitoring App or a bongo "hotline" for people to call in and share relevant observations. Such participatory monitoring will not only help enforce zoning and keep an eye on threats, but also serves to reinforce local pride and ownership over the conservation endeavor (de Araujo Lima Constantino et al., 2012; Evans et al., 2018).

Although areas with low human presence and impact persist, wildlife around the globe for the most part exists within close proximity to humans. A recent study found that the median distance to edge in areas of low human impact is merely 6 km worldwide (Jacobson et al., 2019). Therefore, to give conservation translocations the best chance at success, their planning, implementation, and follow-up must take a holistic approach that carefully considers, shapes, and mitigates both biological and socio-economic factors throughout. We believe that our study convincingly demonstrates the importance of such a holistic approach in the feasibility assessment and planning phase, and are pleased to report that it is already serving as a model for the feasibility analysis at a different potential release site for mountain bongo at the Ragati and Chehe Forest Stations on the slopes of Mt. Kenya. We hope that we have also provided useful pointers on how to integrate biological with socio-economic considerations during implementation and subsequent monitoring and evaluation. Given the ubiquity of humans on this planet, it is paramount that any form of conservation management take impacts by and on humankind into account and actively influence these for mutual benefits to local communities, wider society, and wildlife.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. 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

DSh is responsible for study design, contributed to the underlying research for this article, and together with her field assistants, collected the camera and sign data, and conducted the interviews. TB-C and DSt looked after data analysis, tables and figures. DSt also identified and filled citation gaps. CL is a member of the Mountain Bongo Task Force and provided much of the local history and context in the introduction, methods, and discussion sections of the paper. AM chairs the Conservation Translocation Specialist Group (CTSG) of the International Union for the Conservation of Nature (IUCN) Species Survival Commission (SSC) and helped with framing this paper and recommendations regarding a translocation of Mountain Bongo. JM provided guidance and supervision for much of the work and did the majority of writing. Each author wrote or contributed to sections of the manuscript and manuscript revisions. All authors have read and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcosc.2021.788267/full#supplementary-material

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Guidelines to Facilitate Human-Wildlife Interactions in Conservation Translocations

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Species reintroductions and translocations are widely used management interventions to restore locally extinct or augment severely depleted species. In such projects, the human dimension issues that influence the success of these conservation interventions are encountered at five different stages of the project life cycle: (1) planning, (2) initiation, (3) implementation, (4) ending stage, and (5) post-exit. Overlooking or failing to consider the human dimension in any of these phases could jeopardise the conservation translocation project's success. When the human dimensions are included there is greater possibility of community involvement, peers' acceptance and support from various interest groups and avoidance of conflict situations. The Human-Wildlife Interactions Working Group (HWIWG) was formed in 2018 by members of the IUCN Conservation Translocation Specialist Group (CTSG). HWIWG has facilitated online discussions and workshops with practitioners, researchers and academics from across the globe, on a range of aspects of human-wildlife interactions in conservation translocations, as well as leading discussion sessions during international research conferences. These events have provided a rich source of material from which to draw a series of recommendations. In this paper we discuss findings from the HWIWG that illustrate how, in each of the five stages of the project life cycle, human-dimensions influenced conservation translocation projects. Our aim is to provide useful and multidimensional insights for those working in species' reintroductions and translocations.

Keywords: human dimensions, reintroduction, human-wildlife conflict, biodiversity conservation, wildlife conservation

INTRODUCTION

Characterising the Issues

Conservation Translocation

Conservation translocations, defined as the intentional movement of wildlife for conservation purposes (IUCN, 2013), involve the long-term re-establishment of endangered wildlife to their former range. Sound and comprehensive bio-ecological knowledge, although essential to a project, is insufficient if an understanding of human context in which the translocation is to take place is

misunderstood or ignored. In an era of accelerated biodiversity loss and climate change, the use of conservation translocations and assisted colonisation (to move populations of organisms to areas outside their range) to maintain ecosystem function and protect species from extinction is predicted to increase (Bubac et al., 2019; Brodie et al., 2021). Reintroductions are part of rewilding projects [to regenerate degraded (defaunated?) landscapes, Butler et al., 2021]. Such projects often feature large herbivores and carnivores, landscape engineers and keystone species (Drouilly and O'Riain, 2021). Extinction risks are greatly impacted by anthropogenic causes such as climate change, destruction and disturbance of habitats, introduction of invasive species and pathogens, and over-exploitation. Reintroduction is a useful conservation strategy, but it is rarely conducted in spaces that are totally devoid of people. Therefore, a strategy relating to and including people directly and/or indirectly affected by a reintroduction should be in place.

The Human-Wildlife Interactions Working Group (HWIWG) brings together practitioners, researchers and academics worldwide to discuss key issues and share solutions with the wider community. In February 2018, some members of the IUCN/SSC Conservation Translocation Specialist Group (CTSG) gathered to discuss human-wildlife interactions in the context of reintroductions. This initial event highlighted the need for a forum to promote further discussion, and for the development of a set of principles concerning human-wildlife interactions (HWIs) that could enhance the existing Guidelines for Reintroductions (IUCN, 2013). These Guidelines recognise the necessity of considering socio-economic and cultural aspects in conservation translocations. Nevertheless, it is outside their scope to explore human dimensions in depth, so a need for further guidance remains. A review of HWIs related issues in the IUCN Global conservation translocation perspectives (Soorae, 2021) projects has highlighted some common HWIs issues. Multi-agency collaboration, preventing and addressing human-wildlife conflict; creating long-term benefits and long-term planning, and funding were reported in 39 out of 69 case studies across the phylogenetic spectrum, in all geographic regions. Despite commonalities, human dimensions were seldom addressed consistently throughout projects and often took planners by surprise, becoming a barrier to the success of the reintroduction. These findings reinforce the need for guidance to help project planners make consistent considerations for HWIs at all stages of a project.

Human-Wildlife Interactions in the Context of Conservation Translocations

HWIs are receiving increasing attention from a conservation perspective, possibly as a result of biodiversity decline and changing attitudes and values towards wildlife (Echeverri et al., 2018; Watkins et al., 2021). HWIs can be both positive and negative, can be influenced by context and by previous experience, trends in society and individual processes (Johansson et al., 2016; see Frank and Glikman, 2019 for a review). HWI studies require the integration of several disciplines and knowledge systems as they occupy a position at the intersection of social and natural sciences, psychology and humanities, indigenous and globalised knowledge, and governance. While diverse perspectives enrich the discussion of HWIs role in conservation, differences in epistemology, research paradigms and methodologies may create barriers for conservation research and practise to incorporate HWI studies into projects (Johansson et al., 2016; Echeverri et al., 2018). The present paper aims to facilitate this process, providing a tool for practitioners to consider HWIs at every stage of a conservation translocation project, supported by evidence from literature, discussions and examples from field work.

As there is a shift from focusing on single species towards restoring ecosystem functions, more species that provoke high degrees of environmental change will be the focus of conservation translocations (Seddon and Armstrong, 2016). Keystone species and ecosystem engineers changing the physical landscape and regulating the abundance of other species, are more likely to affect the livelihoods of local people who may have become unaccustomed to their presence. Seddon and Armstrong (2016, p. 21) suggest that "more challenging reintroductions will require resetting "public expectations" of nature through promoting a close relationship between them and local restoration projects, to change attitudes and gain support."

The relationship between people and wildlife may have both material (based on ecosystem services and income generation) and non-material (based on cultural, psychological, artistic, wellbeing and spiritual factors) dimensions. Non-material HWIs in particular may be context dependent, socially constructed and vary according to culture and worldviews, changing over time (Echeverri et al., 2018). These are highly relevant to conservation as they influence decision making, from government policy to local support for focal species. Furthermore, attitudes and behaviours of community members towards a reintroduction project may differ with socio-demographic variables such as age, gender, race and ethnicity, education and income levels (Mogomotsi et al., 2020). While our understanding of species biology and ecosystem dynamics informs reintroduction planning, it must go beyond that to encompass the understanding of the role people play both at the root of conservation problems and at the root of their solutions.

The Conservation Network in Translocations

Translocation projects function within a network of stakeholders (the Conservation Network; **Figure 1**), each of which have different demands and expectations about the outcome of the project. The conservation network includes actors involved with the *in* and *ex situ* populations, the local community, public, supervisory bodies or agencies, team members, and donors (Swaisgood and Ruiz-Miranda, 2019). This network embeddedness is an important aspect because it relates to the direct and indirect effects of the project in question and any ramifications that may affect the execution of other current or future projects (for example see Swaisgood and Ruiz-Miranda, 2019). Project stewards need to be aware how the translocation project affects and is affected by the conservation network as it advances through its phases.

The impacts of the translocation project can be social, cultural or economic, positive, or negative. Negative effects are the most

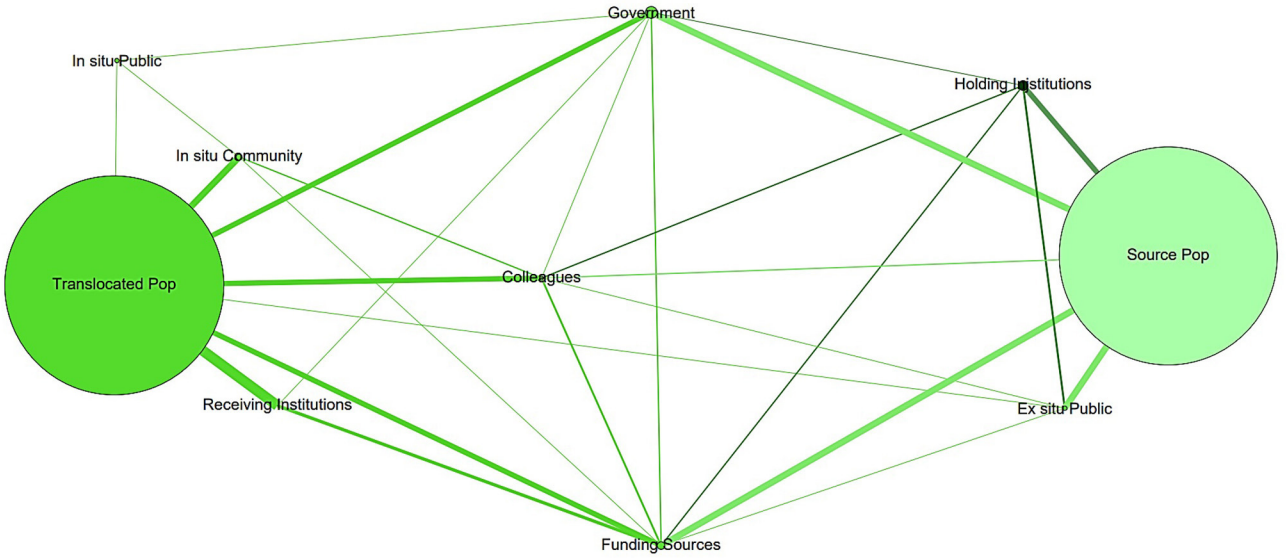

FIGURE 1 | A simplified conservation network for a reintroduction project. Some of the stakeholder nodes represent multiple actors or a smaller network. The *source population* is in a *holding institution* which could be a breeding facility or a network of zoos. The *ex-situ public* are the visitors or public that may have an opinion about or interest in the translocation and influence (via indirect and direct fundraising) the long-term support of the holding institution, the source population and even the *in-situ* work. *Government* is all of the regulatory and permit granting agencies that grant the necessary authorizations for breeding and movement of species. *Funding sources* are institutions or individual donors that provide financial resources either to the translocation project or to the *holding institution* for *ex-situ* and *in situ* work. The *colleagues* node is the network of project participants, collaborators and reviewers that influence the project's evaluation and assessment of goals and outcomes. The *receiving institution* is the organisation or group that will manage or steward the *in-situ* component of the project. *In situ public* refers to the general audience with their perceptions and multitude of opinions about the specific translocation, translocations in general or even wildlife conservation. The *in-situ community* is the part of the population that will interact directly with the translocation project, the landowners or citizens whose daily life may be affected by the released animals or the presence of project staff.

salient and recorded and are discussed in IUCN guidelines (IUCN, 2013). The release of animals can have negative consequences for economic or health reasons. The animals could damage crops, prey on livestock, even harm people (they can introduce diseases that could affect domestic animals or people). The strategic plan must include a communication strategy that informs stakeholders of these potential dangers, mitigation steps, and aim to seek long-term support for the project.

Translocation of animals could also be beneficial by establishing ecological services, creating direct jobs, opening opportunities for ecotourism, by engaging the local community in something that appeals to their sense of aesthetics, pride, or cultural significance. Even when effects are positive, planners must inform stakeholders about potential benefits. Transparency and sharing of information can work towards establishing the project as a "trusted messenger" (Vance-Borland and Holley, 2011; Treves et al., 2021) and consequently allow the project to foster its network towards the conservation goals.

One crucial component of the conservation network is the local community around the translocation site. These are the stakeholders who will reap the benefits and also bear the (ecological and economic) costs of translocation. Ignoring the considerations that the local community may have about a translocation can result in loss of opportunities or even project rejection (Jachowski et al., 2016). Project managers should also be aware of possible secondary consequences. For example, releasing species targeted by the illegal wildlife trade into habitat on private lands may result in increased poaching in that area; the local community bearing the brunt of the negative consequences of unwanted intruders. An engaged local community can also benefit the project. Local expertise about a species natural history can translate into better habitat selection or monitoring techniques; collaborative locals can be the basis for a participatory monitoring program lowering costs of long-term monitoring post-release. Public opinion can be accessed to identify solutions to potential human-wildlife conflict, as in the case of beaver reintroductions in the United Kingdom (Auster et al., 2020) and sea-eagles in Ireland (O'Rourke, 2014). Robust conservation networks, those with positive interactions and free idea exchanges, are probably more resilient and will support the project longer term. For these reasons translocation projects should make strong efforts to carry out an analysis of the social viability of the project.

How Positive and Negative HWIs Affect the Success of Conservation Translocations

Different cultures have different relations with wildlife species. In some rural Indian cultures, large predators like tigers and lions are venerated and seen as religious symbols. As a result, high cultural tolerance for these species is reported (Kolipaka et al., 2015). In other cultures, the same species are seen as pests and communities violently retaliate towards them and those

promoting their conservation. HWIs in wildlife conservation often focuses on negative interactions that lead to human-wildlife conflict (HWC), rather than building on positive interactions to foster coexistence. Acknowledging and exploring a whole range of interactions may build a better understanding of the human dimensions of a reintroduction, towards conservation success (Frank and Glikman, 2019).

Many negative interactions between people and wildlife are deeply rooted in wider societal issues of power imbalances, governance and historical inequalities and conflicts, as well as individuals' psychological needs and identity (Madden and McQuinn, 2014; Baynham-Herd et al., 2018). Among these, many would be better characterised as people-people conflicts, or conflicts between conservation and other competing human interests (Redpath et al., 2015). Conflict often results from clashes between interest groups over conservation objectives, when diverse interests concerning land and resource use, political affiliation, animal welfare values and others are reflected by strongly held positions (Baynham-Herd et al., 2018). Conflict prevention and resolution, however, are determined by human "thoughts and actions" (Manfredo and Dayer, 2004, p. 317).

Coexistence between people and reintroduced wildlife is influenced by historical, cultural and political context, therefore conservation translocations benefit from combining applied and place-based knowledge to achieve it (König et al., 2021).

The 5 Stages of the Cycle Framework

- Planning stage: before initiating contact with community and various interest groups.
- Initiation stage: initiating contact with community and other interested parties.
- Implementation stage.
- End stage and exiting the project.
- Post-exit stage.

After Schaefer et al. (2020).

GUIDANCE FOR DIFFERENT STAGES OF A PROJECT

In this section we discuss the many issues raised during HWIWG discussions, as they relate to each stage of a conservation translocation project. Often these issues may need to be incorporated from an early planning stage and must be continuously re-evaluated and addressed later on. These may be mentioned in an earlier stage but not repeatedly subsequently. Although this paper does not aim to provide an exhaustive discussion on the human dimensions of conservation translocations, it aims to expand the space for the discussion and consideration of such issues during the planning stages of a project by focusing on key issues, sometimes illustrated by field examples (**Supplementary Material**: **Appendix 1**) and recommendations of actions to address them (**Supplementary Material**: **Appendix 2**).

Conservation translocations are commonly faced with a snapshot in time of positive and negative HWIs, limited to the immediate context of the project. Thus, the management of HWIs tends to focus on changing "human behaviours," including behaviours that threaten wildlife by attempting interventions that Baynham-Herd et al. (2018, p. 181) categorise as "technical" (reducing negative human-wildlife interactions and promoting positive ones), "cognitive" (disseminating information, education and awareness campaigns), and "structural" (regulation creation and enforcement, mitigating losses).

Interventions that focus on participation of diverse interest groups throughout all stages of the project, on the other hand, contribute to targeting structural and long-term social dimensions of HWIs that may make a perennial contribution to the success of the project (Baynham-Herd et al., 2018). These include several forms of participatory planning, knowledge sharing, and consultations, as well as conflict resolution and devolution of decision-making power to local people. Each intervention must be considered at each stage of the project to promote prevention of HWC, rather than the need to address these, and to promote positive HWIs (Madden and McQuinn, 2014; Redpath et al., 2017; Baynham-Herd et al., 2018).

Due to the nature and relevance of HWIs, collaboration between biological and social scientists connecting research and practise is necessary to increase success of conservation translocations in all phases of a project.

Planning Stage of the Project-Before Initiating Contact With Community and Various Interest Groups

Deciding How Involved Local People Should Be in the Project Planning Stage

Projects led by state agencies may decide not to involve local communities or inform them of reintroductions due to the belief that they will not be affected (Waters et al., 2021) [e.g., Persian leopard and Asiatic wild ass (onager) in Iran, MF; saltwater crocodile, gaur and tiger in India]. There is no acceptable justification to exclude all interested parties and local people should always be informed. Informing communities is critical whether the project is international or locally owned and managed (e.g., golden lion tamarin, Brazil). The state is often the entity which designates areas for the protection of reintroduced species. However, a species conservation project is better received when local people have a forum in which they can voice their concerns and such a forum can promote public support for the project. Failure to inform the community may result in negative attitudes and actions that pose barriers towards the programme/species/future conservation programmes.

Recommendation: Developing communication channels and mechanisms with local communities, government and NGOs from an early stage, which include a forum where local people may voice their concerns about project plans.

Choosing Conservation Approaches

There are questions about the most effective approaches to protect contentious reintroduced species, such as large carnivores and ecosystem engineers, from negative HWIs. When reintroductions occur and introduced populations are very low, impacts on local people are likely to be minimal and

strict protection may be favoured. However, this situation may change as the species recovers and the impact of wild populations increases. Coercive "top-down" approaches based on command and control policies may raise issues of political legitimacy and result in non-compliance and retaliation, while local governments may not have the capacity to enforce and monitor such policies (Redpath et al., 2017). Legislation concerning command and control and collaborative practises vary from country to country, however collaborative approaches are embedded in the Convention on Biological Diversity.

Recommendation: Developing collaborative and trans-disciplinary approaches to build trust and lead to long term coexistence solutions that withstand changes in the population size of reintroduced species; combining collaborative approaches and law enforcement to protect reintroduced populations, while objecting to militarised conservation.

Identifying and Integrating Interest Groups in a Participation Process

Involving local people creates unmissable opportunities. When Communities are presented with a ready-made plan that excludes participation, they may react negatively. Alternatively, when communities are involved in the early planning stages, able to discuss their concerns and "what ought to be done" to address both eco-biological and socio-economic issues, project leaders and interest groups may then move into the next stage together, to decide what "can be done." This creates a participatory process (HWIWG, 2020b). From bio-ecological features to socio-cultural elements, local context is specific to each project. Participation process is context dependent and not easy to extrapolate, therefore it requires an evidence-based approach so that cost-effective, efficient strategies of community participation may be developed (Reppucci, 2013). While decision making is generally complex, interest groups are heterogenous and focused approaches such as information campaigns and workshops may limit involvement. The effectiveness of diverse management approaches can however be tested and monitored (Luyet et al., 2012; Madden and McQuinn, 2014; Redpath et al., 2017).

Recommendations: Developing a participatory process that creates opportunities for local people to discuss their concerns, addressing both eco-biological and socio-economic issues. This allows project leaders and interest groups to move into the next stage of decision-making together.

The early identification and integration of all current and potential interest groups is necessary to avoid later bias as well as the exclusion of relevant groups that may impact the project later on (see Luyet et al., 2012 for a comprehensive review of "stakeholder identification" and "stakeholder characterisation" techniques; Copsey, 2016). Interest groups and the intensity of their involvement may change along the course of the project, and subject to review. One way of dealing with increasing complexity is to ascribe different degrees of participation to each interest group. Luyet et al. (2012) suggest the creation of a core group that includes the project leader, a few stakeholders, experts and locals who can inform on local context. Degrees of participation, from lower to higher, may include information about the project; consultation; collaboration; co-decision; and empowerment, where decision-making is delegated to the interest group (Luyet et al., 2012). Whatever the level of participation, it is important that none of the groups feel marginalised or under-represented.

Recommendation: Building evaluation mechanisms into the process to allow for groups to identify their desired degree of involvement and how satisfied they are with their involvement, and to avoid conflicts and mistrust amongst interest groups and with project management.

Recommendations: These mechanisms should address residents' concerns effectively, consistently and transparently; Ensuring such processes are known to local people and diverse interest groups (Watkins et al., 2021).

Women and girls are often more exposed to interactions and risks related to reintroduced wildlife. The use and collection of natural resources are often women's duties in patriarchal societies, and livestock losses may affect women's dowries, incurring long term psychological and social costs (e.g., tiger reintroduction to the Sariska Reserve in Rajasthan, India, in Doubleday and Rubino, 2021). In spite of their unique perspectives, women are often excluded from decision making in conservation translocations, as they may also be excluded from resource management roles in their communities. However, the inclusion of women will help inform the most effect ways of reducing risks, reducing HWC, and protecting habitat and focal species, while promoting gender equity.

Recommendation: Listening to and including women from local communities and in management roles in conversations about reintroduction plans, and the decision making process through all stages of the project. Women bring in unique, proximate HWIs perspectives that may be excluded in patriarchal societies, and are often at the centre of HWC.

Ethical Obligations to People Living Around the Reintroduction Area

These are particularly important when the project plans to reintroduce potentially harmful and/or dangerous species. These may include potential livestock predators, crop foragers, disease vectors, or species that are affected by the illegal trade as well as any species that may potentially cause physical or economic harm to people because of the translocation. Although many reintroductions take place in protected areas, reintroduced populations may expand and disperse in the larger landscapes and eventually interact with people (e.g., Vasile, 2018; Jacobsen et al., 2021).

Recommendation: Practitioners planning to work with local communities need an ethics protocol and/or ethics approval from their institutions, and this should be factored in from the early stages of the project (Brittain et al., 2020). For ethics protocol see Johansson et al. (2012, 2017).

Developing a Culturally Appropriate Communications Strategy

Failing to communicate with local people may allow for the spread of fear and other negative emotions (Johansson et al., 2012, 2017). Fear has been a powerful motivator for people to

oppose reintroductions of animals that may have an impact on health/safety/livelihood (e.g., predators, potential crop foragers, venomous animals, Vasile, 2018; Jacobsen et al., 2021).

Recommendation: The foundations of people's concerns about the potential danger of having certain animal species in the landscape must be identified and addressed by the project.

Storytelling

The power of storytelling to emote and inspire people is widely recognised. Expertly devised reintroduction stories can inspire people to care. These may have local appeal when focused on local species, their cultural links to the community, including local traditional and indigenous knowledge, encouraging local pride. Stories and storytelling may also be used as the bases for other engagement activities (e.g. children connecting with local landscape through map creation). Stories may be devised to increase connexion with reintroductions globally, promoting an understanding of impacts caused by the loss of species.

Understanding and Considering the Values of Different Interest Groups

Listening to local people involves learning about their values and expectations in relation to the project. A lot of reintroduction planning concerns animal management, while insubstantial attention may be given to the socio-cultural environment in which the reintroduction will take place. Project planning must consider local people's worldviews, beliefs and values concerning the target species. According to Stoskopf (2012) "The biology is easy. The human issues are hard." Culturally formed attitudes could be hard to address and change. This is because they are deep rooted, passed on through the generations.

Knowing the History

Insights from past coexistence may inform future coexistence. Interdisciplinary research may provide insights into HWIs between diverse groups and the key species, to inform of potential socio-economic consequences of the reintroduction (Echeverri et al., 2018). Knowing how ecological interactions (such as predation or competition) established by the reintroduced species are expected to affect local interests, can inform management decisions. Some effects may be positive (attract ecotourism) while others are negative (reduce populations of financially significant species). Moreover, knowing about the past history related to HWC may shed light on deeply entrenched positions and negative views towards certain groups, focal species or conservation projects (Madden and McQuinn, 2014).

Recommendations: Talking to local people to understand the positive and negative dimensions of coexisting with the focal species; learning from successful mitigation stories. For example, talking with key informants of each of the stakeholder groups to learn of past HWIs.

Decision making about a project by foreign managers/scientists may have "colonialist" connotations (e.g., Chatty, 2002). There have been ethical issues around evicting local people from traditional lands specifically for wildlife reintroduction (e.g., Arabian oryx in the Middle East, Chatty, 2002).

Recommendation: Researching and confronting the effects of colonial history and its continuing influence on the places involved in the translocation.

Managing Culturally Important Species

Freitas et al. (2020, p. 76) suggest that focus on the recovery of culturally important species "can be an effective socio-ecological tool to reconcile biodiversity conservation with local people's quality of life". Such species may play highly significant roles in people's cultural identity, spiritual values and livelihoods. In countries where the local economy relies heavily on income generated by wildlife, improving HWIs and promoting wildlife conservation and restoration over generations are complementary (see Freitas et al., 2020 for case studies in Brazil, and Mogomotsi et al., 2020 for Botswana). Failure to improve HWIs and holistic restoration efforts (for example, see the 4 Returns Framework at www.commonland.com) threatens both livelihoods and biodiversity.

Nevertheless, HWIs cannot be reduced only to monetary costs and benefits of conservation. Communities living alongside wildlife are often not granted recognition for their role in producing ecosystem goods, especially in developing countries, and may experience less tangible psychological and wellbeing gains and losses (Mogomotsi et al., 2020). Research suggests that the local community's rights to sustainable use and their need to access resources' rights, must be built into the co-management of the project, to secure long term collaboration (Freitas et al., 2020; Mogomotsi et al., 2020). If local people benefit from the conservation initiative, they are more likely to show a strong commitment, model positive behaviour norms in the shape of moral obligation and peer pressure and provide local surveillance to support the long-term protection of species and habitat. However, it is important to note that "cultures are dynamic and adaptive" therefore the relevance of a species may vary between groups that are in contact with it, and may change over time (Freitas et al., 2020, p. 75).

Recommendations: Work with local community members and trusted individuals to clearly assess the positive and negative consequences of local cultural attitudes towards reintroduced species to recognise the cultural foundations of local community attitudes and understand the basis for any resistance to species restoration; use this information to work towards changing negative opinions by addressing specific concerns and experiences and integrate positive attitudes into the restoration plan design to highlight its holistic benefits.

Building Trusted Relationships Between Interest Groups

Developing a Trusted Relationship Between Local/Indigenous and Non-local/Indigenous Researchers, Practitioners and Relevant Members of the Community

Developing conservation translocation programmes that are open to diverse knowledge systems and worldviews may help counteract information deficits and biases towards power of influence, associated with scientific knowledge in research and funding priorities. It contributes to fair and just decision-making. As suggested by Wheeler and Root-Bernstein (2020, p. 1634)

in creating and strengthening partnerships between Indigenous and local knowledge holders and scientists "it may be possible to address biological conservation issues alongside ensuring sustainable livelihoods and use of resources, culture, governance and economic development".

Recommendation: Ensuring the involvement of indigenous and local knowledge holders in all stages of the project, from inception to reporting, to promote trust and equitability; considering how knowledge features in the project and making sure that diverse knowledge systems are considered fairly and equally (Rayne et al., 2020; Wheeler and Root-Bernstein, 2020).

Racial Diversity Awareness and Self-Reflection

Confirmation bias may be a side effect of the passionate motivation of professionals working with conservation, creating a sense of "incontestable authority" that precludes acceptance of diverse input into decision-making regarding the project.

Practitioners may be faced with the need to address colonial views, white privilege issues and biases that may come both from project personnel but also from different factions of the public (Waters et al., 2021). In this scenario, affluent white members of a group may not represent the interests of culturally diverse groups that require more representation within the reintroduction. Quantitative questionnaire research is useful for understanding the socioeconomic status of a community. Pairing this with lengthier, semi-structured interviews will provide more nuanced information. Participant observation will then allow for triangulation of interview and behavioural data from individuals of diverse groups.

Recommendations: Fostering self-reflection about ourselves as social actors, evaluating our own actions, values, and preferences and perhaps revising them (Montana, 2020); promoting opportunities to listen and learn from underrepresented groups.

Recommendation: Combining quantitative and qualitative data collection can contribute to a richer understanding of the full picture and a better understanding of relevant interest groups.

Recommendation: Considering the local cultural context and particularities of the relationships between people and the focal species when attempting to transpose methodologies. One solution does not fit all contexts.

Political and Jurisdictional Issues

Expressions such as "*Your wild animals predate on my domestic sheep*" are commonly used by local communities. These are especially pronounced when people resist carnivore restoration efforts by wildlife agencies. Laws and rules vary for each country and many times within the country (states/ provinces). The obligations to restore a species and the rights of those who may suffer losses as a result of such restoration may lack clarity.

It is essential to understand and approach political and jurisdictional issues. Kolipaka (2012) and Stoskopf (2012) suggests that, in democratic nations, policy and law makers apportion greater consideration to public opinion. This means that expert scientific opinions on reintroductions may be overlooked. And, a few active opponents can exert a disproportionate impact on public acceptance of the restoration effort.

For example, in the tiger reintroduction program at Panna Tiger Reserve in India. Protected Area laws prevented mining within the tiger reserve area. When tigers became extinct in the mineral rich area (e.g. diamonds, limestone, sandstone, granite) local groups saw an opportunity to explore other economic possibilities. Reintroduction threatened these interests. So local groups with strong self interest instigated local rural community members to oppose tiger reintroduction. People's resistance quickly caught the attention of local and regional politicians and they in turn assured communities that "*people are more important than tigers*" "*if you want we can stop the tiger restoration efforts*". Successful cooperation with key active opponents, rather than on the ability to court many individuals who could not sway influence at the political level, improved matters at Panna and restoration work could be successfully carried out (Kolipaka, 2012).

People vs. Government Conflicts

Conservation measures to protect the reintroduced species may criminalise practises that were previously legal and acceptable. Lack of public support may result in retaliation against the government, destroying project infrastructure (Waters et al., 2021) and even using violence against the reintroduced animals/present and future conservation initiatives. Reintroduction may become a symbol of state authority (people vs. government).

Recommendation: Developing an understanding of political and jurisdictional issues; ensuring that the planning stage includes representatives of all groups who may be affected by the planned translocation; developing culturally appropriate communications between these groups and the wider public.

Costs and Benefits for Local Community and Project

Wildlife conservation projects often factor ways to promote the wellbeing of local communities when managing and sharing associated costs and benefits. However, the perception and experience of costs and benefits of a reintroduction may differ according to the interest group, and are not limited to material goods (see Thondhalana et al., 2020 for a comprehensive overview of "social approach to wellbeing"). Managing or compensating a wide scope of visible and hidden costs may prevent feelings that the interests, lifestyles, beliefs and values of some groups are being prioritised over others, which could result in negative attitudes and fuel conflict.

Although the assessment of costs and benefits often focus on visible, direct material losses and gains, there are other socially and culturally meaningful elements to consider: hidden costs may include the working hours people may have to dedicate to guarding crops and livestock from the focal species, and non-material costs may relate to cultural identity issues or traumatic experiences involving fear, loss and anxiety associated with the focal species; on the other hand, the restoration of the focal species may promote hidden and non-material benefits that are social, cultural, spiritual and/or psychological (Thondhalana et al., 2020).

Socio-Economic Feasibility Study

Investigating potential costs/risks and benefits (for example ecotourism, engagement with nature, pest control) of coexistence with the focal species may provide an overview of areas to address and to develop through a management plan, in the context of the reintroduction (see Stringer et al., 2015 for a feasibility study of pine marten reintroduction in England). Research on human-wildlife relations can also contribute to building a richer picture of these interrelations, and help identify ways to increase positive and reduce negative behaviours.

Recommendation: Developing measures of wellbeing together with the local community allows for meaningful and relevant assessment of the costs and benefits of the project; building trust and informing management decisions on the most effective material and non-material trade-offs of conservation objectives, in line with local social values and cultural identity (Thondhalana et al., 2020).

Evaluating Positive and Negative Outcomes: A Case Study

Key potential economic factors that have both positive and negative implications of restoration programs have to be evaluated. Such factors include both direct and indirect returns. Direct returns include tourism revenues, increase in real estate values and jobs can be readily estimated.

When tigers became extinct in Panna Tiger Reserve, India, the local Ken River Lodge owner experienced a more than 50% decline in his wildlife tourism revenues between 2008 and 2012. The loss of tigers also destroyed the tourist-fueled local economy and livelihoods around the reserve. For instance, 30 out of the 38 park guides lost their jobs and some were forced to pursue illegal wood collection from the reserve to survive (Pers comm: Shyamender Singh, Owner Ken River Lodge).

After tigers were successfully restored, domestic tourists and revenue flows to the tourist related local economy increased again. Domestic tourists' needs and buying patterns differed from foreign tourists encouraging new businesses (cell phone shops), increasing jobs in property development for local people. These increases exemplify indirect returns of restoration but are seldom included when assessing the economic benefits of restoration.

Costs of Conservation Translocations on Local Communities

Potential economic costs of conservation translocations to local communities should be evaluated. For example, plans to reintroduce the cheetah to Madhya Pradesh, India conflict with the local grazing practises (children accompanying animals and poor corral constructions) making goats and sheep very vulnerable to predation. Changing the age-old practises over a large landscape will need resources and teamwork. Likewise, in areas where large carnivores like tigers or crocodiles or primates are restored, significant changes in livestock management practises, fishing and farming practises are required by community members to minimise losses to local residents. These issues should be understood and addressed pre and post releases, as new conflicts are illuminated.

Recommendation: Assessing both positive and negative economic impacts on the local communities; teasing out solutions that are both politically and culturally acceptable, while optimising gains that are most beneficial to the local economy (Stoskopf, 2012; Kolipaka et al., 2015; Kolipaka, 2018).

Additional Financial Resources

Some species like the tiger and the vulture have large home ranges and move great distances. This means that a larger landscape radiating out from the reintroduction site may become part of the species' future range. In projects that involve large species, resources are necessary to reach local people across large areas to raise awareness and to make changes in local practises (e.g., tigers reintroduced in Panna Tiger Reserve, India travelled tens and tens of kilometres and through villages and towns). Animals are often introduced in poverty prone areas so there are also economic costs to restoration (Kolipaka, 2018).

Recommendation: Considering the foreseeable needs of animals with large home ranges, as planning must take the larger scale into account; factoring financial, NGO and professional support to work on such a large scale.

Impact of Domestic and Feral Dogs Within Reintroduction Sites

Feral and domestic dogs are a human-dimension issue in conservation translocations. Globally they affect the survival of reintroduced wildlife, are under human patronage, and their proposed removal may often meet local resistance. See **Supplementary Material**: **Appendix 1** for full case study.

Initiation Stage: Beginning Contact With Community and Other Interested Parties

Building Trusted Relationships Through Inclusion

Once the management plan has been established it should be carried out with consistency and transparency to inspire trust and confidence amongst interest groups, but project staff should demonstrate flexibility in their planning approach if their subsequent engagement with communities illuminates areas of disagreement or doubt.

The importance of meaningfully including people who may be affected by the reintroduction in the decision-making process is highlighted in diverse aspects of this phase. Research suggests that inclusion promotes dialogue and increases acceptance of conservation proposals (Luyet et al., 2012; Niemiec et al., 2020). Based on case studies in Africa and the USA, Madden and McQuinn (2014, p. 99) associate successful efforts to secure and maintain the commitment of local communities to the implementation of conservation solutions and prevent HWC (such as the use of fencing), with the amount of time spent "asking questions of and listening to the community members, building trusting relationships, supporting creative and positive identity-building events within the community, and not only regularly engaging with communities, but empowering them in a leadership role during the decision-making and implementation process." Solutions based on understanding positive interactions and addressing the social-psychological drivers of negative interactions are more likely to result in a greater sense of ownership, motivation and commitment to uphold support.

Working Together With Local and Indigenous Communities

As suggested by Wheeler and Root-Bernstein (2020), in this phase collaboration with local, traditional and indigenous communities promotes the development of good relationships between diverse interest groups, to build local capacity and reduce inequalities. It also creates opportunities to reduce and address conflict over conservation decisions. Programme staff must use this process to learn from local people's previous and long-term experiences in addressing HWC problems.

Recommendation: Collaborating closely with local and indigenous groups to seek ways to avoid and reduce conflict and identify how the project can benefit them.

The importance of empowering local knowledge is also evident in this case study of beaver reintroductions to the Scottish Highlands.

A study by Coz and Young (2020) identified that negative HWIs depended on the process of reintroduction (planned, accidental/illegal release) on relationships between different interest groups and on their views of "nature" and "right place" for beavers. Members of the local communities considered that the "right/natural place" for release were the most remote "where beavers were not likely to interfere with any existing land use" (p. 415) rather than places with optimal conditions where animals may thrive. Local people's perceptions of landscape, their role in nature, and potential feelings of lack of control and uncertainty over the impact of beaver reintroductions on their land were the most important predictors of support.

The study also highlighted the importance of creating discussion spaces where local knowledge sits side by side with "conservationist elites", and where preconception of the Highlands as "depopulated wilderness" could be challenged.

Listening and Giving People a Voice

Involving different groups of people in a reintroduction project enriches the decision-making process by bringing in new perspectives and new ideas. However, many people who have not been offered an opportunity to express their views before may be suspicious when approached by a research team. Finding the best way to listen and learn from local people may pose challenges but is an essential part of the process to build a relationship of trust and inclusion. Initial contact with local groups may need to navigate pre-conceptions, issues with trust towards the messenger, and people vs people conflicts.

Recommendations: Listening and learning before introducing information; finding out what people already know before introducing the project to them; identifying the gaps in knowledge and the areas that must be targeted for change through communication and education (HWIWG, 2020b).

Cross-Disciplinary Research Collaboration to Support This Process

Working with social scientists/human dimensions research and an applied approach may benefit reintroduction projects by promoting an understanding of the attitudes, beliefs, knowledge and behavioural intentions of interest groups towards animals and management decisions of the project. This collaboration helps to identify which beliefs influence attitudes the most, to help plan message content and to help reach common ground in participatory decision making.

The use of interviews and questionnaires requires extensive consideration about question design, selection of respondents, cultural and ethical issues concerning data collection and use (consult the Ethics Committee of the research body and region for protocols). The focal species means different things to different people and everyone should have a say. However, research may influence but not dictate policy, and it is important to maintain transparency about data collection and its use in understanding the wider picture and in giving people a voice in decision-making (HWIWG, 2020a).

Recommendation: Communicating the message that researchers are there to listen and document people's views; assuring that the concerns and viewpoints of interest groups are respected and incorporated into decision-making; but making clear that research may or may not inform or dictate policy.

Building Strong Relationships to Mitigate Any Potential Conflicts

Credibility of the project and those leading it is built over time, through the development of long-term relationships with interest groups and local people. Both positive and negative HWIs are to be expected to coexist in a translocation program. Therefore, mechanisms to promote positive cultural and emotional bonds and the benefits local people associate with the focal species must exist together with mechanisms to prevent and to mitigate fear and conflict. e.g. Underlying conflict around Hawaiian monk seal (*Neomonachus schaunislandi*) conservation revolves around distrust of the state, distrust of restrictions on resource use, issues of moving or translocating seals and how stakeholders' narratives and social constructions affect how they engage with seal recovery efforts (Sprague and Draheim, 2015).

Dynamics between love for a species, willingness to coexist, and fear, differ across nations and even across regions of the same country. Rather than relying on expectations formed by previous experience, information on people's perceptions of wildlife and its conservation should be collected to build an understanding of the local picture, in the same way data is collected locally to understand ecological interactions.

Recommendations: Trying to understand the motivations behind negative attitudes and/or illegal activities is a first step towards finding solutions; not relying on knowledge gathered from previous experiences but collecting context specific data.

Recommendations: Focusing on coexistence and on bringing people together to find solutions, rather than focusing on conflict; promoting the perception that there is some common ground to strive for; listening to solutions proposed by various interest groups; valuing local solutions as they can be better for the context than solutions devised from the outside.

Education and Engagement

Freitas et al. (2020, p. 75) highlight the importance of education and outreach campaigns for the conservation of culturally important species and advocate that "initiatives worldwide should consider the relevance of formal recognition as a way to stimulate local engagement and peer pressure, since it reinforces

the wide collective perception that the scheme is beneficial and therefore morally and ethically defensible".

Engaging the Public to Build Support

Engaging the public to build relationships, develop common visions for the future, in education and communication programmes, and other key activities are often deployed to work in tandem with translocation projects. These may use diverse ways of engaging the public to build support towards the reintroduction project:

- Focus on individual animals.
- Focus on populations and species.

People may find it easier to care for individual animals (focus on welfare). However, promoting too much care for individual animals may interfere with the reintroduction project's longevity and success (Niemiec et al., 2020). Too much interest in reintroduced animals may put them at risk from people approaching them and potentially bring the perception that the animal is more important than humans. A difficult balance must be achieved between using charismatic species to attract and engage the public with conservation and promoting an understanding that species must be prioritised over individual animals. The scale at which people need to be made aware and involved depends on the reintroduced species and goals of the project (using SWAT analysis may be useful to guide decisions about communication/awareness/education programmes).

The interests and expectations of people in relation to the reintroduction may vary according to their affiliations and to their proximity to release areas. There may be social structures already in place that can help develop a positive relationship between local people and newly introduced animals.

Recommendation: Building a relationship with local leaders; developing an understanding of how attitudes towards individual animals and the focal species may support the project goals; investigating associations between attitudes towards the focal species and people's affiliations, and to their proximity to release sites.

Role of Accredited Zoos and Aquariums

Zoos and Aquariums accredited by national and international organisations (e.g., World Association of Zoos and Aquariums (WAZA), Association of Zoos and Aquariums (AZA), etc.) work at the interface between wildlife and members of the community. As part of the accreditation process, both conservation and education "must be a key component of the institution's mission and messaging," and organisations must plan for and report on their actions towards these areas (Association of Zoos Aquariums., 2021). Ex-situ collections have historically contributed to many reintroduction projects (Gilbert et al., 2017; Consorte-McCrea et al., 2019). Moreover, zoological organisations have long been integral partners in conservation translocation programs, including notable ongoing successes like the California condor, golden lion tamarin, black footed ferrets, and Przewalski's horse. However, the engagement of zoos in these programs has often been limited to breeding and pre-release care of individuals.

Zoos and aquariums can have a larger role in supporting the human dimensions of reintroduction projects in many ways, including:

- Making use of people's innate connexion with nature (see Biophilia hypothesis).
- Using information about the species and their role in the health of ecosystem dynamics.
- Using storytelling and interpretive methods both *ex situ* and *in situ* to promote connexions between people, place, and focal species.
- Combining the opportunity for social interactions with peers and family, with emotional experiences provided by animal encounters and clear messages about how to support their conservation.
- Utilise the experience, knowledge, and expertise in community engagement, Diversity Equity Inclusion Justice and Accessibility (DEIJA), facilitating nature connexions, and wildlife to support positive interactions between practitioners, local people, and released wildlife.

Recommendation: Developing partnerships with local zoos, aquarium and botanical parks to promote positive attitudes towards the focal species, and support towards the project.

Identifying and Changing Behaviours and Attitudes

The public perception of the focal species can change over time from "goods with commercial value" to "local pride" to "disease vector" (e.g., golden lion tamarin). Gaining and retaining public support towards reintroduction and conservation may require targeting misinformation (using environmental education, media and official channels) and promoting behaviour change.

It is necessary to be realistic and clearly identify public behaviours that may negatively impact programme success and the societal levels at which behaviour interventions should be attempted. Harnessing the power of storytelling can be instrumental to align conservation goals with local people's narratives, converting concerns and conflict into positive stories for change (Schaefer et al., 2020).

Recommendations: Developing cooperation between natural, social or behavioural scientists and management to embed people's behaviours and practises that favour reintroduced species, and to select and target human behaviour change that could increase negative HWIs.

Studies suggest that it is more difficult to change attitudes once people have rationalised such costs and benefits themselves, without information. On the other hand, information provided by the media may influence awareness and perception of risk towards HWIs.

Recommendation: Developing information based on well-informed assessments of the ecological, social and personal costs and benefits associated with the reintroduction and ensure it is available early on in the planning phase (Hiroyasu et al., 2019).

Addressing issues related to feral and domestic dogs, dog owners, and impacts on translocation programs (see **Supplementary Material**: **Appendix 1**).

Implementation Stage

In a study of success and failure in conservation translocations Bubac et al. (2019) recommends that "programs develop appropriate strategies and feasibility plans to ensure enough resources are secured for managing and monitoring the translocation for a minimum of the first four years." While environmental and ecological feasibility studies are commonly undertaken, social-cultural feasibility studies should also inform the implementation of a project.

Translocation projects often work with international stakeholders. During the implementation stage projects may be faced with difficulties related to working with partners that have diverse styles, time schedules, and funding expectations. Relationships between different groups in management roles also affect reintroduced species. These may range from changes in personnel, and associated lack of expertise and experience of new people, to the demand for animals from successful reintroduction programmes to found new reintroduction programmes in neighbouring areas.

Recommendations: Budgeting adequate resources to plan, execute, and monitor relevant socio-cultural aspects of your project, and allow for rapid adjustments as the programme, it's members, and their relationships may change throughout the duration.

Trust and Public Perception of Risk Over Time

As defined by Watkins et al., (2021:2) "Trust reflects individuals' willingness to make themselves vulnerable to another and their perceptions of sharing similar values, while confidence is based on a history of successful past experiences that lead individuals to believe that future events will go as expected". Investments in building a trusting relationship between local people and project agents involve effectiveness in responding to crisis situations, such as dealing with disturbance caused by reintroduced animals, as well as fair decision-making, which may include participative processes, and technical competency. Demonstrating willingness to cooperate with local people instils confidence overtime and prompts the establishment of a relationship of mutual support and cooperation.

Watkins et al. (2021) suggest that opposition towards reintroduction projects can be a result of public perceptions of risk (such as potential threat to people, pets, livestock, damage to property, crops, spread of parasites and disease, and environmental change) and lack of trust and confidence in the people and agencies responsible for managing threats associated with the focal species. Research suggests that any level of perceived risk amongst interest groups must be addressed by the reintroduction project, as these may escalate negative attitudes and result in retaliation (Mogomotsi et al., 2020; Watkins et al., 2021). Nonetheless, although they may never completely disappear, risk perceptions can be mediated by the development of long-term relationships of trust, the buildup of confidence over time, and benefits associated with the project.

Local people who are affected by HWC may suffer a decline in physical and psychological wellbeing, reduced food security and income as they share habitat with the focal species. Unaddressed and unmitigated, such costs may lead to resentment and threaten conservation goals (Mogomotsi et al., 2020).

As populations of the reintroduced species become more established they may grow and spread, increasing the chance of encounters and HWIs. During the Implementation stage the attitudes of different interest groups must be monitored as increasing encounters may increase perception of risk**.** Research suggests that trust and confidence in agencies, on the other hand, may reduce the perception of risk and improve attitudes towards the project, increasing its potential for success (see case study of elk restoration in East Tennessee, USA, Watkins et al., 2021). Changes in the population of the focal species and in their management, as well as education campaigns and other changes in circumstances may affect attitudes. Consistency, transparency, and patience are important when building a relationship of mutual support and cooperation and efforts can be easily undermined by a breakdown in trust, which may result in covert or overt resistance to the initiative.

Recommendations: Developing longitudinal studies of human dimensions to be undertaken at key stages of the project to provide a picture of changes of attitudes over time, in a way that mirrors the monitoring of wildlife populations.

Recommendation: Developing structures and processes to maintain good communication and transparency with local people and stakeholders throughout the project cycle.

Understanding How Local People Perceive the Focal Species and Reintroduction Project

In a situation where a species is being restored after a period of absence, local people may have lost the behaviours required to successfully coexist with the animals. This is particularly relevant in the reintroduction of large mammals such as carnivores, which pose a threat to both people and livestock.

For example, a qualitative study of villagers around Sariska Tiger Reserve, India revealed that local communities did not show adaptive behaviours (e.g., vigilance, ...) that would enable them to avoid a confrontation with a tiger within the ∼19 years since the species was extirpated from the area (Doubleday, 2018).

A community's previous exposure to conservation activities particularly if it curtailed their access to resources may also result in distrust and resentment which can quickly lead to outright conflict. Researching and understanding the environmental history of the proposed reintroduction site where this may be the case should encourage practitioners to include and inform communities about their activities to build trust. Methods of communicating controversial information, i.e., where local and scientific knowledge conflict, should be done respectfully and, possibly indirectly, enabling the communities to save face and avoid threatening their cultural identity.

Recommendations:

- Obtaining a deep nuanced understanding of local people's behaviours towards- and perceptions of the species proposed for reintroduction, and of how these may change over time.
- Informing communities continually throughout the process in locally and culturally relevant methods, even when the project is locally owned and managed, as projects can be seen as an intrusion (e.g., the golden lion tamarin reintroduction project has been locally managed for 35 years but issues around communication remain).

Levels of Knowledge and Misconceptions

Differences in the public's knowledge levels about wildlife may also play a part in their level of support for a project. A study to assess people's support for grizzly bear (*Ursus arctos horribilis*) reintroduction in California found that half the respondents supporting the species' reintroduction believed the species was still present while respondents who knew the bears had been extirpated were less supportive. This lack of support may have been due to knowledge about the potential negative consequences of reintroduction (Hiroyasu et al., 2019). Given this relationship between awareness and lack of support for reintroduction, the authors caution managers not to assume that the provision of information alone will result in public support for reintroduction proposals (Hiroyasu et al., 2019). Related to this is the fact that wildlife is often a source of gossip, rumour, and "fake news" if communities are not included in the project, or insufficiently informed about it, or if they do not trust the information provided (e.g., rumours that environmentalists colluded with the state to release wolves which were actually expanding their range naturally in northern Europe, Campion-Vincent, 2005; Skogen and Mauz, 2006).

Recommendations: Developing clear and consistent communication between the project and diverse local groups; recruiting the help of trusted members of the community to convey project information; consulting local people and leadership of interest groups to listen to their beliefs, concerns, as well as knowledge, as these change over time.

Actively Involving the Local Communities

During the implementation phase, do not restrict activities solely to the biologically significant aspects, like the wellbeing, adaptation to the release site, health, reproduction, and survival of the focal species. It is also important to focus on the social significance of the translocation.

Recommendation: Ensuring social significance, and consequently increasing local support, active participation and local ownership of the project.

For example, during the tiger reintroduction program in Panna, the local stakeholders, especially influential landowners, village chiefs, tourism sector representatives were all engaged individually at first and collectively thereafter to develop a common vision of the restoration. The engagement was complimented with monthly updates on the project and actively seeking local inputs to guide project components. Over time, these efforts improved local knowledge of the project, and trust between the local groups and the project staff (Kolipaka et al., 2015). Likewise, local religious leaders were involved to interpret the significance of restoring tigers into forest to communicate in ways that the local communities accepted (Kolipaka, 2018).

A Dedicated Institution/Group for Restoration Project-Local Community Interface During Implementation Phase

Recommendations: Allocating resources for the intensive and time demanding work of engagement with local communities and stakeholders.

Case study

In the Panna Tiger Reintroduction Project, a formal institution, Friends of Panna (FOP) was created to support the project–people engagement process. However, the FOP did not function well because of government heavy handedness and lack of foresight regarding the resources needed to operationalize the institution. Instead, an informal coalition of core members from local groups proved more effective in engaging diverse stakeholders during the reintroduction. Leadership was a vital component of these efforts and the core group members played leading roles within their groups and shared responsibilities (Kolipaka, 2012).

Considerations for Cultural Beliefs in Management Decisions

In some cases, invasive methods of collecting biological data may be dissonant with the cultural beliefs of the communities involved in the project**.** For instance, radio collaring of released animals may be rejected by some indigenous groups as disrespectful to the animals concerned (Clarke and Slocombe, 2009). Other partners may be concerned that telemetry attachments bother the animals and may harm them. In such cases, non-invasive methods of monitoring, e.g., using faecal samples, foraging signs, and trail cameras, should be considered.

Recommendation: Discussing the use of invasive biological data collection methods before release to identify the most appropriate method acceptable in the socio-cultural context.

End Stage and Exiting the Project

Translocations are conservation interventions that by their nature have a definite endpoint, and like all conservation interventions an exit strategy should be structured from the beginning (Conservation Measures Partnership, 2020). For translocations, an exit strategy is the process of terminating the project or an actor's participation in the project. There are various types of exits in conservation and reasons for them (Ruiz-Miranda et al., 2020). Exit strategies apply to the ending of the translocation itself or when a stakeholder stops participating. In either case, the strategy should aim for a responsible or "beautiful exit": leaving with minimal negative consequences to the project's conservation network or the translocation project itself (Ruiz-Miranda et al., 2020). Ideally, all stakeholders should work together to shape the exit strategy or at least all be aware of it. Because exit strategies involve multiple stakeholders with different expectations, a wicked problem approached may be necessary to implement the appropriate communication or negotiation strategies (Game et al., 2014; Mason et al., 2018).

A reintroduction project's endpoint seems to vary along the phases of population growth. The goal of a conservation translocation is expected to be the establishment of at least a minimum self-sustaining viable population (Beck et al., 1994; Kleiman, 1996). This can be achieved by establishing a new population or reinforcing an existing population. However, some translocations are planned as experimental translocations, or for animal well-being, or aim at establishing absent ecological processes (i.e., seed dispersal). In such cases, the endpoint may occur during the early phases of population growth.

Planning With Interest Groups

An Exit Strategy should be devised during the Planning Phase of the project, with input from all parties. Possible partners may include managers (government, other players), sponsors and the local community, or representatives. Different groups may be involved at different levels, with a smaller core group to move decision-making forward. According to Carlos Ruiz-Miranda "all projects need a steward, who will carry the project over time, it is key to have a clear steward that takes responsibilities to make the decisions" (HWIWG, 2019).

The WWF provides a Sustainability and Exit Strategies risk assessment, which may provide useful guidance for conservation translocations (WWF, 2017). Potential areas of weakness should be identified at the beginning of the project. Legal contracts must be considered. If there are fears that one of the partners is likely to withdraw, the effects on the species being reintroduced must be considered. Ethical concerns must address responsibilities of partners, community and all stakeholders. Contracts or agreements must be defined among stakeholders to establish commitments and roles of partners, to ensure their commitment into the plan and to offer warranties in respect to future decision making. Tools such as matrix and decision trees may be used to include ethical considerations in exit planning from the beginning of the project.

Project Endpoint and Associated Exit Strategies

Different exit strategy approaches may be necessary according to where the project endpoint lays in the population growth curve (**Figure 2**). If the translocation succeeded in achieving minimum viable population goals, then either a hand-off or voluntary cessation exit may be appropriate. For most endangered species, the target population will probably need further protection or management actions in the Post Exit Stage. Who will be the steward of the conservation of the population established by the translocation? Will it be another conservation group, or will the local community maintain the achieved status quo, or will a government environmental agency continue other actions or serve as a watchdog? For successful projects the exit strategy could be a "hand-off" to the local community (Ruiz-Miranda et al., 2020).

What to do if the project achieved more modest goals related to the initial phases of population growth? In this case, a hand-off strategy would allow for conservation efforts to maintain stewardship of a more long-term strategic plan. Among the concerns are making sure that necessary scientific, fundraising and governance capacities are present in the new core group that will further the project.

Another reason to exit is when failure is imminent because neither primary nor secondary goals will be achieved or because the negative effects of the release of animals are overwhelming the conservation benefits. Here the exit strategy is intimately tied to the technical criteria for success or failure. Even if feasibility and risk assessments were done, the challenges may be daunting at the time and an exit to rethink, or refit may be due.

Communicating failure is a difficult but necessary component of adaptive management. When the target species is a top or mesopredator that could directly threaten livestock the acceptable levels of risk or economic loss need to be worked out with the local community (see Titus and Jachowski, 2021).

Timescales, Budget and Project Sustainability

The sustainability of a project should feature as a Project Management Goal. It must consider the time scale necessary for actions, as well as the funding necessary to execute these. Therefore, the Exit Strategy must feature as part of planning for the sustainability of the project, towards it becoming self-sustaining.

Time of and decision to exit must reflect the goals of the project, and if they have or have not been achieved; the timeline of the project; its sustainability (who is going to carry it out to the end?); feasibility standards; new opportunities; and changes in scenarios reflecting human pressure and other environmental changes.

Exit Strategy for "Stewards" and Members of the Project's Team

As goals are met, key members of the team are less needed or their roles, involvement and funding may be better channelled elsewhere. However, leaving may impact other members of the team in many ways, emotionally and in practical terms with the capability of completing their tasks.

Recommendations:

- Building Exit Strategies into the project's strategy in connexion with its goals.
- Plotting the role and expectations of funding partners against the goals of the project.
- Analysing the positive contribution a funder can make and the negative impacts of its unplanned exit in relation to the goals of the project.
- Discussing strategies regarding: a minimum time duration of their commitment to funding the project (including a transition period in case of unexpected changes in their circumstances); an exit strategy, with funding partners as part of the planning process. These may be part of a contract or a pledge.
- Considering other stakeholders when planning Exit Strategies, as the reintroduction and its exit may affect each one differently.

Public Perceptions of Exit

Public perceptions must be addressed when decisions are made to reduce the activity of conservation programmes in selected areas. Because exit strategies are part of the adaptive management approach to conservation, they can change as new information is gathered or if conditions change (WWF, 2017). The process of evaluation that drove the decision to exit must be transparent, so that decisions reflect what is feasible and what is best for the species and the conservation network. It is possible that the programme may plan to reinstate efforts if appropriate conditions arise. In some cases, if opportunities arise to connect isolated areas to the core areas, adaptive management can be applied, and conservation strategies can be developed for those

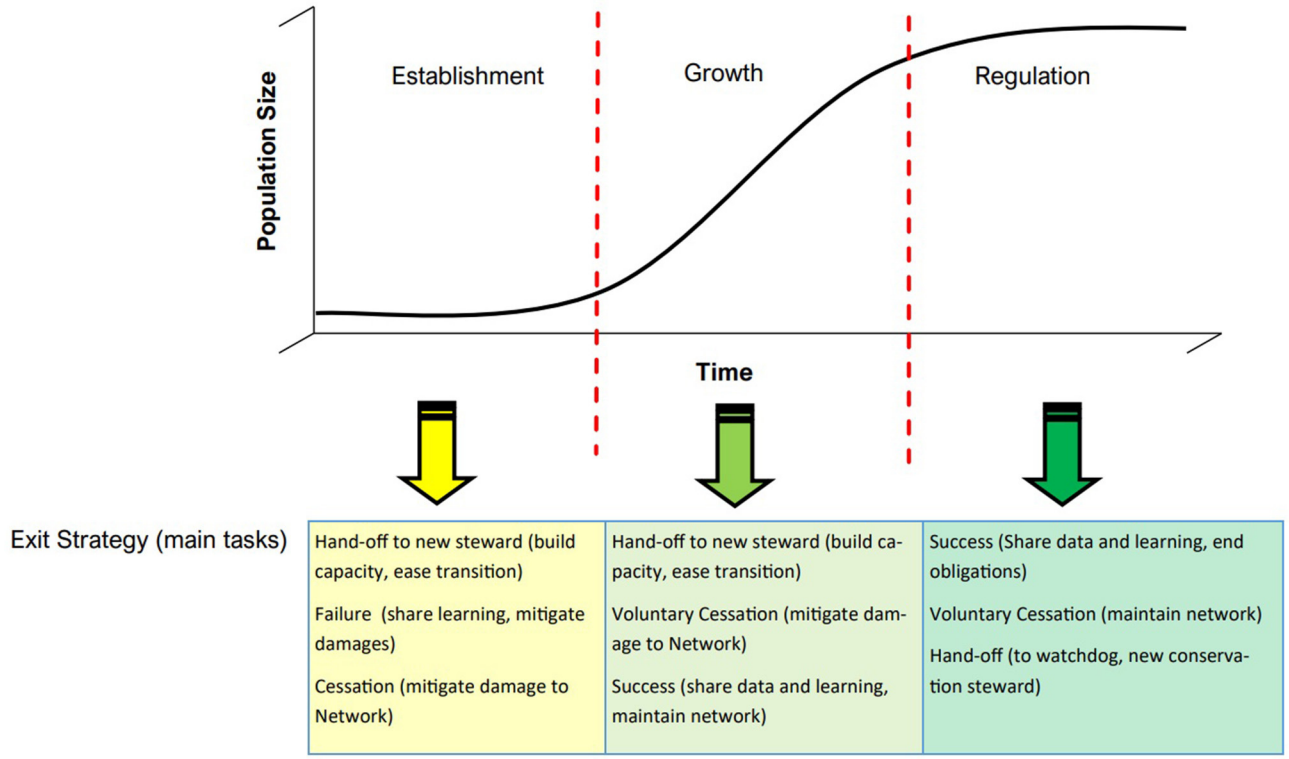

FIGURE 2 | Types of exit strategies and the main concerns associated with each for endpoints occurring during different stages of population growth after a conservation translocation. The main assumption is that the translocation is part of a species conservation project. The main tasks presented are topics of actions necessary for a responsible exit of the main stewards of the translocation. Similar topics apply to exit strategies of individual stakeholders.

areas. In this sense, a responsible exit may foster sustainability of the species' conservation.

It is important to consider that the closing of bases may affect local people on many levels and provoke feelings of disenchantment. The project has an impact on local people's values, attitudes, behaviours, lifestyles; local people may change their livelihoods as a result of the programme and become reliant on jobs associated to the programmes for income or their identity (e.g., from poacher to activist); new careers are created. As stated by Sian Waters "There is an issue of responsibility towards the community that has been engaged and is involved. An abrupt closing of a project when you have community involvement is irresponsible" (HWIWG, 2019). Communication with all stakeholders and their inclusion in developing a proper exit strategy can help avoid disenchantment over not meeting project expectations or goals. Disenchantment should be avoided because it can affect the conservation network and future conservation in the area.

Recommendations:

- Securing long term sustainability for new career opportunities created by the project (which are transferable) and for infrastructures that are more environmentally friendly'; "weaning" people off the project infrastructure.
- Investing in long term strategies to prevent the return of livelihoods/practises that create impact on focal species/biodiversity (e.g., poaching); preventing the development of negative attitudes towards the project that may impact pro-environmental practises and affect the long term conservation of focal species.

Community Based Monitoring

Monitoring starts in the last stages of the implementation phase and continues through the end stage and beyond into the post–exit stage. Community based monitoring requires both technical and financial resources and local NGOs or community institutions are well suited to support this function very well. For example, Schmiedel et al. (2016) highlight the usefulness of developing and involving para ecologists.

Recommendations: To ensure that the restoration is stable, complete and successful monitoring efforts may be aided by the local community; monitoring must be funded to ensure stability and long-term success of the conservation translocation.

Enabling and Enhancing Traditional PRACTISES

Local/indigenous populations are well placed to carry out long-term monitoring and management practises to maintain the population of reintroduced species at a sustainable level beyond the exit of the project. Conservation translocations are part of indigenous practises across the globe to restore and enhance biodiversity, in connexion with cultural practises and sustainable harvesting (see freshwater conservation translocation case study, New Zealand, in Rayne et al., 2020).

Recommendations: Enabling and enhancing traditional practises that are already in place may be the most effective way to promote biodiversity conservation and to benefit the focal species, in certain cases.

Post-exit Stage

Although some people may support a reintroduction and get involved in associated initiatives as a result of social or cultural motivation, circumstances may change over time. Ensuring sustainability after "Handoff" strategies.

Investments in capacity building during previous phases of the project are important to prepare and empower local institutions to take over and carry out the long-term project. By creating and facilitating a sustainable conservation culture the project invests in achieving its long-term goals. This way, pro-environmental values and behaviours remain and are transferable to other situations (including other jobs and careers), socio-economic benefits to local people continue to be associated with the focal species and support for its conservation continues to exist post-exit. Lack of economic options after project conclusion, on the other hand may cause a return to activities that harm conservation success, such as poaching (Chatty, 2002).

Good Exit Strategies may enhance the reputation of conservation professionals, while a bad reputation is often associated with failure. A focus on ethical decision-making also impacts positively on the reputation and marketing profile of project funders.

Recommendations:

- Considering the positive and negative consequences of a project beyond its immediate goals, in relation to how it affects the conservation of biodiversity in general.
- Maintaining clear communication with interest groups, to avoid making unrealistic promises.

DISCUSSION AND CONCLUSION

Throughout the HWIWG webinar discussions and 2019 ICCB session, several key themes related to HWIs and the success of conservation translocation programs were repeatedly discussed.

Despite often creating barriers to translocation program success, the human dimension is often still omitted during program development. All relevant stakeholders should be identified and included in the initial planning phases and throughout each program's duration. Local people must always be informed about proposed translocations and planning should include a pre-release period where extensive consultation and outreach takes place with interest groups. Although this can be time consuming, building strong relationships with local communities helps de-escalate potential conflicts and mitigate existing ones. This process of discovery may help address local beliefs and attitudes associated with cultural constructs, to improve the likelihood that key behaviour changes occur.

Finding inclusive solutions to avoid or mitigate conflict with local people requires research, outreach, and thinking outside-the-box. Practitioners should ask how the project might contribute to fulfilling the interests of local groups and individuals. To answer this question, practitioners should apply a social science-based approach to elucidate the attitudes of interest groups towards wildlife and the goals of the translocation project and encourage all project stakeholders to reach consensus via participatory decision making. By developing connexions between the translocation program and fulfilling local community needs we are more likely to promote long-term success. The success of any given action may depend on local norms and perceptions, so place-based actions should be developed.

Transparency is key to program success and the advancement of the field. Documenting and disseminating the translocation process and problems encountered using research-based data enables us to improve dialogue with local people and governments. Consistent transparency, data sharing, and dialogue is essential for developing and maintaining the trust that is critical to long term success. The publication and sharing of program results helps concurrent and future programmes learn from both successful and failed experiences of othersand encourages successful practises, reducing the waste of time and resources. Our community of conservation translocation professionals must continually improve collaboration and communication via the CTSG.

Concluding Remarks

Echeverri et al. (2018, p. 57) suggest that collaboration between biological and social sciences, arts and humanities to understand HWIs, may contribute to an exploration of "additional layers of complexity in conservation problems." Cross-disciplinary and cross-paradigmatic research collaboration may be particularly achievable when applied to problem-solving in wildlife conservation, consistent with pragmatic research orientation, and should be explored when planning future projects.

The science of reintroduction has come a long way, advancing knowledge towards the achievement of success regarding the establishment, growth and regulation of reintroduced populations. While the 2013 guidance acknowledges the need for considerations regarding social context and impact on reintroductions on local people, progress has mostly focused on population, metapopulation and ecosystem levels, as illustrated by Seddon and Armstrong (2016).

Rampant climate change and the biodiversity crisis require that we adapt and develop our practise to be responsive to the inevitable changes both in ecological and in socio-political systems where projects are based. Much of the evidence reviewed here suggests that in order for us to save species in peril we must abandon hasty solutions and invest in long term collaborations. We must build relationships that foster trust and respect amongst all parties, to support decision-making and commitment to conservation solutions, increasing lasting success.

Achieving progress in consideration for HWIs may require a coordinated effort involving practitioners and researchers. The

examples and recommendations offered here are intended as an aid to advance the inclusion and consideration of factors concerning HWIs that play a substantial role in the long-term success of conservation translocations worldwide.

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All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcosc.2022.788520/full#supplementary-material

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Evolving Our Understanding and Practice in Addressing Social Conflict and Stakeholder Engagement Around Conservation Translocations

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The conservation field has evolved to include an understanding of human values and attitudes toward wildlife; however, there is still too little emphasis on, and prioritization of, building understanding of the complex and context-specific social conflicts among people and groups involved with or impacted by conservation actions, including translocation. Both foci add value, but the latter is critical for building receptivity for conservation efforts and more thoughtfully designing appropriate context-specific processes for stakeholder engagement and shared decision-making. A deeper analysis of the social conflict dynamics involving the human relationships among individuals and groups engaged in a conservation conflict is needed as a first step in paving the way for the long-term success of conservation projects. Using a "Levels of Conflict" model offers a starting place for the analysis of social conflict often underpinning conservation translocation efforts. Further, we recommend employing a Conservation Conflict Transformation approach when considering conservation translocations to ensure that stakeholder engagement processes sufficiently engage the system, reconcile deep-rooted conflict among those involved and offer the best chance for shared progress and conservation success.

Keywords: human dimension, conservation conflict transformation, levels of conflict, decision-making process, engagement process, conflict analysis

INTRODUCTION: DEEPENING ANALYSIS OF AND THE PUBLIC'S ENGAGEMENT IN CONSERVATION TRANSLOCATION DECISION-MAKING

Conservation translocations involve the deliberate movement of living organisms from one area to another through reintroduction or reinforcement efforts of existing species populations to benefit conservation of the focal species (IUCN, 2013). In the same way that conservationists seek to learn what an endangered species' biological and ecological needs are before designing a recovery

plan suited to that species specific needs, one needs to understand more comprehensively what the social conflict dynamics—that is, the conflicts among people and groups that inhibit shared progress to address diverse needs, concerns and goals—are in a given context before designing or implementing decision-making processes (Madden and McQuinn, 2014; Riley and Sandström, 2016; Butler et al., 2019; Harrison and Loring, 2020). Further, those impacted by the focal species translocation need to be engaged early, genuinely, and inclusively in decision-making processes that are designed specifically for that context. Yet, typically a rushed, one-size-fits-all process for engaging different voices is employed under the erroneous assumption that simply convening and facilitating a big meeting—often using an existing template for social engagement used in previous contexts elsewhere—will be sufficient to meet the needs of the diverse individuals and groups (Bennett et al., 2017). These typically fail to address unique social and psychological needs, untangle complex histories, reconcile relationships, and disentangle deeper roots of conflict (Dickman, 2010; Skrimizea et al., 2020). We propose that conservation translocation projects should employ early analytical tools that orient the conservation practitioner and stakeholders to the depth and types of conflict that are at play in conservation efforts.

We are writing this perspective as we have worked in the field of social conflicts for decades, from human dimensions to community engagement processes to transforming social conflicts in conservation. Conservation Conflict Transformation (CCT) is both a philosophy and approach whereby the energy from conflicts are engaged and changed into an opportunity for shared progress in a constructive way (Lederach, 2003; Madden and McQuinn, 2014). Engagement processes allow for ongoing stakeholder involvement in projects or policy decisions from their inception right through to implementation. Such processes create the venue for people to get involved in crafting, informing, validating, implementing and adapting decision making- from the start to the end of the project or policy.

LEVELS OF CONFLICTS IN CONSERVATION TRANSLOCATIONS

Standard approaches that ignore or fail to fully embrace the unique system and human needs in which social conflicts are embedded, typically fall short of creating the kind of change needed for conservation projects and people to succeed in mutually beneficial ways (Leong et al., 2009; Peterson et al., 2013; Bennett et al., 2017; Madden and McQuinn, 2017). This is because acceptance of a species is often less about the species itself, and more about the perception that the species in question is symbolic of deeper unresolved conflicts (e.g., Skogen and Krange, 2003; Iwane et al., 2021). For instance, the conservation translocation of protected species may feel like a physical manifestation of government or authority overreach (Eriksson, 2016). Similarly, what may seem to be a conflict about a species, could be a deeper conflict among groups over power, status, autonomy, recognition, or identity—and these deeper conflicts need to be transformed if shared progress is to be achieved (Madden and McQuinn, 2014).

The field of conflict and peace studies offers many conceptual models for understanding conflicts between groups of people, including tools that analyze the sources, cycles, patterns, and types of conflicts (Ramsbotham et al., 2011). One starting place to deepen understanding is the "Levels of Conflict" conceptual model, which can help orient practitioners and stakeholders to the types and depths of conflict in a given situation (Madden and McQuinn, 2014; Sprague and Draheim, 2015; Zimmermann et al., 2020). As with most models, the Levels of Conflict model simplifies complex dynamics. Yet understanding the model embraces the interplay of complexity and non-linearity between the different levels of conflicts. Good analysis will likely illuminate how many of the most obvious conflicts for conservationists focused on translocation appear to be at the dispute level, even as deeper conflicts simultaneously exist below the surface (Zimmermann et al., 2020). Disputes are the physical, tangible manifestation of conflict. These may include addressing conflicts related to: whether to recover, translocate, or reintroduce a species in an area, the number of individuals to be re-introduced, the species management, and the tools used for implementation. Practitioners of CCT consider disputes as opportunities to begin constructively engaging the deeper roots of conflict that exist among those involved or invested in the outcome so as to create an enabling environment for effective, lasting, widely-supported conservation efforts (Lederach, 2003; Madden and McQuinn, 2014). Sustained progress will only be achieved if the deeper roots of conflict are transformed.

To illustrate "Levels of Conflict" (**Figure 1**), we share a current conflict scenario involving a potential conservation translocation, applying Chatham House Rules (i.e., removing any potential identifier of the participants) to the case to protect the identity of engaged parties and due to the sensitive nature of the case. The conflict involves the likely imminent extinction over the next few years of several bird species on an archipelago in the Pacific Ocean—and the effort among several pro-conservation parties to come to a shared agreement on what is the best approach to conserve these species. While there are numerous factors affecting the survival of these bird species, and while enormous resources from various institutions have been expended to save them over the last 30 years, climate change is now causing invasive mosquitoes, carrying avian malaria, to move further into the birds' range—with lethal results. As a result of the changing range of mosquitoes, viable habitat for these species is shrinking and shifting to higher elevations, where some islands can no longer support the birds. Multiple species may be extinct in the next few years. The involved parties include a national government, local government, indigenous peoples, multiple conservation NGOs and the public at large.

At a dispute level, the conflict looks like a lack of agreement among the various actors as to which strategy will best save the birds—capture and captive breed the birds to prevent extinction until new technology can suppress the mosquitoes, translocation of birds to another island with higher elevation to buy the birds more time, or leave the birds where they are and wait

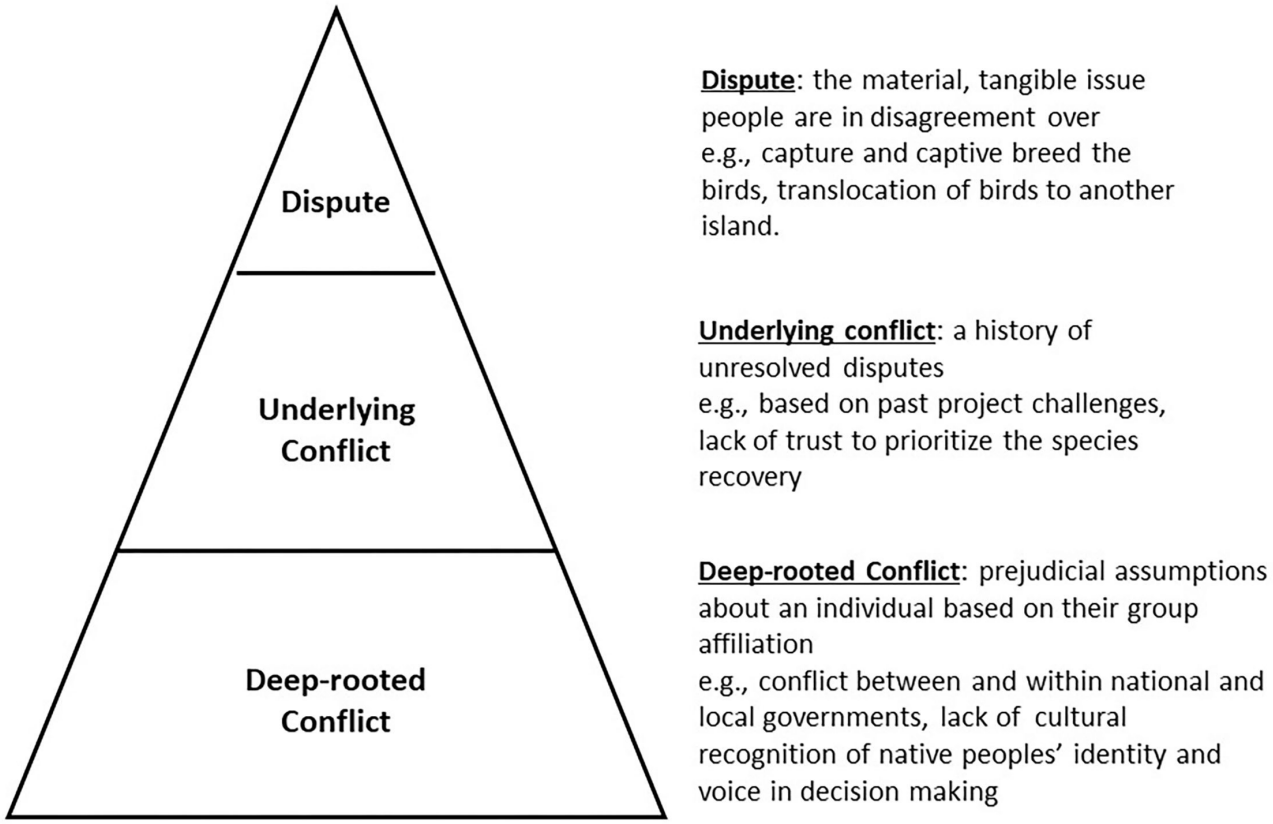

FIGURE 1 | The levels of conflict in conservation translocation. Adapted from Madden and McQuinn (2014) and Zimmermann et al. (2020).

for new technology (**Figure 1**). If this were all that was going on, or if no deeper conflict were investigated, the process for settling this issue might be designed to merely weigh the pros and cons of each strategy and arrive at the best option to implement. After all, all parties in this case want the species to survive. However, a deeper examination of the conflict reveals that each "side's" opinion about what would best support the birds' recovery is less informed or swayed by science, and more influenced by a history of unresolved issues, such as distrust, emotions, unmet social and psychological needs, and deeper threats to identity that make the current dispute more complex and seemingly intractable—and thus require a different kind of dialogue process. For instance, in the recent past, key partners in this current project were also involved in several previous projects, and the results of those challenging efforts created deep distrust and a lack of confidence by some individuals in their partners' capacities, motivations, and willingness to put the conservation of the species ahead of their own needs and ideas (**Figure 1**). At a deeper level, there is conflict between and within national and local governments that center around decision authority, means of influence and mandate; between government and NGOs over perceived credibility and a lack of willingness to look at past failures and learn from them that creates prejudicial assumptions about the institution as a whole. In addition, conflict exists between government and indigenous peoples because of historical harms done to the indigenous peoples by the national government and a lack of cultural recognition of native peoples' identity and voice in decision making, which fuels resistance to some options (**Figure 1**).

In this example, untangling the levels of conflict allows for the thoughtful consideration of biological and social factors that influence whether a conservation translocation of the species to another island should proceed. Ecologically, these considerations include, for example, whether suitable habitat exists and if it will remain suitable given the increasing effects of climate change; whether there are sufficient numbers of birds in the source populations to meet translocation needs, as well as the impact of translocated species to and from other native species. There are also critical social considerations that influence the decision. For example, whether suitable sites have landowners that are supportive of accepting a species, community support for a species being removed from their "home" island, the cultural appropriateness of moving species and the process by which it is conducted, and the ability for conservation entities to work collaboratively within and between themselves to develop and implement the conservation translocation. These types of social considerations, while often overlooked, are foundational to the success of any conservation translocation, and in this example, exemplify the rationale for using CCT to analyze and inform decision-making processes.

While the confines of this article do not allow for a complete analysis, the above examples hint at the implications and benefits of untangling the levels of conflict. Doing so offers strategic direction for how parties need to be engaged, what types of processes are needed to get all sides to be better capable of, and receptive to, evidence-based planning for the species in question (Zimmermann et al., 2020; Auster et al., 2022). In fact, while providing scientific evidence for why one approach or another may result in better conservation outcomes for these imperiled birds may seem initially a logical place to start, if the deeper roots of the conflict are not addressed first, then receptivity to evidence and shared agreement are unlikely. For instance, if the distrust among some partners persists, then that distrust will continue to hinder one or more parties from being able to constructively harness the full suite of resources and power of a broad partnership (Auster et al., 2022). In such a case, the underlying conflict that gave rise to the distrust needs to be addressed before all parties can be fully open to determining the strategy most likely to result in positive conservation outcomes. If the deeper analysis indicates that resistance is due to a perceived lack of cultural recognition and security, and a threat to identity and a lack of voice for indigenous peoples by the national government, then no amount of scientific evidence will influence the community's perception of the situation until these deeper roots of conflict are reconciled. The reason is that the birds—and the community's fight for the birds' survival—is intricately tied up in the fight for the inclusion of cultural values and voices in the management of natural resources.

Conservation translocations, including the discussion of the possibility of a translocation, may accompany, provoke, or exacerbate existing social conflicts, since most projects cannot be separated from the human-centered history of, and context around, conservation-related actions or research (Auster et al., 2022). Many conservation projects and contexts, just like many societal issues and engagements, are often characterized by prejudicial assumptions about individuals based on group affiliation and embedded social injustice, meaning there is deep-rooted conflict at play (Madden and McQuinn, 2014; Rodríguez and Inturias, 2018). Given the underlying and deep-rooted conflict, even seemingly simple disputes may be charged with antagonistic feelings and community resistance to change, perhaps especially where that history includes groups who have felt marginalized and disempowered by more powerful groups (Coleman, 2006; Madden and McQuinn, 2014; Rodríguez and Inturias, 2018). As such, employing a process that fails to untangle and reconcile these deeper relational and structural conflicts may unintentionally escalate or aggravate conflict within this system. At the very least, any solutions or decision will be short-lived (Madden and McQuinn, 2014; Skrimizea et al., 2020).

MOVING BEYOND A "STANDARD" ENGAGEMENT PROCESS

Participants of conservation engagement processes too often feel they are part of a "check box" approach because the unique attributes of their conflict have not been recognized, appreciated, or acted upon (Madden and McQuinn, 2014; Zimmermann et al., 2020). What may feel satisfactory to some decision-makers and authorities can be perceived as superficial and insincere to those people and groups involved with or who have a stake in the outcome—hereafter mentioned as the public. Often, many of the individuals and groups involved feel marginalized, imposed upon or disempowered and thus desire more decision-making power over processes and projects that may deeply affect their core values, way of life and wellbeing (Rodríguez and Inturias, 2018).

Even if well-intentioned, a poor engagement process may unintentionally generate more harm than good, especially when given cursory attention. Conservation entities desiring species translocation may assume that having a diverse public convene to make decisions about a translocation is meeting the needs of all those who are invested in the outcome (Auster et al., 2022). However, the very act of narrowly defining the process around translocation may already be setting the process up for failure since only the needs and goals of conservation are under consideration in the process. As a result, the process could lead to a perpetuation of or increase in opposition to conservation goals (Innes and Booher, 1999; Reed, 2008; Madden and McQuinn, 2017). Too often a process is poorly designed because it lacks the contextual, conflict-oriented analysis necessary to inform the process design. Context-specific design may also be missing when a process is "recycled" from other contexts where it worked well for that time and situation, but may not be the right fit for this unique context and point in time. Further challenges arise when unrealistic expectations are placed on a process; a process is left unmonitored; resources, adequate skillset or time are lacking to "do it right"; or a process lacks a sufficiently broad scope or clear goals (Reed, 2008). A process may also fall short when the limitations of participant capacity and power imbalances are not addressed.

A well-designed engagement process that is informed by a social conflict analysis and centered on the human relationships can untangle both the presenting issue, as well as related or deeper conflicts that can impact conservation outcomes, thus resulting in lasting conservation outcomes (Lederach et al., 2007). Such a process ideally fosters meaningful dialogue and trust, develops the group's capacity to reconcile relationships and work through complex issues through to the implementation of shared solutions. A good process increases transparency, integrity, and legitimacy for those directly and indirectly involved, and builds capacity and support for making thoughtful, shared decisions around conservation translocation as well as other conservation or community issues (Reed, 2008; Pomeranz et al., 2021). A good process considers the political realm, public environment and cultural appropriateness—the complex social system—in which the project is embedded (Reed, 2008; Pomeranz et al., 2021). Imposed processes or prescriptive solutions will likely fail to both secure diverse support and achieve the desired aims. Decision-making power should be as widely shared as possible to ensure buy-in by all sides (Reed, 2008; Pomeranz

et al., 2021). Furthermore, a good process keeps the public engaged over time, with all sides recognizing that when the public's input is not taken, a clear justification will be made (e.g., the contribution goes beyond the agency's jurisdictional power, or the suggestion cannot be supported by current regulations). This ensures that the public feels they have meaningful input into decisions through participation and feedback, which is important for the integrity of the process. Monitoring and evaluating progress through time will allow for adjustments to be made to better address the public's needs and concerns (Reed, 2008; Pomeranz et al., 2021).

Leaders or initiators of a conservation translocation effort may be disinclined to rethink their process investment, scope and design and may resist giving up control or power in the process. However, perhaps counterintuitively, a well-designed, facilitated, and inclusive, transformational process where needs and power are balanced, will increase the necessary receptivity and creativity needed to find shared solutions and durable conservation outcomes (Madden and McQuinn, 2017; Iwane et al., 2021). To be clear, transforming deeply-rooted conflict does not eliminate conflict, but rather it creates the conditions for constructive engagement with conflict when it does occur, as it inevitably will (Deutsch, 1973; Lederach, 2003; Madden and McQuinn, 2017).

Given the likely complexity of conflict in any conservation translocation endeavor, and given the needs for long-term success for both species and communities, the philosophy and approach of CCT offers a better match to conservation realities and needs through time (Lederach et al., 2007; Madden and McQuinn, 2014). Philosophically, conflict is conceptualized as a natural, potentially constructive, and even creative element of human relationships and processes. As an approach, CCT honors the needs and values of all sides, builds receptivity for shared engagement, ensures diverse needs are met in decision-making, and creates the conditions for lasting progress (Deutsch, 1973; Lederach, 2003).

The Center for Conservation Peacebuilding (www.cpeace.ngo) leads CCT capacity building workshops and third-party neutral facilitated interventions in the conservation field, continuing to advance the practice of CCT as the science and our society evolve. Practitioners who have integrated CCT have created the conditions for positive progress in conservation translocations and other conservation efforts in places ranging from Ecuador, USA, Kenya and Mozambique (Glikman et al.; *forthcoming*, Madden and McQuinn, 2014; Draheim et al., 2015). In doing so, building the capacity of those impacting or impacted by the conflict or the conservation effort in CCT is critical, since these people are the most important agents for long-term progress and success. The cornerstones of CCT proficiency go beyond theoretical understanding to include high levels of self-awareness and intellectual humility; a genuine ability to empathize, relate to and engage at the individual level with people who are different from and/or who disagree with you; a high capacity to visualize, engage, and navigate strategically within and through complex social system dynamics; and skills to design processes that prioritize reconciliation of deep-rooted conflict in relationships and shared problem-solving. Proficiency is achieved through mentorship and strategic guidance experiential learning, continual practice, self-reflection and receptivity to feedback.

CONCLUSION

Although the goal of conservation translocations targets a biological need for ecosystem or species restoration through time, the biological component is only one part of the equation for success. Too few conservation professionals have sufficient knowledge of and/or capacity in conflict approaches that specifically target the deep-rooted, complex, and systemic conflict that is a ubiquitous challenge in the conservation field. There is a pressing need to evolve how conservation as a field addresses conflict, beginning with prioritizing and improving the capacity of conservation leaders, institutions, and practitioners to better understand and transform destructive conflicts into opportunities for positive change that benefit both the people and the species. Lasting success is more likely to be achieved if sufficient resources, knowledge, and energy are focused on transforming the social conflict among people and groups that inevitably underlie the conservation challenge.

The success of conservation translocation projects is inherently tied to complex social human dynamics that determine conservation outcomes. The quality of the engagement process and relationships is as necessary to success as consideration of the biological needs of the species. To ensure both, the decision-making processes need to create the space for genuine trust-building, mutual learning, inclusion, and empowerment—not as a "check box" effort. To start, relevant parties need to undertake high quality analysis of the social conflict dynamics as a first step in co-developing the engagement processes with the impacted and interested parties. In doing so, societal skepticism and division around conservation endeavors can be better addressed without fueling further conflicts and reactionary opposition to conservation translocations.

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/s.

AUTHOR CONTRIBUTIONS

JG and FM share first authorship as they contributed equally to this work. Both JG and FM are corresponding authors for this article. BF contributed to the conceptualization of the article and MB contributed the case study. All authors contributed to editing the manuscript and approved the submitted version.

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Stakeholders' Perceptions of the Outcomes of Translocated Eland in Nyae Nyae Conservancy, Namibia

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Translocation of wildlife species from one area to another is a conservation tool that contributes to the restoration of depleted populations, augments declining populations, or establishes of new populations. This paper documents one of the first studies examining in detail stakeholders' perceptions of the factors influencing the outcomes of translocations of wildlife into a community conservation area, using the case of eland (*Taurotragus oryx*) translocations into the Nyae Nyae Conservancy in Namibia. The translocations took place between 2000 and 2005 as part of the national community-based natural resource management programme and were monitored through annual waterpoint counts. These data on perceptions were collected through a household survey and focused group discussions involving community members and leaders and key informant interviews with external stakeholders. Community members' perceptions could not confirm that the translocated eland decreased or increased, however, reflected that eland individuals moved away from the release site soon after translocation to more distant locations further away from human settlements. The outcomes of the translocations were perceived to be most strongly associated with anthropogenic factors compared to habitat or environmental factors. However, stakeholders exhibited divergent perceptions regarding which of the anthropogenic factors was of most importance, particularly with respect to the roles of the different types of hunting, and to a lesser degree, the role of traditional burning of landscapes on translocation outcomes. The paper illustrates the complexities associated with translocations of wildlife into community conservation areas compared to state protected areas, given the strong influence of human disturbances on translocation success. It highlights the importance of understanding the social factors influencing how and why translocated individuals may adapt well or poorly to their new environment. Building this understanding is essential to improving the outcomes of similar translocations in the future.

Keywords: translocation, community perceptions, eland, Namibia, conservancy, community conservation

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INTRODUCTION

Community-based natural resource management (CBNRM) in southern Africa allows rural communities to take a leading and active role in managing natural resources, including wildlife (Jones, 2001; Taylor, 2009; Child and Barnes, 2010). In Namibia, following the enactment of the *Nature Conservation Amendment Act of 1996,* the development of communal conservation areas outside protected areas, known as conservancies, enables local communities to actively participate in the conservation of wildlife and their habitats (NACSO, 2004; Weaver and Petersen, 2008). Silva and Mosimane (2014, p. 184) describe communal conservancies as "legally-recognized, geographically-defined institutions, formed by communities and designed to achieve environmental conservation objectives (e.g., increasing wildlife numbers and preserving habitats) by allowing local residents to manage and benefit from wildlife and other natural resources." The benefits derived include income for conservancy members and communities from tourism and trophy hunting activities and providing game meat for households in conservancies (MEFT/NACSO, 2018). These benefits contribute to livelihoods and economic development both locally and nationally (Jacobsohn and Owen-Smith, 2003; Van Schalkwyk et al., 2010; Silva and Mosimane, 2014).

Communal conservancies play an important role in biodiversity conservation, including connecting wildlife corridors within the country (NACSO, 2014). Conservancies have led to increases in wildlife populations and greater protection and restoration of habitats (MEFT/NACSO, 2018; Stoldt et al., 2020), contributing to meeting the objectives of the international Convention on Biological Diversity. However, the establishment of some conservancies in Namibia necessitated translocation or restocking of wildlife where these had become locally extinct or had very low populations (NACSO, 2014). These translocations involved the movement of wildlife species from state protected areas or privately owned game farms into communal conservancies (Seddon et al., 2007; Paterson et al., 2008; NACSO, 2014) to enhance existing populations or to re-establish populations within their natural range (Buijs et al., 2016).

Historically, local communities' views were often disregarded in natural resource management planning and decision-making, but more recently, understanding people's views has been recognized as important in the evaluation of the ecological impact of conservation, and in responding to them over time, in order to enhance positive outcomes of conservation (Bennett, 2016; Angwenyi et al., 2021; Iñiguez-Gallardo et al., 2021), in particular for CBNRM (Beyerl et al., 2016). Attention has been given to understanding how the involvement of different stakeholders and their interests contributes to natural resources management decision-making, planning processes and practices (Beyerl et al., 2016; Arumugam et al., 2020). For example, the establishment of protected areas, including national parks, which by nature of their establishment, restrict the ability of human populations to access resources necessary for their livelihoods, necessitates engagement or involvement of local communities to include their knowledge and inputs to assure its success (King and Peralvo, 2010). In a similar manner, the establishment and success of community conservation initiatives such as the Namibian CBNRM programme is premised on the involvement and engagement of different stakeholders (NACSO, 2004; Weaver and Petersen, 2008).

This paper, therefore, documents the perceptions of multiple internal and external stakeholders involved in the ongoing management of Nyae Nyae Conservancy, in order to better understand the different experiences and standpoints of stakeholder groups and their perceptions of the translocation outcomes. In this paper, perceptions refer to what people regard, understand, and interpret or peoples' experiences and their interpretation of these realities encountered (Beyerl et al., 2016; Ntuli et al., 2018). Perceptions not only determine people's attitude and behavior—in the case of the present study, toward the translocation and conservation in general—but therefore, also the success of natural resources management (Ntuli et al., 2018).

The perceptions of different stakeholders regarding natural resources management initiatives are shaped by multiple factors and their interactions, with social factors and community expectations standing out as particularly important (Ogra, 2008; Dickman, 2010; King and Peralvo, 2010; Gore and Kahler, 2012; Villamor et al., 2014; König et al., 2020; Cruise and Sasada, 2021; Hebinck, 2021; Van Der Wulp and Hebinck, 2021). Consideration of often divergent perceptions, values, knowledge, and experiences of different stakeholders facilitates the identification of shared views and contentious grounds (Villamor et al., 2014) that are relevant to the outcomes of natural resources management interventions. Thus, it is important to examine the perceptions of more than one group, to allow for broader inputs in conservation programs, recognizing that opinions will differ not only between groups (Cortes-Avizanda et al., 2021), but also within groups.

There is a wide variety of natural resources management contexts in which research on perceptions of different stakeholders has been investigated and reported. These include (but are not limited to) conservation in general (King and Peralvo, 2010), human-wildlife conflicts (HWC) in and around protected areas (Ogra, 2008; Dickman, 2010; Drake et al., 2020; König et al., 2020), deforestation (Durand and Lazos, 2008), marine and freshwater resources management (Velez et al., 2014; Beyerl et al., 2016; Arumugam et al., 2020) and poverty (Hargreaves et al., 2007). Studies have also looked specifically at gendered perceptions associated with HWC (Gore and Kahler, 2012), carnivore translocations (Bavin et al., 2019), costs and benefits associated with wildlife tourism (Drake et al., 2020; Lekgau and Tichaawa, 2020), and contestation over allocation and meaning of land and use of resources (Van Der Wulp and Hebinck, 2021).

However, while the literature demonstrates the clear interest in perceptions of conservation stakeholders, there is still little known about how different stakeholders perceive the effect of their own activities and those of other stakeholders on the outcomes of wildlife translocations. The choice to examine stakeholder perceptions of the eland translocations, specifically in Nyae Nyae Conservancy was made to contribute to this

knowledge gap, and the focus on eland was particularly pertinent because of the species' cultural and historical significance to the residents of the conservancy.

This case study is of particular interest because translocating wildlife from state protected areas to community conservation areas is a relatively recent phenomenon, and is infrequently documented. The range of views of translocation outcomes expressed in this paper, and continuing uncertainty about the outcomes of the eland translocations, demonstrate the need for proper monitoring systems and evaluation of translocation outcomes from both a social and ecological perspective. The sharing of information should allow conservancy residents, local leaders, community rangers and other stakeholders to have a common understanding of the factors affecting translocation outcomes, and of relevant management actions to improve the chances of success, especially for sensitive species like eland.

MATERIALS AND METHODS

Study Area

The study was carried out in the Nyae Nyae Conservancy (located at 20°S, 20°E) in the Tsumkwe Constituency of the Otjozondjupa region (see **Figure 1**). The constituency covers an area of 26,010 km^2, including the Khaudum National Park and communal lands (Mendelsohn and El Obeid, 2002), and Nyae Nyae Conservancy makes up 35% of the area of the constituency, with an area of 8,992 km^2 (NACSO, 2004).

Tsumkwe Constituency is the least populated constituency in the country, with fewer than 10,000 inhabitants (NSA, 2014). Tsumkwe settlement is the main town in the constituency and the conservancy and has a population of 2,000–3,000 people (Hays et al., 2014), the majority of whom belong to the Ju|'hoansi San ethnic group.

The Nyae Nyae Conservancy was formally registered in 1998, making it one of the oldest communal conservancies in Namibia. It borders Ondjou Conservancy in the south, N≠a Jaqna Conservancy in the west, Khaudum National Park (NP) in the north, and the Namibia–Botswana border in the east.

The majority of the people in Nyae Nyae Conservancy are historically hunter-gatherers, though declining natural resources, legislation regulating access to and protection of natural resources and modern education programs in schools has diminished hunter-gathering interest, knowledge and skills (Suzman, 2001). The livelihood activities and support systems on which community members have depended in more recent decades include old age pensions and other social welfare grants, food aid, permanent and casual employment, subsistence crop production, livestock, small businesses, the sale of natural products, and tourism-related activities (Suzman, 2001; Biesele and Hitchcock, 2013; Dieckmann et al., 2014).

However, hunting remains an important activity in Nyae Nyae Conservancy, and there are three main types: (a) hunting for own use; (b) subsistence/traditional hunting; and (c) commercial trophy hunting. Hunting for own use is organized by conservancy management, and carried out by qualified Ministry of Environment, Forestry and Tourism (MEFT) officials or professional hunters, and the resultant meat is distributed to households and community social events (e.g., conservancy meetings, local festivals and funerals in the conservancy). All conservancy members are allowed to conduct subsistence hunts to provide meat for themselves, their friends, and their family, as long as they use only traditional bows and arrows in the hunt. Commercial trophy hunting (including shoot-and-sell arrangements) is carried out by contracted professional hunters within the conservancy. People from outside the conservancy are not permitted to hunt within conservancy boundaries without appropriate permits.

Natural Resources of Nyae Nyae Conservancy

Although the Nyae Nyae Conservancy receives relatively good rains compared to many parts of the country ranging between 400 and 500 mm, the area still mostly relies on water from boreholes and some dry drainage routes that retain water for a short period after rainfall (Mendelsohn and El Obeid, 2002). The area is fairly homogenous in terms of vegetation type as it is situated within the Kalahari woodlands, which consist primarily of mixed, broad-leaved and acacia woodlands (Curtis and Mannheimer, 2005). Nyae Nyae Conservancy is home to diverse free-roaming wildlife species (Mendelsohn and El Obeid, 2002). The Nyae Nyae Conservancy contains Buffalo Camp, a self-contained area surrounded by game fencing. The camp was initially an area of 2,400 hectares and was established in 1996 to accommodate buffalo that were found in the area, to prevent contact with other species and reduce the potential transmission of foot-and-mouth disease. The rest of the conservancy is open, with free-roaming wildlife species. 2,200 individuals were translocated into these open landscapes of the conservancy, including eland, springbok, oryx, giraffe, red hartebeest, kudu, black rhino, blue wildebeest and Burchell's zebra (Lendelvo, 2018). A total of 268 eland individuals were translocated into the open landscapes from commercial farms (Waterberg and Farm Eden) in 2000, 2003 and 2005 (Lendelvo, 2018). These supplemented a very low founding or existing eland population in the conservancy (12 eland individuals that were counted during an aerial survey in 1998 (Weaver and Skyer, 2003). Wildlife monitoring was carried out annually using the annual water-point counts of all wildlife species at water points in different landscapes. **Figure 2** shows the records for the eland between 2000 and 2013 including the translocated numbers of eland into the Nyae Nyae Conservancy.

Data on Stakeholder Perceptions

Household Survey

A questionnaire survey was administered in the Nyae Nyae Conservancy during June and July of 2015. The bulk of the questionnaire comprised closed-ended questions about respondents' socio-economic status, their awareness of the eland translocations, their views on the changes in the eland population and interaction with different species, and on aspects of hunting. Trained field assistants helped the principal researcher to administer the questionnaire to representatives of sampled households.

The population of interest in this study were household members within the Nyae Nyae Conservancy. Conservancy

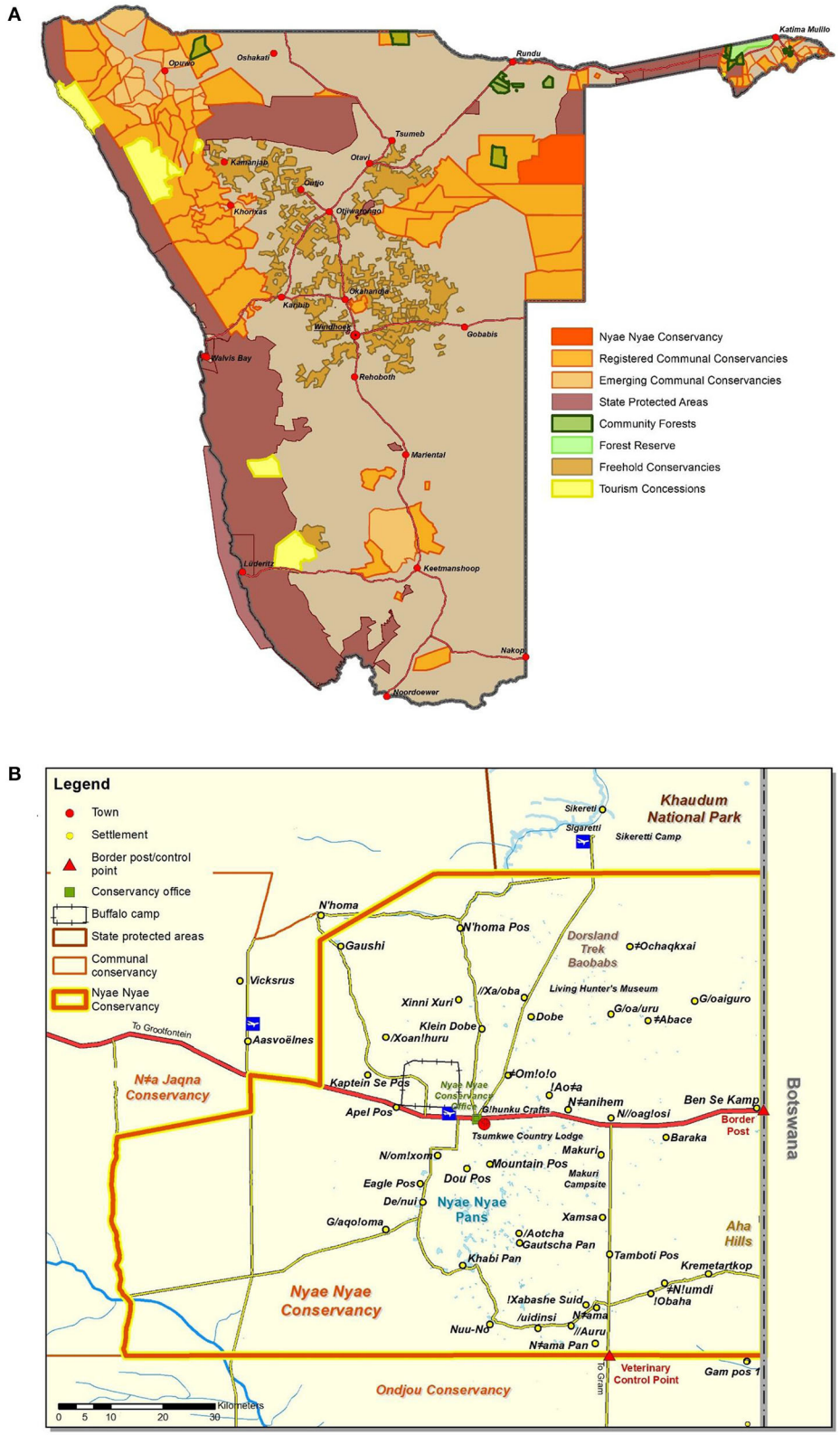

FIGURE 1 | (A) Location map of the Nyae Nyae Conservancy in Namibia and **(B)** map of the Nyae Nyae conservancy. Source: Lendelvo (2018).

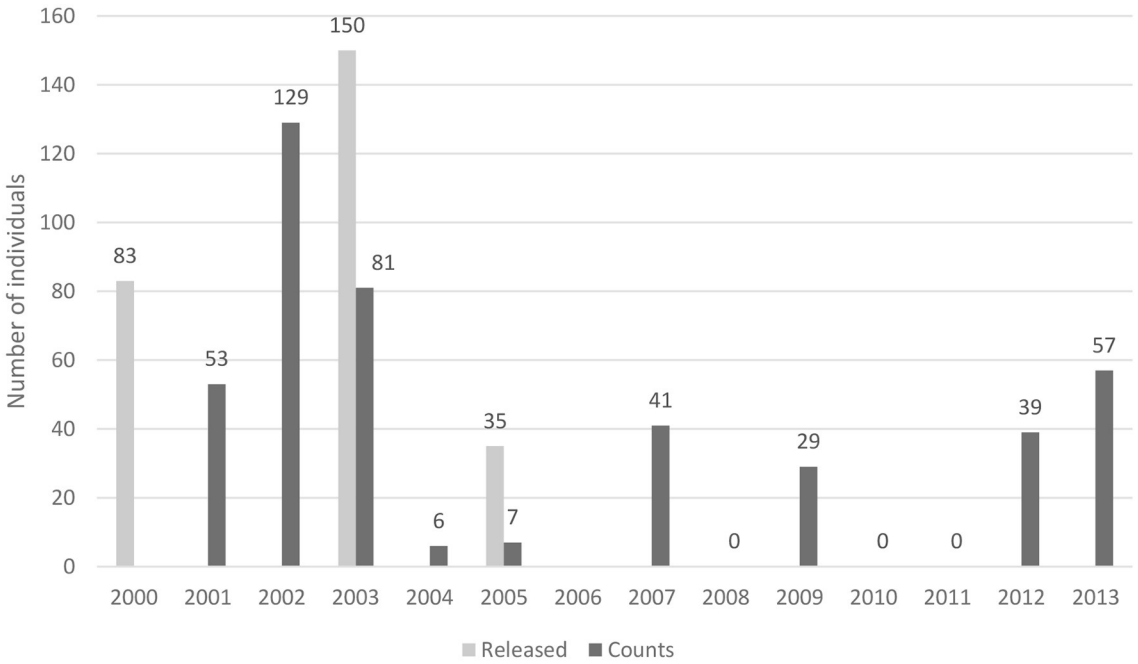

FIGURE 2 | The number of translocated (released) eland and annual counts for eland in the Nyae Nyae Conservancy, 2000–2013.

records showed that there were approximately 500 households in the 38 villages and 300 households in Tsumkwe settlement. These villages are divided into four districts, one of which included Tsumkwe settlement. With the exception of Tsumkwe settlement, the villages are very small, with approximately 10–15 households per village (Hays et al., 2014). The sampling strategy aimed to interview 10 households across four villages in each of the four districts (i.e., two or three households per village). However, additional 20 households were randomly selected for interview from Tsumkwe settlement, given its significantly larger size than other villages. Households were selected randomly from four villages from each of the four districts using a list of computer-generated random numbers. This method was chosen because of its relevance in situations where the population is characterized by widespread variation (Taherdoost, 2016). One respondent from each household was interviewed, who was either the household head, their spouse, or another adult household resident, with all respondents being aged 18 years or over.

Respondents from 56 households from 13 villages from the four districts and the Tsumkwe settlement were interviewed. The actual sample of 56 completed surveys was less than the planned 60 households, because in two originally selected villages, people no longer lived there, and so four interviews could not be undertaken. It was not possible to achieve a larger sample due to financial and logistical constraints. The relatively small sample size means the results presented below are not generalisable to the conservancy population, but they do allow for the examination of a range of views from across the conservancy, and representing with different levels of proximity to the translocation site and wildlife populations, and also likely to have different levels of interaction with the conservancy management.

TABLE 1 | Number of key informant interviews and their organization.

Sector	Total number of respondents
Traditional leaders	4
Nyae Nyae Conservancy leaders and staff	7
Government (Ministry of Environment, Forestry and Tourism)	5
Non-governmental organization (NGO)	2
Conservation support organization	4
Private sector (trophy hunter)	1
Total key informant interviews	**23**

Key Informant Interviews

Local leaders in the Nyae Nyae Conservancy assisted with mapping out potential key informants to be interviewed. They identified different categories of informants to ensure the inclusiveness of a range of different stakeholders' perspectives. 23 key informant interviews (KIIs) were conducted—around half were from the local community, including traditional leaders, conservancy staff and committee members. The remainder were "external" stakeholders, including MEFT and representatives of NGOs and donor organizations (see **Table 1**).

KIIs were typically conducted in English, except those with conservancy leaders and staff who were interviewed in Afrikaans. Traditional Authority members were interviewed in the local Ju|'hoansi language with the assistance of a Ju|'hoansi–English translator. The KIIs aimed to document the perceptions amongst a knowledgeable group of individuals regarding eland translocations in the conservancy, and the influence of anthropogenic and environmental factors in determining the outcomes.

Focus Group Discussions

A total of seven focus group discussions (FGDs) were conducted with conservancy residents in different villages in the Nyae Nyae Conservancy. Three of these groups included both male and female participants, two were women-only groups, and one was a male-only group. Each FGD included people of different ages. Six of the FGDs aimed to build an understanding of community perceptions of the eland translocations and to stimulate open debate around the community's understanding of both the anthropogenic and environmental factors affecting the success of the translocations. The seventh FGD was held with traditional and conservancy leaders. The FGDs were facilitated in Afrikaans with a translator in the Ju|'hoansi language. The facilitation of the FGDs was executed to elicit the range of views of participants, not to achieve a consensus view on the outcomes of, or the factors affecting the eland translocations.

Data Analysis

The questionnaire survey data was entered into SPSS, where frequencies and cross-tabulations including descriptive statistics were generated to establish the proportions of different variables in SPSS. The data from the KIIs and FGDs data were transcribed and analyzed using ATLAS.ti version 7.1.4. Perceptions of the local communities and stakeholders regarding factors that affect the establishment of the translocated eland in the Nyae Nyae Conservancy were derived from the transcribed KIIs and FGDs.

RESULTS

Socio-Demographic Characteristics of Respondents

The demographic characteristics of the survey respondents are summarized in **Table 2**. The respondents were predominantly male (84%) and the household head (79%), and conservancy members (93%). The average age of respondents was 47 years, and the levels of education attained are very low, which is likely correlated with high unemployment levels. Those that were employed (30%) were employed in the government, state-owned institutions, conservancy, private businesses, and also in tourism and hunting. Most of the respondents indicated their livelihoods depended mainly on the conservancy and natural products (plants and animals) from the surrounding forests.

TABLE 2 | Demographic characteristics of respondents (%) (n = 56).

Demographic characteristic	%
Gender	
Male	84
Female	16
Age group	
18–30	21
31–40	16
41–50	27
51-60	20
61 and older	16
Relationship to household head	
Household head	78.6
Wife of the household head	3.6
Sons-in-law	10.7
Other relatives	7.1
Highest educational levels	
None	35
Primary education	44
Secondary education	17
Tertiary education	4
Occupation	
Unemployed	59
Employed (including self-employed)	30
Retired/ Pensioner	11
Conservancy membership	
Yes	93
No	7

Perceptions of Factors Affecting the Translocated Eland

The majority of survey respondents (81%) were aware of the eland population translocated into their conservancy. Many were also able to distinguish the recently translocated eland that was free-roaming in the conservancy and the eland that was translocated into Buffalo Camp before the establishment of the conservancy (62%). However, there were mixed views among the residents about the population trends of the free-roaming eland since the first translocation in 2000. Almost half of the respondents believed the eland population had increased (46%), and close to another half was of the opinion that the eland population had decreased (48%) in the conservancy, while the remaining 6% reported that eland numbers had not changed.

In the 12 months prior to the survey, 52% of respondents reported that they had seen eland and 39% had only seen their tracks. One in five respondents stated that they had sighted an eland or its tracks recently (21%), within the month prior to the interview. These respondents—those who saw the eland or its tracks—did so at their villages (18%), at water points that are close to the settlements (21%) or those further away from the settlement (45%) or in forested areas at a distance from settlements (16%).

FGD participants believed translocated eland were doing well in the conservancy, but indicated that they had moved away from settlements, where there is limited human disturbance. Participants believed eland had moved away from settlements because they felt it had been becoming increasingly difficult to spot eland over time. Living away from the human settlement was believed to give the eland species an opportunity to survive better with limited human interactions. Household members' perceptions about the seriousness of various factors influencing the translocation outcomes are presented in **Table 3**. It is evident that most survey respondents felt that neither water availability, vegetation/range condition, predation, nor farming activities had a serious influence on the translocation outcome of eland. However, a majority felt that poaching, human settlements, and wildlife migrations away from Nyae Nyae had exerted serious influences on the translocation outcomes.

TABLE 3 | Perceptions of community members on the level of seriousness (whether serious, not serious or do not know) with which various factors influenced whether eland had successfully established following translocation in Nyae Nyae Conservancy (n = 56).

	Migration (%)	Human settlement (%)	Poaching (%)	Water availability (%)	Predators (%)	Range conditions (%)	Farming activities (%)
Serious	50	49	40	37	34	26	18
Not serious	41	45	51	63	64	68	55
Don't know	9	6	9	0	2	6	27

Ecological Factors

Availability of Water Resources for Wildlife

The Nyae Nyae Conservancy has many water points, the majority of which are artificially supplied with water from solar and diesel-powered boreholes. Most respondents—both community members and other stakeholders—indicated that water availability was not a serious threat to the establishment of eland in the conservancy, though MEFT officials noted that the frequent breakdown of pumps at water points forced some wildlife to move closer to boreholes established for human use near settlements. Local rangers stated they had witnessed eland using water points in villages. Furthermore, rangers, local leaders, MEFT, and NGO respondents viewed dysfunctional water points as contributing to the disturbance of the eland, especially when they had first been translocated and were new to the environment. Both conservancy rangers and local MEFT staff reported that some translocated eland started moving away from the area they were released into immediately, while others stayed in their release area for up to 6 months. The water points at the release site, although in the central part of the conservancy, were distant from human settlements.

Vegetation and Rangeland Conditions

Over two-thirds of survey respondents (68%) reported that the rangeland condition of the conservancy did not have a serious influence on wildlife species in the conservancy, including the eland species. Key informants were also in agreement that vegetation and habitat in the conservancy were in good condition and able to support a variety of wildlife species, and so not likely to be a factor negatively affecting translocation outcomes.

The vegetation was perceived by both the conservancy residents and other stakeholders to be suitable for eland—that vegetation they generally feed on were still available, and that little has changed in the quality of the habitat: *"These forests of Nyae Nyae are full of different plants that we knew from childhood as good food for eland, meaning that people must know this is a good area for the eland*" said an elderly local pioneer in the establishment of the Conservancy.

A local MEFT official stated that *"This [Nyae Nyae] conservancy has good land cover of different species and has much better vegetation condition than other conservancies."* Another MEFT official observed that the large size of the conservancy and the fact that it is sparsely occupied leaving large expanses unoccupied, combined to enhance and maintain the integrity of the vegetation thereby providing suitable habitats for wildlife, including translocated animals.

Furthermore, almost all FGDs participants and key informants agreed that there were only few and isolated signs of land degradation where loss of vegetation was evident. An NGO representative remarked that the Nyae Nyae area has very good habitats for eland and other wildlife such that in the past, many animals moved into Nyae Nyae Conservancy from neighboring farms due to good range conditions. This observation was further supported by a rhetorical question that was asked by a local ranger: *"if eland could survive for many years in the Buffalo Camp, why should it be hard for them to survive outside the Camp where there are more resources?"*

Predation and Wildlife Movements/Migration

Only 34% of survey respondents believed predation was a serious threat to wildlife, including eland. A similar sentiment was expressed by FGD participants. However, key informants from the conservation support organization, MEFT and NGOs cautioned that predation may only be a threat to translocated individuals around the time of their release into new habitats, as at that time they have increased vulnerability due to their unfamiliarity with their new habitat. Although local rangers and MEFT confirmed there was evidence of predation of some eland, with only three carcasses of eland recorded in the event books between 1999 and 2014, they were therefore assured that it was not a serious problem.

However, evidence of predators was noted during interviews and FGDs: a female conservancy leader recalled that in 2012 *"two lions were seen roaming around their village,"* while an elderly man noted that *"the number of leopards had increased as most of the kills of wildlife and some livestock pointed to them [leopards]."*

Migration of the eland out of the conservancy was thought by 50% of survey respondents to be a serious threat to translocation outcomes of the eland, though 49% did not agree.

Anthropogenic Factors

Human Settlement and Farming Activities

There were mixed views among the survey respondents with regards to the seriousness of the effects of human livelihood activities on the success of the translocated eland. Almost equal proportions of respondents considered human settlements to have a serious impact on the establishment of translocated eland (49%) and to not have a serious impact (45%) on the settling of the translocated eland individuals. A key informant from traditional authority noted that the villages have very small numbers of residents and are spread across the vast conservancy, and that such low human density suggests that the utilization of the landscapes by community members contributed minimally to disturbance of the translocated eland.

Over half (55%) of the survey respondents indicated that farming activities did not have a serious impact on the translocated species, and just over one quarter (27%) did not know what they might be. The KIIs with local respondents highlighted the difficulties for many respondents to provide views on the effect of farming activities because farming is still not common in the conservancy. During an FGD, one resident raised a concerne that the observed influx of people and their large herds of livestock moving into Nyae Nyae Conservancy (at the time of the survey) in search of pasture could potentially heighten competition over resources between livestock and wildlife, including eland.

Because of the low and sparsely distributed population, the location of villages is not broadly perceived to be a problem. However, some stakeholders did feel that the movement of local people into wildlife habitats for hunting and to graze livestock may threaten wildlife, as observed by a MEFT official: *"although this human population size in this conservancy is very low, their livelihoods are solely depended on the forests in their vicinities, and no one is there to monitor the activities carried out there … remember, hunting is the economy of these people."*

Veld Fires and Cultural Burning

Setting veld fires (wild grass and woodland fires) is commonly practiced in many parts of Namibia, including Nyae Nyae Conservancy. FGD participants and key informants noted that burning is a cultural practice where fires are set for various purposes, including (but not limited to) increasing visibility when people were in the 'wild' areas of the conservancy, whether that was for hunting, collecting food products, or simply moving from one area to another. Burning patches of grassland is also done to attract wild animals with the fresh sprouting of new grass. These cultural burning practices are not restricted to any one season—though most of it is possible only during the dry season. Typically, only relatively small areas are burned, except when fires get out of control, if they are set in conditions that are too windy and when the grass is too dry.

In contrast to the views of the local community, local MEFT and NGO respondents expressed their concern about the manner in which burning was carried out by local people, saying that the problem starts if people start fires at any time of the day, any time of year, which can have the cumulative effect of burning large areas of wildlife habitat. A local NGO interviewee suggested that these practices do not need to be stopped but do need to be controlled.

Hunting

In this study, perceptions of survey respondents and stakeholders were most divergent regarding the effect of the different types of hunting on the translocation outcomes of the eland translocations/populations. Conservancy leaders and key informants confirmed that, at the time of the interviews, hunting eland for subsistence was prohibited, mainly because of the instability in the population. Further, there was no evidence from the survey or FGDs to suggest that eland was being hunted illegally by community members. In fact, the results of this study indicated that community members were aware they were not allowed to hunt eland for subsistence, and no household claimed to have hunted eland during 2001 and 2013. Note, however, that survey respondents may have been hesitant to openly report hunting eland, knowing that it was not a legal activity at the time. Some respondents said that the eland had previously been a target of local hunters, especially before the conservancy was established. However, through public awareness, communities were educated regarding reasons why eland should not be hunted until at such a time after they increase in population size.

Both the FGDs participants and key informants confirmed that hunting is an important household and conservancy income-generating activity. Individual local community members hunt wildlife (species other than eland were legally hunted for subsistence at the time of the research), but trophy hunting—carried out by external, professional hunters, following an agreement with the conservancy—is the major source of conservancy income. The key informants revealed that regular reporting by both subsistence and trophy hunters to the conservancy and MEFT was important for the maintenance of sustainable hunting in the conservancy. One local traditional leader said: *"Hunting is our main source of livelihood. Household families go out to hunt as they require food, just as other people go for shopping. Our parents lived with wildlife in this area, only these days they say we are disturbing the animals".*

Besides its economic importance to the community, subsistence hunting (of all species) also remains culturally important. Participants in the FGDs understood that translocation was meant to improve wildlife numbers in the conservancy and enable conservancy members to hunt and feed their families into the future. They believed that conserving and managing local populations of wildlife in the conservancy would allow the continuation of their hunting culture. One traditional leader expressed their appreciation of the eland translocation because of the cultural importance of this species to their area. Another participant stated that "traditionally most rituals of our culture required eland products such as hides, horns, meat and fat," while yet another noted "for anyone to be pronounced and viewed as a good hunter, you needed to hunt an eland." However, the discussion in the FGDs indicated that participants had not heard of any eland being hunted in the conservancy in the years prior to the research being undertaken.

External stakeholders and the conservancy staff and leaders highlighted the complexities associated with subsistence hunting, particularly with respect to the complications associated with accurately monitoring the species and numbers being hunted, when hunting decisions are made at the household level. Indeed, most external stakeholders (MEFT and NGOs) expressed the view that, in practice, traditional hunting was likely to exceed quotas, leading to overhunting, because it was not easy to apply a systematic monitoring system. Conservancy leaders also could not confirm with certainty the reliability of the hunting records regarding hunting by the locals, although they indicated recent improvements in the recordings at the settlement level. *"At least if our people could honestly report the animals they hunted, that will help our management and monitoring efforts,"* said a conservancy leader. However, another view of constraints on hunting was expressed by one local respondent, asking a question anchored on

the local livelihoods: "how can one stop the locals from hunting even when quota levels are reached." The conservancy leadership finds it difficult to stop people hunting, even after quotas are reached, due to its importance for households.

Despite the lack of evidence provided by external stakeholders of illegal hunting in the conservancy (generally, or of eland specifically), those stakeholders did suggest a number of measures they felt would improve the control and monitoring of hunting by locals, including having rangers accompany hunters, local hunters requiring a formal registration and to have to apply for and be granted a new form of hunting permit, and the introduction of a hunting season when conservancy members could hunt. Some suggested that the national regulation that permits hunting by the San people of Namibia be eliminated, and that hunting by locals should be decided by the conservancy leadership. Others called for effective control mechanisms to be put in place to ensure that traditional hunting did not pose a threat to wildlife in the area, considering the importance of wildlife to the livelihoods of the conservancy members.

Hunting activities may have affected translocated populations, even if the animals were not killed by hunters. The NGO respondents believed that most of the conservancy's translocated species, including eland, were mostly affected at the time of their release when some residents started hunting them before they were fully settled into the new habitat, causing fright among individuals in these species. The natural sensitivity of the eland meant that the species would move in search of safer places if they felt threatened. An elderly local male key informant, and a MEFT official concurred that eland had the ability to travel long distances, especially when they were unable to settle due to disturbances. Other stakeholders suggested, with confidence, that eland have moved out to the outskirts of the conservancy, perhaps because locals had tried to hunt them. The professional hunter operating in the conservancy and the conservation support organization both pointed out that translocated eland has the potential to contribute economically if viable populations were established, because of their high value.

DISCUSSION

The relatively high awareness of the eland translocations among conservancy members indicates that the community was well-informed of this initiative in the conservancy. Although community members' views could not confirm that the eland population decreased or increased, they indicated that the tracks were sighted in areas further away from human settlements. Community members' perceptions support the suggestion that eland individuals may have moved away from the release site soon after translocation and remained in those more distant locations. This suggestion is corroborated by the aerial survey reports of 2004 and 2013 showing that eland was mostly spotted toward the edges of the conservancy, and in the neighboring Khaudum NP (Stander, 2004; Craig and Gibson, 2013). Generally, wildlife translocations are considered successful when a viable and self-sustaining population of the translocated species is established in the new location (Pinter-Wollman et al., 2009), and a failure when translocated species die out or severely decline, either naturally or due to habitat and anthropogenic impacts, or when they move out of the area (Novellie and Knight, 1994). Globally, evidence suggests that translocated ungulates can establish viable populations both within and outside their historical ranges because they have the ability to adapt to different habitats, especially when human activities are absent or limited (Novellie and Knight, 1994; Spear and Chown, 2008; García-Marmolejo et al., 2015).

The results of this research show that there are quite different views expressed by different stakeholders about the anthropogenic factors affecting translocation outcomes. Broadly, local community members thought they had little impact, while other (external) stakeholders believed residents' activities probably contributed to the failure of the translocated individuals to create a viable population at the release site, though there is no hard evidence of this. However, the results do illustrate well the additional complexities of translocations of wildlife into community conservation areas—compared to those into state protected areas—and the need to explicitly consider social factors, that are less necessary for state protected area translocations, excepting with respect to control of poaching. Divergence of perceptions of stakeholders or actors in natural resources management is commonly reported, with differences in social factors being the most prominent reasons (Ogra, 2008; Dickman, 2010; King and Peralvo, 2010; Gore and Kahler, 2012; König et al., 2020; Hebinck, 2021). It is, therefore, important to include or consider views or perceptions of different stakeholders, in order to assure success in conservation programs or projects (Knapp et al., 2014; Villamor et al., 2014). The results of this study also highlight that post-release monitoring is critical to understanding the performance of the species in the new environment (Bubac et al., 2019), and why they may adapt well or poorly. Monitoring of eland in Nyae Nyae Conservancy post-release, through established methods such as live or radio tracking, would have contributed data on their establishment, distribution and changes in population sizes.

While there was little evidence found suggesting predation was a negative factor on the eland translocation outcomes, Nyae Nyae Conservancy is characterized by the presence of several predator species such as spotted and brown hyena, wild dogs, leopard, lion, cheetah, caracal, and jackal species (Mendelsohn and El Obeid, 2002; MEFT/NACSO, 2018). This conservancy was among the first conservancies in Namibia to introduce local monitoring of wildlife parameters using the event-book system carried out by the local Rangers (Stuart-Hill et al., 2005). The interviews with government, NGO and conservancy officials revealed a programme implemented to remove some predators from the conservancy to reduce the impact of predation on the ungulate species, a strategy viewed as necessary based on records of predation (of species other than eland) in the event book monitoring system. One of the common characteristics of an ungulate population is to develop natural predator avoidance behaviors (Griffin et al., 2000; Skinner and Chimimba, 2005). However, this is only possible if the ungulate population has good knowledge of the habitat through long-term interaction with a

particular area, which is not the case with newly translocated individuals (Griffin et al., 2000). Thus, eland may have been at higher risk of predation shortly after their release, when they were unfamiliar with the new habitat.

Although conservancy residents were divided in their opinion about the influence of human settlements on the translocated eland, external stakeholders were concerned about the level of interaction with wildlife areas by the residents of the conservancy, via the burning of grassland and woodlands, which was thought to cause disturbances among the translocated species. Both historical and more recent evidence suggests that where there are free-roaming eland populations in Namibia, South Africa and Tanzania, these populations have declined as a result of human activities (Underwood, 1981; Watson and Owen-Smith, 2000; Jessen et al., 2004; Harris et al., 2009; Waltert et al., 2009), in particular by disrupting the species' natural activities, such as breeding and foraging (Bolger et al., 2008).

While conservancy residents light fires during hunting or for other forest uses, these fires typically only cover small patches, though external stakeholders expressed concern about the impact of these fires on translocated species. During the dry season, the fuel load is often high and dry, which may enhance the spread of fires, making them uncontrollable. It should also be noted that while many African societies use veld fires as a traditional habitat management tool to manage the vegetation structure and also as part of hunting activities, this is often done with limited destruction to the environment (Nyamadzawo et al., 2013).

Of all of the factors likely to affect translocation outcomes, the greatest variance in the views of different stakeholders was about the hunting of eland in the conservancy. While hunting remains an important livelihood activity among conservancy residents, the model of allowing household level hunting decisions and self-reporting of hunted animals does create challenges for accurately monitoring the offtake of species. The eland is a very sensitive species to human activities, and the fright response can cause animals to travel long distances away from disturbances, reducing the opportunity for community members to benefit from them (Verlinden, 1998; Harris et al., 2009; Crosmary et al., 2012). In the context of this study, attempts to hunt the eland by the locals may have driven the species away, fleeing from such interactions to habitats farther away.

All external stakeholders and conservancy leadership perceived subsistence hunting to have a negative effect on translocated species, and there is some evidence that eland is targeted by hunters (Buijs et al., 2016), but it should also be recognized that there is a tendency among conservationists to believe that indigenous people are involved in overhunting, poaching and non-sustainable economic activities (Hitchcock et al., 2020). While the residents claimed not to have hunted any eland as it is prohibited by the conservancy, they did not shy away from the recognition that eland is very important to their culture. Hunting by local people is not unique in the Nyae Nyae conservancy but has been viewed in other conservancies as an important livelihood activity contributing to food security (Koot, 2019; Lubilo and Hebinck, 2019).

CONCLUSION

Community members' perceptions could not confirm that the translocated eland decreased or increased, however, reflected that eland individuals have moved away from the release site soon after translocation to more distant locations farther away from human settlements. The results further show that stakeholders' perceptions that the outcome of eland translocations into the Nyae Nyae Conservancy were more strongly associated with anthropogenic factors than with habitat or environmental factors. However, additional research is needed to determine whether the eland failed to survive or whether the translocated individuals simply migrated from the release area to more remote parts of the conservancy or to the neighboring Khaudum National Park. While this migration would technically suggest that the translocation was a failure, the apparent survival of the individuals is clearly a more positive outcome than a translocation failure involving the death of the translocated individuals.

This paper, in which we describe a series of translocations of wildlife into community conservation areas, not a state protected area, illustrates the additional complexities associated with such translocations. These results highlight the importance, in such contexts, of understanding of the social factors influencing the success, or otherwise, of translocations (especially given that ungulate translocations are more likely to succeed when human activities are absent or limited), and how and why translocated individuals may adapt well or poorly to their new environment. Building this understanding is essential to improving the outcomes of similar translocations in the future.

Hunting emerged as the most contentious of the anthropogenic factors affecting the translocation outcomes, with the widest range of views held by different stakeholders. Although there is little evidence of conservancy members hunting eland, there was a strong feeling from external stakeholders that subsistence hunting was likely to have posed a threat to the species translocated into the conservancy, including eland, with hunting disturbances encouraging them to move away from their release site. The accurate monitoring of subsistence hunting by households is difficult and is likely to only be improved with better engagement, trust and knowledge of conservancy activities amongst residents, such as its purpose, benefits derived, and the sense of ownership.

Strengthening collaboration between the community and the MEFT, NGOs and other stakeholders to work together more productively in an ongoing process will be necessary to improve understanding of the game count data and wildlife movements, of the outcomes of translocations, and of other game management activities. If this can be achieved, and these collaborations are based on appropriate respect for all knowledge and knowledge types, such striving for a common understanding and one voice has the potential to improve any future translocation outcomes.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ministry of Environment, Forestry and Tourism Research Permit. The participants provided their verbal informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

SL and JM developed the original idea and designed the study. SL conducted field data collection and analysis. SL, HS, and JM wrote and edited the manuscript. All authors gave final approval for publication and agreed to be held accountable for the work performed therein.

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Assessment of leopard translocations in South Africa

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Translocations are commonly employed to mitigate human–carnivore conflict but rarely evaluated, resulting in conflicting reports of success, particularly for leopards (*Panthera pardus*). We evaluate the status of available leopard translocation data, the factors driving the intentional removal of leopards, and the potential causal factors associated with successful and failed translocation events. We obtained data on 60 leopard translocation events across five provinces in South Africa between 1994 and 2021. We considered a successful translocation outcome when (1) the animal was moved outside of its original home range, (2) the animal established a new home range away from the capture site, (3) no substantive livestock losses were linked to the translocated animal in the post-release monitoring period, and (4) the animal survived at least 6 months post-translocation. If mortality occurred due to factors that were equally likely to impact resident individuals and were unrelated to the translocation event (*e.g.*, poaching), the event was not considered a failed effort. Most translocations were the result of human–carnivore conflict (HCC; 82%, n = 49), stressing the high prevalence of HCC and the importance of advocating preventative conflict mitigation efforts to conserve leopards. The leopards were moved distances from 2.5 to 196.3 km (63.3 ± 51.7km). Forty (67%) translocation events had unknown outcomes, indicating the limited data available on translocation outcomes. This also indicates the disparity in the objectives of translocations by various entities involved with translocations and suggests that monitoring be a prerequisite for future translocations. Twenty events offered reliable outcomes by means of post-event monitoring, with seven (12%) considered successful, with three (5%) as failures, and with four (7%) not moved beyond their original home ranges, while six (8%) ended in unrelated deaths. The failed events were attributed to inter/intra-specific competition, and one animal returned to its original home range after a translocation distance of 68 km. Translocation success was strongly explained by translocation distance. We found that

damage-causing leopards were successfully translocated under specific conditions, and longer translocation distances increase success. Translocations are commonly employed but are still poorly monitored. We discuss basic standardized protocols to improve future leopard translocations (including pre- and post-monitoring) while advocating alternative non-lethal practices to reduce the prevalence of human–carnivore conflict.

KEYWORDS

carnivore conservation, damage-causing animal, human–carnivore conflict, leopard, *Panthera pardus*, translocation, conservation management

Introduction

Mitigating human–carnivore conflict (HCC) by balancing often-contradictory human interests and species conservation needs is key to conserving biodiversity (Inskip and Zimmermann, 2009; Seoraj-Pillai and Pillay, 2017; Pooley et al., 2021; Consorte-McCrea et al., 2022). Lethal interventions used to control predator species are largely ineffective at reducing livestock depredation and are increasingly considered inhumane (McManus et al., 2015; Treves et al., 2016; Moreira-Arce et al., 2018; Lorand et al., 2022). Furthermore, lethal interventions have been shown to negatively impact carnivore populations by disturbing their social structure through the loss of breeding individuals, promoting mesopredator release (Stahl et al., 2001; Teichman et al., 2016), or increasing infanticide (Steyaert et al., 2012; Teichman et al., 2016). To address these problems, alternative non-lethal tools have been tested. The employment of guarding animals, herdsmen, barrier methods (*e.g.*, electric fences and protective livestock collars), and other deterrents (*e.g.*, auditory, visual, and olfactory) in livestock husbandry significantly decreases livestock losses due to predation (Rust et al., 2013; McManus et al., 2015; Treves et al., 2016; Moreira-Arce et al., 2018; Khorozyan and Waltert, 2021; Lorand et al., 2022). Translocation is an additional HCC mitigation tool and is considered a humane alternative to killing damage-causing animals (DCA; *i.e.*, habitual livestock killer or an animal that poses a threat to human safety), particularly for vulnerable species (Fontúrbel and Simonetti, 2011; Treves et al., 2016; Moreira-Arce et al., 2018; Berger-Tal et al., 2020). However, translocations can be controversial, with conflicting reports of success (Athreya et al., 2011; Fontúrbel and Simonetti, 2011; Berger-Tal et al., 2020; Lorand et al., 2022).

A variety of carnivore species have been successfully translocated, including DCA (Goodrich and Miquelle, 2005; Fontúrbel and Simonetti, 2011; Weise et al., 2015b; Bauder et al., 2021; Stenhouse et al., 2022)—for example, in Wisconsin, USA, 86% of black bear (*Ursus americanus*) translocations were considered successful when the animals had established home ranges, and no evidence of mortality was found after the translocation (Bauder et al., 2020). In gray wolves (*Canis lupus*), 80% of the translocated animals stayed at the release areas in northwestern USA (Bradley et al., 2005). In addition, translocations can help reinforce genetic diversity among populations where landscapes are fragmented and the connectivity of extant population genetics is low (Johnson et al., 2010; Tensen et al., 2019; Miller et al., 2020). Translocations have also been used to reintroduce species previously extirpated from their historical range (Clark et al., 2002; Mowry et al., 2015; Mueller et al., 2020). However, for large felids, translocation attempts are sometimes considered problematic, either because the animal returned to their capture site, died prematurely, or contributed to HCC (Athreya et al., 2011; Houser et al., 2011; Morapedi et al., 2021).

Apex carnivores, such as leopards (*Panthera pardus*), have large spatial requirements and can exist in diverse environments where they can occur at various densities depending on resource availability and HCC (Bailey, 1993; Hunter et al., 2013; Ripple et al., 2014; Devens et al., 2018; Devens et al., 2021). Their wide-range behavior increases the interface with anthropogenic landscapes, reducing their survival. Habitat loss and fragmentation, pray depletion, conflicts with livestock or game owners, edge effects, and poorly managed hunting practices contribute to the significant decline of leopard populations in Asia and Africa (Swanepoel et al., 2013; Jacobson et al., 2016; Swanepoel et al., 2016). With merely 25% of their historic distribution remaining (Jacobson et al., 2016), leopards are listed as vulnerable by the IUCN Red List (Stein et al., 2020). In South Africa, most leopard habitats exist outside of protected areas, where HCC is high (Swanepoel et al., 2013; McManus et al., 2021; McManus et al., 2022). The lack of connectivity between isolated, low-density populations of South Africa's Eastern and Western Cape provinces contributes to reduced gene flow (McManus et al., 2014; Devens et al., 2018; Mann et al., 2020; Devens et al., 2021; Müller et al., 2022).

Although leopards are commonly translocated as a management tool to mitigate HCC or as a conservation strategy to restore genetic diversity in isolated populations (Mondal et al., 2013; Briers-Louw et al., 2019), the acrimony

towards leopards in livestock production landscapes and legislative controls make leopard translocations controversial. As a result, many translocations have taken place in a clandestine manner, adding to the unreported nature of these interventions and the lack of monitoring to evaluate translocation outcomes. The divergent anecdotal reports and conflicting literature make translocations an important topic to better understand the potential as a mitigation tool to conflict and species management (Hayward et al., 2006; Weilenmann et al., 2010; Weise et al., 2015a; Power et al., 2021). Since most studies focused on local to regional extents (Hayward et al., 2006; Weilenmann et al., 2010; Power et al., 2021), with only one national (Weise et al., 2015a), we attempted to upscale to the whole of South Africa and considered the contribution of multiple agencies, whether private, non-government (NGO), or government. This study evaluated (1) the availability of leopard translocation data in South Africa, (2) the contexts and mechanisms driving the intentional removal of leopards, (3) three potential factors associated with successful and failed leopard translocation events, and (4) recommendations towards standardized pre- and post-translocation efforts to encourage an evidence-driven approach for future leopard translocations.

Materials and methods

Definitions

We defined a successful translocation event to include four criteria. First, the leopard displayed a home range stabilization behavior away from the site of capture (Weise et al., 2015a). Therefore, if the animal was moved and relocated within its original home range, it was considered a relocation (Power et al., 2021). Second, success was also evaluated on the survival of the individual (Weise et al., 2015a; Briers-Louw et al., 2019; Power et al., 2021). If mortality was a direct result of the translocation effort, such as intra- or inter-specific competition within 6 months post-translocation, it was considered a failed translocation. However, if mortality occurred after 6 months or was unrelated to the translocation effort (*i.e.*, poaching and natural causes), it was considered a non-translocation-related death (unrelated death). This assumes that the individual is more vulnerable in the months following the translocation event. Finally, if habitual livestock losses were linked to the translocated individual within the first 6 months post-release, it was considered a failure. Where post-translocation monitoring through collaring failed early on, as unreliable technology of animal tracking does demonstrate on occasions, the outcome was listed as unknown.

Data collection

We obtained two types of data for analyses: first, metadata from South African governmental departments, parastatals, NGOs, and private entities relating to any intentional movement of leopard in their jurisdiction or part of their efforts as far back as records were available and, second, we obtained post-monitoring GPS data from 13 translocation events from leopards that were captured, collared, and translocated.

Metadata

The metadata included information on the individuals' demographics, capture location, reason for capture, release site, type of release (soft or hard release), and if monitoring efforts pre- and post-release were employed. We included all translocation events when individuals were considered DCA (known or perceived) and rescue events (*i.e.*, reported as non-target captures where landowners would otherwise kill the animal). We did not consider orphaned animals, confiscated animals (from illegal trade), or any captive-held sourced animals in this study, as the conditions regarding the translocation were different in that these cases involved animals from unknown locations and were placed in captivity for some period (Power et al., 2021).

Leopard management is governed by South Africa's National Environmental Management: Biodiversity Act (Act 10 of 2004), Threatened or Protected Species Regulations, as well as provincial legislation. Currently, there are no overarching national or provincial policies on leopard management nor leopard translocations in South Africa. Each province is governed by a relevant statutory conservation body with varying approaches dealing with HCC incidences and the translocation of DCA incidents. In all events, the animals were translocated under the regulatory oversight and direction of the relevant statutory conservation agency in each province.

GPS data

Leopards were captured using walk-in, fall-door cages specifically designed by local conservation authorities to capture leopards with least risk of injury to individuals. In some cases, animals were rescued from devices set due to HCC and poaching, including leg-hold traps (gin-traps) and wire snares. None of the animals suffered severe injuries in the cages; however, two rescued individuals (Table 1) suffered toe amputations due to gin-trap devices. Once an animal was captured, it was immobilized by a veterinarian using a drug combination of zoletol-medetomidine at a standard dosage (1 to 2 mg/kg) or ketamine (4–6 mg/kg) with xylazine (1 to 2 mg/kg). The animal was immobilized for approximately 60 min before the reversal drug was administered. During the immobilization, the animal was fitted with a tracking collar (African Wildlife Tracking Pretoria, South Africa; Hotgroup, Pretoria, South Africa; Tellus, Lindesberg, Sweden; or Vectronics-aerospace,

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TABLE 1 Biological and technical details relevant to the 60 translocation events across South Africa.

Number	Parties	Leopard age and sex	History	Tracking device (brand)	Capture date	Province	Protected capture site	Translocated distance (km)	Days in boma	Post-release survey effort	Outcome
1	PW	AM*	DCA	GPS (African Wildlife Tracking, AWT)	Jan-15	NW	No	37.0	17	Yes	Failure
2	COT	AF	DCA	GPS (AWT)	Jun-18	LP	No	81.0	0	Yes	Failure
3	LF	AM*	DCA	GPS (Tellus)	Apr-20	WC	No	68.0	0	Yes	Failure
4	PW	AF*	DCA	GPS (AWT)	Aug-15	NW	No	8.0	0	Yes	Relocation
5	LF	AM*	DCA/ rescued	GPS (AWT)	Sep-17	EC	No	18.0	0	Yes	Relocation
6	CN	AM	DCA	Camera traps	Apr-19	WC	No	7.8	0	Yes	Relocation
7	LF	AM*	DCA/ rescued	GPS (Tellus)	Feb-20	WC	No	5.4	0	Yes	Relocation
8	LF	AM	DCA	VHF	Apr-04	EC	No	150.0	0	Yes	Success
9	CN	AF	DCA	GPS (AWT) + camera traps	Apr-04	WC	No	133.8	0	Yes	Success
10	FP	UM	DCA	VHF	Jan-05	EC	No	161.2	0	Yes	Success
11	LF	AF	DCA	Field obs.	Apr-06	EC	No	153.0	0	No	Success
12	LF	AM*	DCA	GPS (Vectronics)	Dec-06	EC	No	93.0	0	Yes	Success
13	PW	AF*	DCA	GPS (AWT)	Sep-19	NW	No	88.0	0	Yes	Success
14	LF	AM*	DCA	GPS (Tellus)	Jul-21	WC	No	196.3	0	No	Success
15	CN	AF	DCA	–	Aug-94	WC	No	52.9	0	No	Unknown
16	CN	SF	DCA	–	May-05	WC	No	120.0	0	No	Unknown
17	CN	AM	DCA	–	Apr-06	WC	No	44.8	0	No	Unknown
18	CN	AM	DCA	Camera traps	Aug-06	WC	No	85.0	0	Yes	Unknown
19	LF	SM	DCA/ rescued	–	Aug-07	EC	No	92.0	0	No	Unknown
20	LF	SF	DCA/ rescued	–	Sep-07	EC	No	57.0	0	No	Unknown
21	LF	AF*	DCA/ rescued	GPS (Hotgroup)	Sep-07	EC	No	91.0	0	Collar failure	Unknown
22	LF	AF	DCA/ rescued	–	Oct-07	EC	No	67.0	0	No	Unknown
23	FP	UM	DCA	–	Nov-07	EC	No	150.0	0	No	Unknown
24	LF	AM	DCA/ rescued	GPS (Vectronics)	Apr-08	EC	No	35.0	0	Collar failure	Unknown
25	SANP	AM	Unknown	–	Sep-10	MP	Yes		0	No	Unknown
26	FP	UM	DCA/ rescued	VHF	Apr-13	EC	No	51.0	0	Yes	Unknown
27	FP	UF	Unknown	–	Jun-14	EC	Unknown		3	No	Unknown
28	SANP	AF	Unknown	–	Jul-14	MP	Yes		0	No	Unknown
29	FP	UM	Unknown	–	Mar-15	EC	No	101.2	0	No	Unknown
30	CN	AM	DCA	–	Mar-15	WC	No	19.2	0	No	Unknown
31	CN	AM	DCA	–	Apr-15	WC	No	2.5	0	No	Unknown
32	CN	Unknown	DCA/ rescued	–	Sep-15	WC	No	9.1	0	No	Unknown
33	CN	Unknown	DCA	–	Dec-15	WC	No	26.2	0	No	Unknown
34	SANP	AM	Unknown	–	Jun-16	MP	Yes	30.3	0	No	Unknown
35	COT	AM	DCA	–	Jul-16	LP	No	66.0	0	No	Unknown

(Continued)

TABLE 1 Continued

Number	Parties	Leopard age and sex	History	Tracking device (brand)	Capture date	Province	Protected capture site	Translocated distance (km)	Days in boma	Post-release survey effort	Outcome
36	CN	AF	DCA	–	Jul-16	WC	No	37.8	0	No	Unknown
37	CN	SF	DCA	–	Mar-17	WC	No	123.0	0	No	Unknown
38	COT	AM	DCA	–	Apr-17	LP	No	3.0	0	No	Unknown
39	SANP	AF	DCA	–	Jun-17	MP	Yes	89.4	0	No	Unknown
40	COT	AF	DCA	–	Jul-17	LP	No	16.0	0	No	Unknown
41	COT	SF	DCA	–	Jul-17	LP	No	16.0	0	No	Unknown
42	CN	AM	DCA	–	Feb-18	WC	No	14.8	0	No	Unknown
43	CN	AF	Unknown	–	Mar-18	WC	No	3.6	0	No	Unknown
44	CN	AF	DCA/ rescued	–	Nov-18	WC	No	6.9	0	No	Unknown
45	CN	AM	DCA	–	Mar-19	WC	No	9.7	0	No	Unknown
46	CN	AM	DCA/ rescued	–	May-19	WC	No	6.9	0	No	Unknown
47	SANP	SA	DCA	–	Aug-20	MP	Yes	20.9	0	No	Unknown
48	SANP	Unknown	Unknown	–	Aug-20	MP	Yes		0	No	Unknown
49	SANP	Unknown	Unknown	–	Aug-20	MP	Yes		0	No	Unknown
50	SGM	AF	DCA	GPS (AWT)	Aug-20	WC	No	65.0	0	Yes	Unknown
51	AGM	AM	DCA	GPS (Vectronics)	May-21	WC	No	64.6	0	Yes	Unknown
52	COT	AM	DCA - game	–	Jul-21	LP	No	120.0	0	No	Unknown
53	COT	AF	DCA - game	–	Jul-21	LP	No	26.2	0	No	Unknown
54	COT	AF	DCA - game	–	Oct-21	LP	No	30.0	0	No	Unknown
55	LF	AF	DCA/ rescued	GPS (AWT)	Jan-14	EC	No	51.0	180	Yes	Unrelated_Death
56	PW	AM*	DCA	GPS (AWT)	Sep-15	NW	No	33.0	26	Yes	Unrelated_Death
57	PW	AF	DCA	GPS (AWT)	Jun-16	NW	No	194.0	133	Yes	Unrelated_Death
58	LF	AM*	DCA/ rescued	GPS (AWT)	Apr-18	EC	No	80.5	0	Yes	Unrelated_Death
59	PW	AM*	DCA	GPS (AWT)	Aug-18	NW	No	102.0	0	Yes	Unrelated_Death
60	PW	AM*	DCA	GPS (AWT)	Sep-21	NW	No	68.0	0	Yes	Unrelated_Death

LF, Landmark Foundation; CN, CapeNature; COT, Cheetah Outreach Trust; FP, Frontier Parks; SANP, South African National Parks; AGM, Amakhala Game Reserve; SGM, Shamwari Game Reserve; PW, Power et al., 2021; EC, Eastern Cape; LP, Limpopo; MP, Mpumalanga; NW, northwest; WC, Western Cape; AM, adult male; UM, unknown age of male; AF, adult female; UF, unknown age of female; SM, subadult male; SF, subadult female (age category definition based on Power et al., 2021); DCA, damage-causing animal; Unknown, information not provided.

Berlin, Germany; Table 1). The collars recorded location data between four and six hourly intervals. We used these tracks to evaluate home range stabilization. All statistical analysis were conducted in the R environment, version 4.1.2 (R Core Team, 2021), using the R Studio interface (R Studio 2021, Boston, MA, U.S.A.). We evaluated home range stabilization using the continuous-time movement modeling "ctmm" package (Calabrese et al., 2016; Fleming and Calabrese, 2016). We plotted semivariograms to establish if translocated leopards displayed home range stabilization behavior. Semivariograms plot the variance in GPS locations as a function of the time lag between locations (Noonan et al., 2019). Stabilization in a home range establishment was a factor of reaching the asymptotic smoothing of semi-variance. Finally, we tested if the outcome of the translocation (*i.e.*, success or failure) was correlated to the distance the animals were moved, using a simple regression model. Prior to the analysis, we visually inspected the normality of the residuals and the homogeneity of the variance.

Translocation costs

We obtained information relating to the cost of translocation events from the first-hand capture and translocation events, where costs were known. Costs included veterinary, staff, travel, tracking collar, and satellite data transfer costs.

Results

Metadata: Leopard translocation events

We obtained information on 60 translocation and relocation events that took place between April 1994 and December 2021 from five provinces in South Africa (Eastern Cape, n = 18; Limpopo, n = 10; Mpumalanga, n = 5; Northwest Province, n = 7; and Western Cape, n = 20; Table 1; Figure 1). Most original capture sites of leopards were located outside formal protected areas, except in five cases (n = 5) in Kruger National Park where animals were removed *via* cage traps and one (n = 1) instance where the animal was caught in a gin-trap along the boundary of the Greater Addo Elephant National Park (Table 1). All release sites occurred within protected areas (*i.e.*, national park, provincial nature reserve, or eco-tourism-based private game reserve) based on habitat suitability for leopards (*e.g.*, slope, terrain, vegetation type: Gavashelishvili and Lukarevskiy, 2008; McManus et al., 2022) and land uses considered to have a reduced likelihood of HCC.

Overall, the mean Euclidian distance leopards were moved was 63.3 ± 51.7 km (range, 2.5–196.3 km). In the Limpopo, Mpumalanga, and Western Cape provinces, leopards were moved similar distances on average (44.8, 46.9, and 50.2 km, respectively), while in the North West and Eastern Cape provinces, leopards were moved farthest on average (75.7 and 90.1 km, respectively).

Forty-five (75%) of the translocation events included adult leopards (19 female and 26 male), six (10%) of which were sub-adults (5 female and 1 male), and age category was unknown in nine cases (15%). Overall, 25 (42%) female leopards and 31 (52%) male leopards were translocated, while in four (7%) cases, the sex or age category of the animals was not reported.

Of the 60 events, 49 (82%) were reported to be associated with perceived or known DCA incidents. Of these, leopard killed game animals that made up natural prey in three instances but were reported as DCAs due to the hunting value of the game. In eight events (13%), the reason for the animal being moved was unknown. Of the 60 events, 36 (60%) events had no pre- or post-monitoring efforts. Overall, 40 (67%) cases resulted in unknown outcomes (collar failure, no information provided, and no/unsuccessful post-monitoring), seven (12%) were considered successful, three (5%) failed, and four (7%) were relocation events (short distance relocations: 5.4–18 km), resulting in these animals being released within their original home ranges—therefore, the individuals were not translocated away from the site of capture—and six (10%) ended in unrelated deaths (Table 1).

The probability of a successful translocation increased as a result of translocation distance (β = 139; r^2 = 0.51, t = 3.2, p = 0.01), and failed outcomes were also strongly correlated to distance (β = 62; t = 3.1, p = 0.02) (Figure 2).

Leopard movement post-translocation from GPS collar data

From the 22 leopards fitted with tracking collars (Table 1), location data was available for 13 of these events (3 female and 10 male, Table 2). This discrepancy is due to some collars being audio-tracking devices that do not store GPS data or, in some cases, GPS-capable collars that failed, or there were limitations in acquiring the GPS data from various entities.

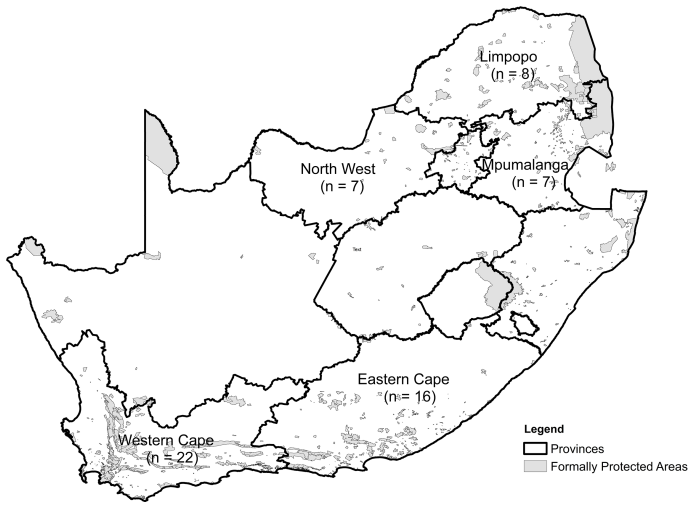

FIGURE 1
Distribution of reported translocated leopards within five provinces in South Africa.

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Leopard identities L111 and L2344 were the same male moved on two unrelated occasions (18 and 80.5 km, respectively), and leopard L6849 and L6897 were the same male moved 68 and 196 km on two unrelated occasions, respectively (Table 2). These two individuals were moved due to consistent damage caused to livestock and would otherwise have been killed. All post-release monitored leopards were reported as DCAs. We analyzed each translocation event separately.

Leopard L111 was first moved a short distance (18 km) within its original home range (Figure 3) and continued to predate on livestock. L111 was later captured and re-collared as L2344 where it was translocated outside of its original home range (80.5 km) but was killed 16 days post-translocation *via* poaching and died prematurely in a gin-trap set along the boundary of a formally protected area (the Greater Addo Elephant National Park; Table 2). Similarly, LM14 and LM17 were translocated and died *via* poaching (wire snare and unrelated death) after 13 and 87 days post-translocation, respectively (Table 2). Leopard LM07 (moved 8 km) and L6773 (moved 5.4 km) were relocated within their respective original home range where LM07 survived and L6773 died of natural causes 148 days after the relocation event. Leopard L6849 was translocated outside of its original home range (68 km) but returned to its original home range approximately 5 weeks post-release (Figure 3) and continued to cause livestock damage, resulting in a failed translocation (Table 2). The collar of leopard L1038 malfunctioned (20 days post-translocation), resulting in an unknown outcome. L2996, L6897, and LF16 displayed home range stabilization (Table 2; Figure 3), and no livestock losses were associated post-release, resulting in successful translocation events. LM06 and LM08 were translocated outside of their original home ranges, and home range stabilization was reached, but both died *via* intraspecific competition at 86 and 188 days post-translocation, respectively. Home range stabilization occurred within 3 months for six individuals (Figure 3).

Translocation costs

We used information on 7 translocation events where specific costs were known to infer the costs of translocation events (see also Weise et al., 2014; Power et al., 2021). For each event, tracking collars used to monitor leopards cost 3,400 USD, veterinarian cost varied between 300 and 1,000 USD, travel and accommodation cost 500 USD, and satellite data cost 400 USD per collar. On average, each individual cost 4,700 USD to be translocated.

Discussion

Translocation is a commonly employed management tool to mitigate HCC (Fontúrbel and Simonetti, 2011). While increased scientific evaluations of translocations have been undertaken in the African context (see Weise et al., 2015a; Briers-Louw et al., 2019; Power et al., 2021), sampling remains low, especially for wild felids. This continues to limit our understanding of translocations. In efforts to contribute to these samples and

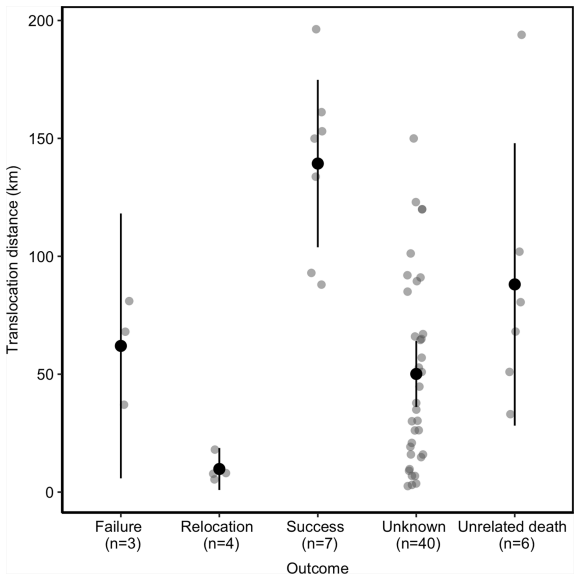

FIGURE 2
Outcome of translocated leopards in relation to the distance moved, with the average distance and 95% confidence interval.

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TABLE 2 Details of post-release monitoring of 13 translocated leopards fitted with tracking collars.

Collar ID	Sex	Start	End	Days monitored	Distance translocated (km)	Home range stabilization	Livestock depredation	Outcome
LM06	M	26-Jan-15	22-Apr-15	86	37	Yes	No	Failure: killed *via* intraspecific competition <6 months
L6849b	M	18-Apr-20	29-Jun-20	72	68	No	Yes	Failure: returned to home range
L111a	M	08-Sep-17	07-Apr-18	211	18	Yes	Yes	Relocation event
L6773	M	21-Feb-20	18-Jul-20	148	5.4	Yes	No	Relocation event
LF07	F	05-Aug-15	17-Aug-16	378	8	Yes	No	Relocation event
L2996	M	08-Dec-06	14-Dec-07	371	93	Yes	No	Successful
L6897b	M	05-Jun-21	21-Jan-22	230	196	Yes	No	Successful
LF16	F	07-Sep-19	05-Apr-20	211	88	Yes	No	Successful
L1038	F	29-Sep-07	29-Oct-07	30	91	No	No	Unknown: collar failed
L2344a	M	08-Apr-18	24-Apr-18	16	80.5	No	No	Unrelated death: killed *via* poaching/HCC (gin-trap)
LM08	M	02-Oct-15	07-Apr-16	188	33	Yes	No	Unrelated death: killed *via* intraspecific competition >6 months
LM14	M	28-Aug-18	10-Sep-18	13	102	Yes	No	Unrelated death: killed *via* poaching (wire snare)
LM17	M	15-Sep-21	11-Dec-21	87	68	Yes	No	Unrelated death: killed *via* poaching (wire snare)

better understand the nuances of translocation as a management tool, we assessed data from 60 translocation events obtained from various conservation entities from five South African provinces.

While not all reported DCAs were confirmed to be occasional or habitual culprits, most translocation events (82%) were attributed to DCAs because of known or perceived livestock depredation. Conflicting reports of successfully translocating DCAs exist, with some studies suggesting that damage-causing leopards are not suitable to be translocated because the animals returned to their original site of capture and continued to cause damage around the release site (Weilenmann et al., 2010; Athreya et al., 2011; Power et al., 2021), while other studies showed success (Hayward et al., 2006; Weise et al., 2015a; Briers-Louw et al., 2019). This can be related to variations on how success is gauged (Weilenmann et al., 2010; Briers-Louw et al., 2019; Power et al., 2021). Our definition was similar to the one of Weise et al. (2015a), where a leopard (1) is moved outside of its original home range, (2) can establish a home range anywhere away from the original home range, (3) does not contribute substantively to livestock depredation, and (4) survives at least 6 months post-translocation. The seven translocation events considered successes in our study were DCAs, which support findings that DCA can be successfully translocated under specific conditions (Hayward et al., 2006; Weise et al., 2015a; Briers-Louw et al., 2019). Of the relocated animals (moved within their home ranges), two continued to contribute to livestock losses and were ultimately recaptured and translocated to farther distances. We found that translocation success was significantly correlated to the distance the animals were moved. This supports results from other studies where translocations were successful when animals were translocated to farther distances, including leopards (Weise et al., 2015a; Briers-Louw et al., 2019), foxes (*Vulpes arabica* and *V. ruppelli sabea*: Lenain and Warrington, 2001), gray wolves (Bradley et al., 2005), black bears (Landriault et al., 2009; Bauder et al., 2020), and grizzly bears (*Ursus arctos*: Milligan et al., 2018). We report on a small sample size; however, the failed events (n = 3) were statistically inversely correlated to the distance moved, and relocating wide-range species over short distances often resulted in the animal being replaced within its original range (n = 4). One failed event included a male leopard that re-homed 5 weeks after a 68-km translocation distance. Therefore, the wide-range nature of leopards contributes to the outcome of

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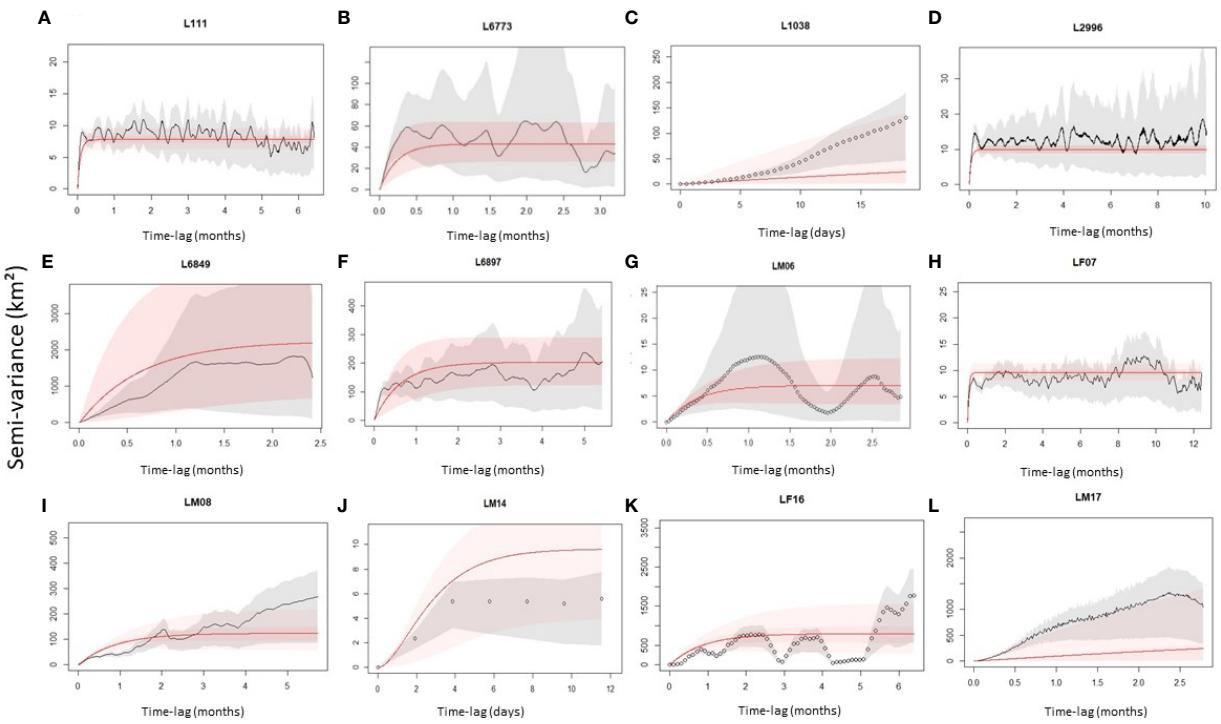

FIGURE 3
Variograms of translocated leopard home range stabilization regimes **(A–L)**. The gray shading indicates pointwise 95% CI, and the red shading represents fitted model 95% CI to indicate home range stabilization. Leopards A, B and H home ranges stabilized; however, these were considered relocated individuals moved within their home ranges. Leopards C, E and J indicates non-stabilization. Leopards D, F, G, I, K, and L indicate stabilization at different locations to their original home ranges.

translocations. This is relevant to the home range sizes of leopards which vary greatly across various bio-regions, depending on pray resources, land cover types, topography, and social structures, with some leopards requiring small home ranges of <20 km², while others require >1,000 km² (*e.g.*, le Roux and Skinner, 1989; Bailey, 1993; Mondal et al., 2013; Weise et al., 2015a; Devens et al., 2018; Müller et al., 2022). As such, regional variations of leopard spatial requirements should be considered when planning an appropriate translocation distance. Some authors have recommended moving leopards at least 200 km from the capture site to prevent capture site fidelity and homing instinct (Weise et al., 2015a; Briers-Louw et al., 2019). It would seem prudent to lean towards developing translocation distances of greater than four diameters of the regionally known localized leopard home ranges—for instance, based on the leopard home range size in the southern provinces of South Africa (Devens et al., 2018; Müller et al., 2022), our findings support the consideration of translocation distances between 200 and 400 km in these provinces.

The definition of translocation success or failure rarely include the impact on source and receiving populations (but see Weise et al., 2015a). Translocations could be a detriment to leopard populations if poorly implemented, such as releasing individuals into a high-density area (*e.g.*, Hamilton, 1981; Athreya et al., 2011; Lorand et al., 2022). Weise et al. (2015a) mitigated these challenges and demonstrated success in the repeated release of individuals into the same geographic region by releasing individuals into a receiving population with low to moderate densities of conspecifics and by ensuring at least 6 months of inter-release period for individuals to assimilate the additional leopards. Further considerations should include the asymmetrical dispersal behavior of leopards, whereby male individuals are primarily the dispersing sex, moving vast distances compared to female leopards (Fattebert et al., 2013; Elbroch et al., 2016; Sunquist and Sunquist, 2017; Müller et al., 2022). Female individuals are generally philopatric and influence the local structure of populations and their dynamics (Elbroch et al., 2016; McManus et al., 2021). The removal of female leopards from a system could cause far-reaching changes in the structure of the population (Elbroch et al., 2016; McManus et al., 2021). Almost half (42%) of the reported translocations were those of female leopards, further emphasizing the need to reduce HCC. Furthermore, the removal of established male leopards from a stable population also has disruptive and potentially negative impacts on leopard populations. Adult

male leopards occupy larger home ranges which typically encompass multiple female ones and often a combination of land use types (Balme et al., 2009; Devens et al., 2018; McManus et al., 2021). Territorial and dominant male leopards may keep the younger ones at bay, and the removal of these territorial male individuals from their home range could (1) exacerbate livestock depredations as multiple younger male leopards could compete for the same range (previously occupied by a dominant male; Rabinowitz, 1986), (2) elicit infanticide (Balme et al., 2009; Balme and Hunter, 2013; Fattebert et al., 2015), potentially resulting in population declines (Balme et al., 2009), and (3) lead to inbreeding when off-take is dramatic (Naude et al., 2020). Therefore, sex-related behavioral differences should be considered when translocating animals and particular attention should be made to avoid translocating leopards into areas with saturated leopard populations (Athreya et al., 2011; Weise et al., 2015a).

Leopards in South Africa are part of a single genetic species, *Panthera pardus pardus* (Jacobson et al., 2016), and their wide-range behavior should allow them to interchange genes over vast areas. However, modified landscapes and human-caused mortality impede connectivity among separated populations (McRae et al., 2005; Dutta et al., 2013; Roques et al., 2016; McManus et al., 2022). Such genetic restrictions have been observed in the Eastern and Western Cape provinces where three sub-populations have been identified as with moderate to low gene flow among them (McManus et al., 2014). Low population densities, low gene flow, increased isolation due to loss of habitat, and human-caused mortality are all major conservation concerns that contribute to inbreeding and local population extinctions (Keyghobadi, 2007; Dutta et al., 2013; Ripple et al., 2014; Swanepoel et al., 2016; Lino et al., 2019). The translocation of leopards that would conventionally be culled in DCA scenarios can reduce these threats and have been used to successfully re-establish locally extinct wildlife populations (Clark et al., 2002; Mowry et al., 2015; Briers-Louw et al., 2019; Mueller et al., 2020). This would facilitate gene flow among isolated, low-density, and declining populations, making it an important conservation tool (Johnson et al., 2010; Houser et al., 2011; Tensen et al., 2019; Miller et al., 2020; Morapedi et al., 2021). However, for translocations to contribute constructively to conservation, increased monitoring efforts and improved implementation are key.

Unfortunately, the majority (67%) of translocation events reported in our study had unknown outcomes, largely due to the lack of monitoring efforts—a clear deficiency in the employment of this management intervention. The limitation of evaluating translocations therefore continues, contributing to the challenge of effectively employing these tools in practice (Mills, 1991; Grimbeek, 1992; Athreya et al., 2011; but see Weise et al., 2015a; Power et al., 2021). We echo the need to promote transparency and a structured monitoring approach both before and after the translocation events, of the source and potential resident populations at the release site (Mills, 1991; Hayward et al., 2006; Briers-Louw et al., 2019). However, this may not always be possible for one organization to achieve—for example, the financial cost of translocation can be high (Weise et al., 2014; Power et al., 2021), and resources into monitoring translocated animals might fall outside the scope and budget of conservation bodies. Furthermore, the objectives among stakeholders involved in large carnivore management are often divergent. This misalignment of objectives is an important factor impeding the knowledge of leopard translocation outcomes as was observed in the current study with the high number of unknown outcomes. Therefore, reporting on translocations and promoting transparency and collaborations among stakeholders can improve the monitoring and evaluation efforts of translocations.

We suggest the development of basic standardized operational translocation protocols (see the Box 1) as a starting point to address this challenge. First, the use of non-lethal techniques mitigates HCC by effectively reducing livestock losses, increasing tolerance and co-existence (McManus et al., 2015; Treves et al., 2016; Khorozyan and Waltert, 2021; Boronyak et al., 2022), and should always be advocated for and employed prior to any translocations. Increased tolerance, awareness, and building trust with the local community are key to mitigating HCC (Bennett et al., 2017; Boronyak et al., 2022; Consorte-McCrea et al., 2022). Second, to avoid translocating non-culprit animals, the specific individual should be identified and confirmed to be a DCA (*i.e.*, *via* a camera trap survey, carcass evaluations, and/or GPS tracking). This could be determined using a standard operational guideline on best practice at local governmental scales. Finally, pre- and post-translocation monitoring efforts, including identifying and surveying suitable release sites, and ensuring that materials are available to monitor the animal post-release are required to better understand the drivers of failed or successful translocations (IUCN/SSC, 2013). The use of GPS collars, camera traps, and genetic analyses are required to monitor aspects such as home range stabilization, record mating behavior, population genetic dynamics, and survival (Weise et al., 2015a; Briers-Louw et al., 2019; Power et al., 2021). We found that GPS-tagged leopards displayed home range stabilization within 3 months after a translocation event. Monitoring should take place for as long as possible post-release, recognizing financial, technical, and practical constraints, but at least for a 6-month period to improve the evaluation and success of translocations (Armstrong and Seddon, 2008; Weise et al., 2015a; Briers-Louw et al., 2019; Power et al., 2021).

Furthermore, employing techniques such as soft release using a *boma* infrastructure is considered to promote release site fidelity and reduce the stress of the translocated animal (Linnell et al., 1997; Weise et al., 2015a; Briers-Louw et al., 2019). However, soft releases are not synonymous with translocation

BOX 1 Proposed protocols for leopard translocations.

Conditions required for consideration for the translocation of damage-causing leopards

1. Leopard causes validated, repeated, and regular losses to livestock where several non-lethal mitigation actions have failed.
2. All mitigation measures proposed by conservation authorities have been exhausted.
3. Leopard causes validated, repeated, regular, and excessive losses to wild game or domestic specimens managed in breeding camps, which is inconsistent with the animal's natural behavior and is ecologically or excessively commercially damaging in areas with certificates of adequate enclosures for the species affected.
4. Leopard presents an imminent and realistic threat to human life.

Pre-conditions for translocation to be undertaken

1. Ensuring that the release site is large enough to support leopards in a wild, free-roaming territory.
2. Release site habitat has depleted presence or absent leopard activity, as is reasonably possible to determine, or areas where such releases would be tolerated and provide opportunities for ecological dispersal.
3. Encourage ecologically compatible release site habitat to the original capture site habitat.
4. Receiving habitat has adequate suitable natural prey availability.
5. Release site is considered to have no or very low chance of post-release human–carnivore conflict present.
6. Release site is not surrounded by intensive livestock farming or intensive game breeding camps with rare, very-high-value game which is also natural prey for leopards.
7. Released leopards must be GPS satellite and monitored and form part of a scientific analysis of the efficacy of such translocations.
8. Data on basic morphology, sex of the animal, and reason for translocation should be collected.
9. Genetic analysis of all leopards will be undertaken to understand the genetics of local populations, and best available information must be consulted, i.e., ecotypes, subspecies.
10. Consideration should be given to local institutional arrangements and variations of different leopard conservation imperatives in each region by considering variations in leopard biological responses within their respective areas.

Post-translocation objectives

1. Leopards are not to be habituated or kept captive beyond the release period deemed appropriate by the conservation authorities and veterinarians caring for the animals.
2. Leopards must be GPS satellite-collared and monitored for as long as possible, but at least 6 months post-release, and form part of the scientific analysis of the efficacy of translocations.
3. Preferentially, leopards are to be released into state/or collaborating private protected areas wherefrom they had been extirpated.
4. Private landowners or entities receiving the translocated leopards must be encouraged to contribute towards the costs of translocation, collars, and any costs incurred in monitoring or analysis of the translocation effort.
5. Private protected area entities receiving the leopards must enter a legal contract with the authorities to take all legal and financial responsibility for any damage that may result from the relocated animal.
6. Any subsequent interference with the leopard must be subject to relevant permitting.
7. The entities receiving the leopards will comply with all permit requirements and conditions.
8. Translocated leopards may not be hunted.
9. Entities that want to receive leopards may not canvas for leopards to be labelled as DCA, any such actions will disqualify applicants from participating in translocations.
10. Leopards will be randomly allocated to receiving entities by the authorities if competing private applications exist, but ecological considerations will more than likely be able to discriminate the most suitable release sites.
11. The authorities may elect to serially send opposite sexes sequentially to the same location should attempts be supported to re-establish leopards in former areas of distribution (i.e., reintroduction).

success, as many authors have reported successful translocations using hard releases (Houser et al., 2011; Mondal et al., 2013; Weise et al., 2015a). Translocation efforts are expensive, and these costs increase with soft release efforts (Weise et al., 2014; Power et al., 2021). While our findings indicate that translocation distances of four times the diameter of home ranges (200 – 400km) will likely increase success without soft release efforts, we were unable to test the effect of release type on the likelihood of translocation success due to the small sample size.

Finally, clearly defining criteria of success and failure will improve the comparability among translocation evaluations. Incorporating monitoring efforts on source and receiving populations can reduce the dangers of translocation (Weise et al., 2015a). In addition to the parameters considered in our study (*i.e.*, stabilization of home range, survival, and no livestock depredation at the release site), reproductive success was previously considered a barometer of translocation success (Weise et al., 2015a; Power et al., 2021). However, this requires a long post-monitoring survey (1 to 2 years) and is not always possible for practical, financial, and technical reasons. Importantly, there is a need for reporting the findings of all translocation attempts, as these findings, along with other scientific literature, would probably improve the success rates. The lack of transparency hinders the efforts to understand the scope of the problem, reduces the possibility of finding solutions, and limits our understanding of the effects that translocations have on leopard populations (Athreya et al., 2011; Lorand et al., 2022).

Therefore, there is a need for standardized protocols for pre- and post-release monitoring to promote successful translocation efforts while respecting the legislation of each South African province. Standardizing the translocation protocols can contribute to managing DCAs and inform conservation strategy that can restore vulnerable populations or re-establish an extinct population within their historical range, if implemented responsibly. Moreover, formalizing data gathering prescripts and maintaining a rigorous centralized

database for all translocation events will contribute to evaluating the effectiveness of each event. Without such efforts, translocation actions may remain inconclusive and controversial as a management tool, which limits its potential to contribute towards the conservation management of species.

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

This research was reviewed and approved by Rhodes University ethics authorization (2007/11/1), Witwatersrand University (2011/05/04), University of the Western Cape ethics authorization (AREC19/2/1) and provincial research permits as issued by the Eastern Cape Department of Economic Development, Environmental Affairs (24503), and Western Cape: Cape Nature (0035-AAA004-00797).

Author contributions

All authors contributed to draft editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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A glimpse of the long view: Human attitudes to an established population of Eurasian beaver (*castor fiber*) in the lowlands of south-east England

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Introduction: The Eurasian beaver (*Castor fiber*) is a native species to Britain that after being absent for 400 years has been restored to the English countryside. The first beavers were released into a reserve in Kent in 2001/02, making this one of the first beaver release areas in the UK. This paper examines attitudes towards beaver presence in the landscape as well as public perception of beaver benefits and impacts with respect to the environment and human society.

Methods: Qualitative questionnaires were utilised to investigate factors influencing social attitudes and support for beaver reintroduction, as well as the relationship between sociodemographic variables and attitudes. Inhabitants of Kent and its immediate surroundings were surveyed during June and July of 2020 (n=407) with a focus on three interest groups – environmentalists, farmers and the general public.

Results: Perceptions included mostly beneficial impacts on nature and biodiversity, whereas less positive impacts were associated with economics, agriculture and fisheries. In general, local attitudes towards beavers were positive, mainly sustained by feelings of liking this wildlife species and valuing their presence. People´s attitudes positively influence willingness to support the reintroduction of beavers. Twenty years after their initial release, results indicate broad support for the beaver reintroduction in Kent and people´s tolerance of beavers. The majority of respondents were in favour of nonintrusive management techniques to mitigate beavers' undesirable impacts.

Discussion: These findings suggest the need to develop an optimal management strategy that incorporates public views and gives advice on the

best approach to manage this wildlife species. This research provides theoretical and practical underpinning for beaver management and conservation in Britain.

KEYWORDS

wildlife management, human-wildlife interactions, human dimensions, conservation translocation, reintroduction, rewilding, Kent

1 Introduction

The Eurasian beaver was the first mammal to be successfully reintroduced into the wild in Britain after a 400 year period of absence (Gaywood, 2018). Beaver re-introduction is predicted to confer a number of benefits both in terms of human value and ecosystem services (Stringer and Gaywood, 2016; Auster et al., 2019; Thompson et al., 2021). In Britain, beaver reintroduction has taken two main forms with both licensed beaver reintroduction and a growing number of fenced projects in existence (Campbell-Palmer et al., 2016; Beaver Trust, 2022). The British population is currently estimated to be up to 2000 Eurasian Beaver (Rosell and Campbell-Palmer, 2022).

Reintroduction projects can unsettle social and ecological norms, are often controversial (Nyhus, 2016; Crowley et al., 2017), and can sometimes conflict with human interests as re-introduced wildlife disperses into new areas (Collen and Gibson, 2001; Schwab and Schmidbauer, 2003; Jonker et al., 2006; Jonker et al., 2006; Gaywood et al., 2008; Gaywood et al., 2015; Campbell-Palmer et al., 2016; Crowley et al., 2017). In order to integrate animals, such as the Eurasian beaver into the management of cultural landscapes and mitigate some of their undesirable impacts, it is recommended that the identification of conflicts with human interests should occur as soon as possible, and management techniques should be implemented before issues become more widespread (Campbell-Palmer et al., 2016). In Britain, national consultations and public surveys on the human-wildlife dimensions of beaver re-introduction have been conducted, and stakeholder engagement exercises are ongoing in the areas surrounding some areas where beaver have been introduced (Jones et al., 2012; Gaywood et al., 2015).

The most closely studied and documented Eurasian Beaver populations in Britain are currently the River Otter population in Devon and populations in Scotland (Beaver Trust, 2022; Rosell and Campbell-Palmer, 2022). These populations have been subjected to study, both in terms of ecology (e.g. Needham et al., 2021) and human-wildlife dimensions (e.g. Auster et al., 2019). It is perhaps worth noting that the origin of the River Otter beaver population is unknown (Auster et al., 2021).

The beaver population in East Kent is at the same time relatively unstudied, and different, both in terms of human population density in the surrounding area and landscape ecology when compared to the River Otter population and the populations found in Scotland. Eurasian beaver were released into Kent in 2001/2002, into an area enclosed by beaver proofed and electrified fencing, at Ham Fen near the town of Sandwich. The aim of this release was to help manage and enhance Kent´s largest remaining fenland using rewilding techniques (The Wildlife Trust, 2017). A wild population established outside of the Ham Fen enclosure dates to 2008/2009 at the latest (Reid, R., personal communication), which makes the wild population in Kent at least contemporary to the first licensed re-introduction of free living beaver into Britain (Scottish Wildlife Trust, 2021). In 2016 beaver were described as 'very active' in the Kentish River Stour (Bramley et al., 2022), and featured in local press (Warren, 2016). The beaver population in East Kent has spread since 2008, with little initial recognition or engagement with stakeholders. The current distribution of Eurasian beaver is mainly in the Kentish Stour River catchment from east of the City of Canterbury downstream to the sea, and as far south as the marsh systems bordering the northern limits of the town of Deal (Bramley et al., 2022, personal communication). Beaver have therefore been a part of the East Kent landscape for 21 years at the time of writing, with a well established wild population about which no human dimensions work has been carried out and published subsequent to the release. The East Kent population is found in lowland grazing marsh in the east of its current range, between the towns of Deal and Sandwich. This area includes isolated small copses of trees, but is mostly open fields mainly vegetated by lowlying grasses. Towards Canterbury the population can be found in both the Stour, main river running through the area, and in reedbeds and wetlands lying on either side of the river. This isunlike the beaver population on the River Otter, which is mainly confined to the immediate river environment (Crowley et al., 2017).

The human population density in East Kent is also much higher than other release sites, potentially increasing the risk of human-beaver conflict.

A better understanding of the complex social dimensions of wildlife reintroduction amongst different interest groups could play an important role both in long term beaver conservation and sustainable beaver management (Ulicsni et al., 2020).

The aim of this exploratory study was to provide a baseline of attitudes towards presence, impact and mitigation of the established wild beaver population in a lowland marsh system near areas of relatively high human population density, which could serve as a baseline for future studies in this area as the expanding beaver population come into greater direct contact with human infrastructure. Objectives of this paper were to explore whether livelihood, distance from the original release site or gender affected human attitudes towards beaver. In order to maximise the use of this research for landowners and NGO's we also sought stakeholder opinion on perceived impacts of beaver, and the acceptable ways to manage beaver populations in potential conflict situations.

2 Method

The Theory of Planned Behaviour (Ajzen and Fishbein, 2005) was employed to produce a questionnaire that to measured knowledge, attitudes and beliefs in relation to the Eurasian beaver and its conservation in Kent. The questionnaire design was further influenced by similar studies on human dimensions in wildlife management, (Auster et al., 2019; Bath, 2008; Consorte-McCrea et al., 2017b).

The survey comprised a total of 32 beaver-related items and 6 sociodemographic questions. Different types of questions were formulated, including multiple-choice, scale and dichotomous questions. Questions of interest were closed-ended in order to yield quantitative data for statistical analysis. Additionally some qualitative data was gathered by means of a comment box where respondents could elaborate on the reasons for selecting their answers and leave further observations. The questionnaire was wide ranging, however this paper focuses on the portion of the questionnaire covering attitudes, impacts and management with respect to beaver in Kent.

2.1 Data collection and sampling

The survey was distributed using the online platform 'Qualtrics' between 24 June and 28 July 2020. In addition, the questionnaire was e-mailed to individual people working in environmental and wildlife organisations, including Wildwood Trust, Kent Wildlife Trust, Environment Agency and River Stour Internal Drainage Board. To capture views of the general public, the survey was also shared on several local Facebook groups of Canterbury, Sandwich, Whitstable and Herne Bay. The participants were invited to share the survey within their networks which allowed many participants to be recruited *via* the snowball method. Farmers and landowners were particularly sought, and were contacted by other participants and *via* email and LinkedIn through farmers´ associations such as the National Farmers' Union. Despite this effort the number of farmers and landowners engaging with the study were not expected to equal other groups, due to the low ratio of agricultural workers to other groups, and the analysis methods were chosen to allow for such an eventuality. All data were collected and analysed anonymously. Paper copies of the questionnaire were available to participants who desired an alternative to electronic submission, however no paper copy questionaires were requested.

2.2 Attitudes towards beaver in Kent

Four questions concerning personal feelings about beavers and emotional responses to beaver existence were added together to form an overall Attitude score for beaver. Answers to these questions were presented as a 5 point Likert scale (Allen and Seaman, 2007). Attitudinal items were coded using a 5-point ordinal rating, ranging from -2 ("Strongly dislike") to +2 ("Strongly like"). Sum attitude scores (AS) therefore potentially ranged from -8 to +8. In addition, negative mean scores represented negative attitudes towards beavers while positive mean scores represented positive attitudes towards beavers.

2.3 Perception of beaver impact

Perceptions of beaver impacts were explored for 11 impact themes (Wildlife & Biodiversity; Habitat & Ecology; Trees and Forestry; Land use & Agriculture; Water Quality; Flooding; Fisheries; Economics; Recreation &Leisure; Health & Welfare and Education).

2.4 Beaver management

Participants were asked to score the following methods of beaver management, which were identified as best practice recommendations (Campbell-Palmer et al., 2016): *Dam removal, Flow control devices, Individual tree protection, Exclusion fencing, Creation of riparian buffer zones, Trapping animals for translocation, Lethal control, Fertility control, Other* and *No management*.

2.5 Sociodemographic details

Participant information about gender, age, occupation, level of education and residential area was also gathered. Ages were classified into 7 groups (*18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75 or older*). Occupations were grouped into three categories (*Farming & Agriculture, Wildlife Conservation & Environmental Sciences* and *Other*).

Level of education was grouped into three levels: *Secondary education, Further education* and *Higher education*. Also,

respondents' first half of their postcode was requested. Postcodes were then arranged in 5 zones corresponding to distance from the original 2001 beaver release site, with zones 1-4 being inside Kent (Figure 1), and zone 5 encompassing all questionnaire returns from outside Kent.

Statistical analysis was performed using IBM SPSS Statistics 24 software. Attitudes data were not normally distributed (Shapiro-Wilk test; $p < 0.05$ in all cases), therefore non-parametric Mann-Whitney U and Kruskal-Wallis tests were undertaken to examine differences in the attitudes to beaver between occupations, gender, and area. To understand if there was an association between distance from reintroduction site and attitude score, a Pearson's Correlation was performed. Finally, crosstabs were used to test measures of association for two-way tables and expected outcomes were compared with observed outcomes. Pearson Chi-square Test was applied to examine relationships between support for beaver reintroduction and support for beaver management techniques. Mean results were accompanied in the text with standard deviation in the form Mean ± S.D.

3 Results

The questionnaire was completed by 407 individuals. The response rate varied among the three interest groups. A total of 50 environmentalists, 10 farmers and 347 respondents from the general public participated in the survey.

3.1 Sociodemographic characteristics

Respondents´ sociodemographic characteristics are displayed in Table 1. The sample had a higher proportion of females (67.8%, n=276) than males (31.2%, n=127). Most environmentalists (66%, n=33) and the public (69%, n=239) were female. In contrast, there were more male landowners (60%, n=6) than females. The most numerous age group in the sample was 45-54 (23.1%, n=94), followed by 35-44 (21.6%, n=88) and 55-64 (21.1%, n=86). In particular, most landowners (30%, n=3) and the public (23.1%, n=80) were between 45-54 years, but most environmentalists (32%, n=16) had an age between 25-34. Most respondents resided in the CT postcode area (Zone 1, 2 and 3), with the majority residing in Zone 3 (34.2%, n=139).

3.2 Attitudes

Attitudes towards beavers were mainly positive among participants with an overall mean attitude score of 5.91 ± 2.54 (Figure 2).

Only 9 respondents held general negative attitudes towards beavers (Figure 2). A Mann-Whitney U test found no significant gender difference between median attitudes towards beaver ($U = 17{,}731.5$, $p = 0.468$). All three interest groups held positive attitudes towards beavers. Environmentalists held the most positive attitudes (AS=6.22 ± 2.71) followed by members of the public (AS=5.91 ± 2.40) and farmers (AS=4.80 ± 3.65) who

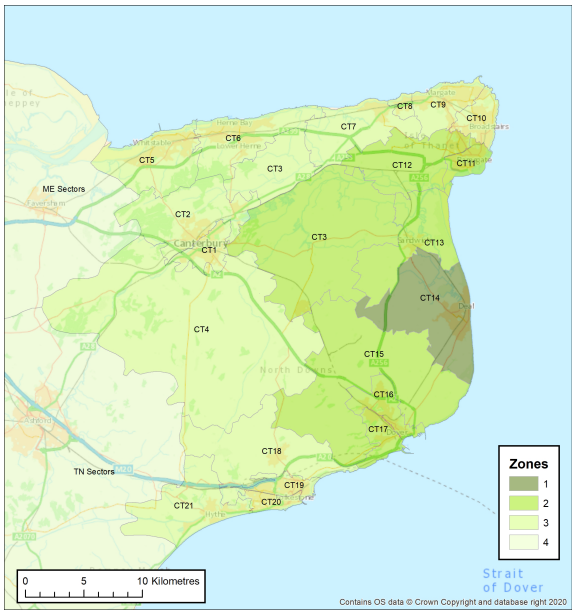

FIGURE 1
Map of the postcode areas in Kent grouped in 5 residential zones according to distance from Deal (Zone 5 is not represented on the map).

TABLE 1 Frequency and percentage of respondents' gender, age group, education level, occupation, landownership and residential area.

Sociodemographic Variables		Frequency (n)	Percentage (%)
Gender	Male	127	31.2
	Female	276	67.8
	Unspecified	4	1
Age	18-24	35	8.6
	25-34	64	15.7
	35-44	88	21.6
	45-54	94	23.1
	55-64	86	21.1
	65-74	31	7.6
	75+	8	1.9
	Unspecified	1	0.2
Education	Secondary education	55	13.5
	Further education	55	13.5
	Higher education	291	71.5
	Unspecified	6	1.5
Occupation	Farming & Agriculture	10	2.5
	Wildlife Conservation & Environment Science	50	12.3
	Other (General Public)	347	85.3
Landowner	Yes	48	11.8
	No	357	87.7
	Unspecified	2	0.5
Residential Area	Zone1	15	3.7
	Zone 2	89	21.9
	Zone 3	139	34.2
	Zone 4	121	29.7
	Zone 5	28	6.9
	Unspecified	15	3.7

formed the negative end of the attitudinal spectrum. However, a Kruskal Wallis test found no significant difference between the three interest groups ($H_{(2)}$ = 2.686, p = 0.261). A Pearson's correlation analysis found a significant positive correlation between distance from the beaver release site and attitudes *(r=0.133, p=0.008)*.

3.3 Perception of beaver impact on the landscape

Overall, respondents perceived beavers to have positive impacts in each measured category (Figure 3). Perceived impacts followed this ascending order according to their mean rate: *Wildlife & Biodiversity*; *Habitat & Ecology*; *Education*; *Water Quality*; *Recreation & Leisure*; *Flooding*; *Health & Welfare*; *Trees & Forestry*; *Economics*; *Land use & Agriculture* and *Fisheries*.

3.4 Support for beaver reintroduction

Respondents´ support for the beaver reintroduction in Kent was broad, with: 91.6% (n=373) agreeing or strongly agreeing that re-introduction was a positive action, 5.4%

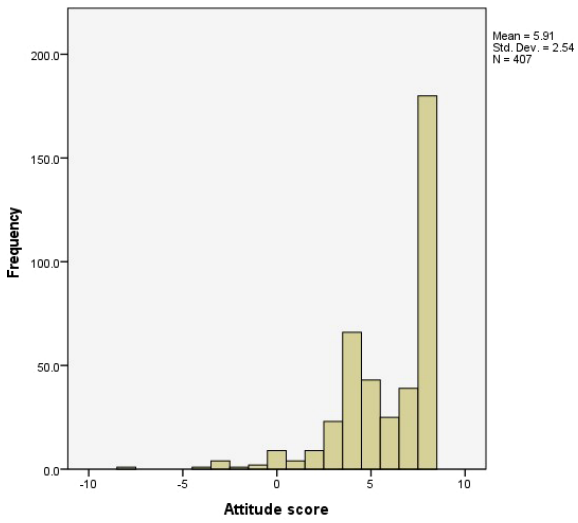

FIGURE 2
Beaver-related attitude frequency distribution for all survey participants.

(n=22) neutral and 2.9% (n=12) disagreeing or strongly disagreeing with beaver re-introduction.

3.5 Priorities for beaver management

Respondents' support for different beaver management techniques was diverse. More than a quarter of participants (27.8%, n=113) disapproved any type of management to mitigate beaver impacts or control beaver populations. Of the management measures presented, the most supported was *individual tree protection*, followed by *exclusion fencing, flow control devices* and *creation of riparian buffer zones*. On the other hand, *trapping animals for translocation, dam removal, fertility control* and *lethal control* did not receive much support (Figure 4). No significant association was found between support for beaver reintroduction and support for beaver management ($X^2 = 5.139$, $p=0.273$).

4 Discussion

The present study provides an exploratory insight into social attitudes and perceptions among different members of a local community in the UK, almost 20 years after Eurasian beavers were introduced to the county. The main findings suggest a high degree of tolerance and acceptance towards the Eurasian beaver

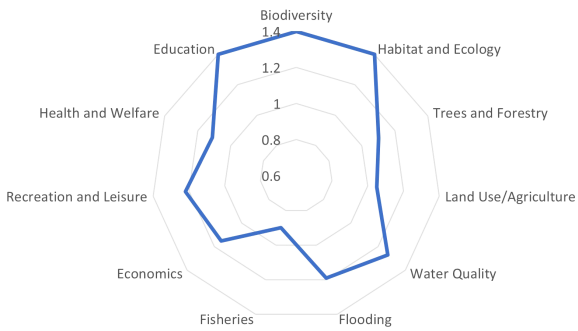

FIGURE 3
Respondents' perceived beaver impact scores for each impact theme.

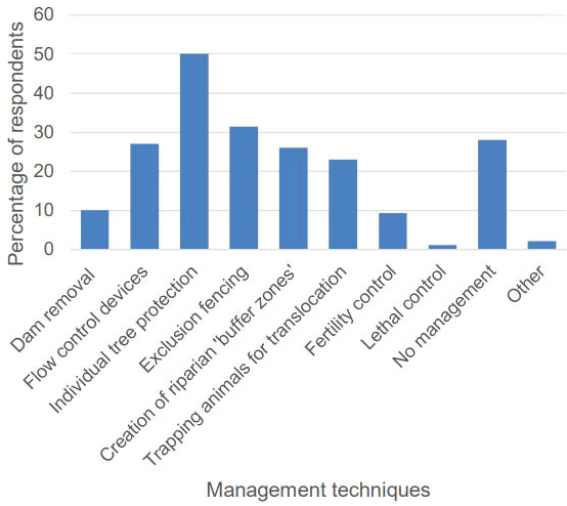

FIGURE 4
Respondents' support for potential beaver management techniques(participants could select multiple answers).

from the local people surveyed, as well as interest and support for beaver reintroduction and conservation. Many respondents highlighted attractive traits of beavers in free comments. This has particular relevance because evidence shows that human aesthetic appreciation of wildlife species influences public attitudes towards their conservation (Kellert, 1994; Gunnthorsdottir, 2001; Roque de Pinho et al., 2014). Only one individual respondent reported signs of fear or apprehension towards beaver in any of the responses, suggesting that beaver could be aggressive. The overall positive attitude is consistent with findings from the literature that herbivores, such as beaver, do not raise anxieties about public safety nor livestock depredation, which are mainly associated with large carnivores (Bath et al., 2008; Consorte-McCrea, 2011; Dabon, 2018; Castillo-Huitrón et al., 2020).

The results for perceptions of beaver impacts indicated that public concerns about beaver reintroduction were more focused on aspects associated with human livelihoods and that the perceived detrimental impacts are, essentially, on land uses and human activities. A nationwide survey about social attitudes towards beavers in Britain conducted in 2017 reported identical results (Auster et al, 2020). Conversely, disparities in perceptions of beavers' role in nature were evident in Scotland (Coz and Young, 2020). This was linked to a similar dynamic to the wild Kent beaver population, where a similar lack of detailed planning of the wider reintroduction process and little guidance for the management of beavers as in Tayside occurred.

There was evidence in the survey results of diverse perceptions of the impacts of beavers on ecosystem services, being that the effects of beavers on cultural services (aesthetic values) have been mostly perceived as positive in comparison to provisioning and regulating services (Ulicsni et al., 2020). Public appreciation and awareness of the Eurasian beaver might have been enhanced by the extensive UK press coverage about the return of beavers, which has made news in the *Daily Mail, Sky News, Daily Telegraph, Guardian, Independent* and *BBC News*. Very commonly, beaver coverage has an affectionate and curious tone (Gurnell et al., 2009) which might have been able to popularise wildlife conservation knowledge (Blewitt, 2011) and, in turn, influenced people's impressions about and attitudes towards beavers. Additionally, local zoos might have played an important role in people's views on beavers, which is consistent with the finding of Consorte-McCrea et al. (2017a) who suggested that zoos offering a wide range of learning experiences with live animals may encourage empathy. In particular, Wildwood Trust, the nearby wildlife park responsible for sourcing and providing the initial population for reintroduction into Ham Fen, is the only wildlife park in the South East of England that has a beaver exhibit and actively disseminates information and news about beaver status and importance.

Social studies on human interactions with the Canadian beaver in North America demonstrate strong negative correlations between factors such as experience of beaver damage (Jonker et al., 2006), or beaver density (Siemer et al., 2017) and attitudes to beaver. The attitudes of stakeholders could worsen if the frequency or severity of beaver impacts increase. Work on the population dynamics and general ecology of beaver in the marsh systems and adjoining urban areas is at an early stage, and could add to the considerations of future human dimension studies of this population.

4.1 Differences between interest groups

The opinions expressed by the three interest groups – environmentalists, farmers and the general public - about beavers and their reintroduction were not significantly different to each other in attitude scores. These results differed from similar research (Auster et al., 2019; Gurnell et al., 2009) which found that respondents whose occupation were in 'Farming & Agriculture', as well as 'Fisheries & Aquaculture', had less positive views about the Eurasian beaver, in contrast to those in 'Environment, Nature & Wildlife' who held the most positive attitudes.

Great effort was made to recruit farmers to participate in the survey. Despite this the number of farmers in this study is small (n=10). According to the census for Kent (Kent County Council, 2021) only 1% of Kent's population is made up of skilled agricultural workers, and 10 individuals represent proportionally over twice the number of farmers expected in a sample of this size. However, the investigation of attitudes among key stakeholders and the differences between them could have been affected by this extreme inequality inin group sample sizes, for example the attitude of each individual farmer who participated would have been amplified, which could misrepresent the attitudes of all farmers. Therefore, these results should be viewed with appropriate caution. Future work could increase farmer participation by physically visiting a sample of farmers to seek their participation, and actively distributing paper copies of the questionnaire, rather than just offering it as an option. This targeting could coincide with work planned next year to map out the distribution of beaver in east Kent more accurately.

4.2 Sociodemographic characteristics

The majority of respondents in this sample were female and aged between 35-54, however attitudes towards beavers did not seem to be associated with gender, age groups or education levels. The relationship between gender and attitudes towards the Eurasian beaver in this study differs from the results in other human dimensions studies that have found variations in attitudes between females and males (Bath et al, 2008; Decker et al., 2009). In particular, Kellert and Berry (1987) argued that gender is among the most important demographic factors in determining attitudes towards animals in American society. However, these study findings suggest this does not apply in the case of social attitudes and perceptions towards beavers in Kent.

Regarding residential areas, there was a positive correlation between residence distance from the beaver release site and attitudes. Although evidence of beavers has been reported outside of Ham Fen in the River Stour Catchment (Beaver Trust, 2022), this relation could be an effect of beaver presence, or perceived presence. (Bath et al., 2008), reported a similar effect indicating that positive attitudes may increase with distance from release site, although they also reported that in some cases living in the locality of a species could increase positive attitudes towards that species. Participants experience of Eurasian beaver and beaver impact and any influence on participant attitudes could therefore form a useful basis for future work.

4.3 Beaver reintroduction

The process of Eurasian beaver reintroduction in Kent received overwhelming support from the participants. This is in accordance with several public consultations which suggest that public support for beaver reintroduction is high and rising (Gaywood et al., 2015). A repeated study of Attitudes to Beaver re-introduction found a rise between 2017 and 2019 from 86.25% to 89.64% (Brazier et al., 2020). In England, the positive public reception is mirrored by largely positive media coverage (Gurnell et al., 2009).

Those in favour of beaver reintroduction tended to focus on specific environmental benefits associated with beaver dam systems. Many respondents highlighted the sense of human responsibility to restore a species extirpated by humans as a moral duty which is a common argument for reintroducing the Eurasian beaver to Britain (Philip and MacMillan, 2005). Additionally, some participants recognised some opportunities to humans that may arise from beaver presence. However, no respondents mentioned the potential economic benefits stemming from eco-tourism which is frequently cited as an important aspect of beaver reintroduction (Gurnell et al., 2009; Jones et al., 2013).

4.4 Beaver management

Debates regarding beaver conservation and management in Britain tend to be polarised and controversial (Jones et al., 2013). Predominantly, participants were in favour of some form of beaver management to mitigate beaver impacts or control beaver populations. The majority of respondents considered that a regulating system for beaver populations is necessary. Nonintrusive techniques, were the most highly selected, whereas more invasive techniques, were less preferred. These results agree with other studies that have found more support for indirect techniques, such as education in order to address misinformation with respect to beavers (Brazier et al., 2020; Campbell et al., 2007). The least supported option was *lethal control*, in accordance with other evidence showing wider social interest in non-lethal wildlife management solutions (Campbell-Palmer et al., 2015). The acceptability of lethal control has been reported to increase over time as beaver populations expand and

the reality of living again with the impacts of this species becomes an actual experience (Jonker et al., 2006; Siemer et al., 2017), which is a further argument for a future follow up study. As the beaver situation in Britain changes rapidly and dynamically and social opinions develop, it is important that beaver management strategies are adaptive (Ulicsni et al., 2020).

An alternative strategy for managing conflict and damage caused by wildlife is the establishment of compensation schemes to reimburse farmers, gamekeepers and landowners who experience damages (Morzillo and Needham, 2015). Government compensation schemes for damages or losses inflicted by beavers are generally popular with the public, as well as payments for landowners to host beavers (Auster et al., 2019; Gurnell et al., 2009). However, results show no predominant opinion on this topic among residents of Kent, suggesting this might need further deliberation if ever considered. If landowners get advice, help and financial support in case of problems with beavers they can be more willing to accept beaver presence (Schwab and Schmidbauer, 2003). These findings suggest that strategic decisions are needed on what beaver management should occur in Britain, particularly by whom, as this will be affected by any level of legal protection applied. Currently, the UK Government is being urged, by conservationists, to legally classify beavers as a 'native species' and give the species more protection in Britain (Beaver Trust, 2022). In the same way, almost all respondents felt beavers should be given some form of legal protection, a finding mirrored in the national study by Auster et al, (2019).

Other studies have identified stakeholders concerns about the consideration of future beaver management, with special attention to who would be responsible for management in practice, management funding and the actual management techniques that could be employed in the future (Auster et al., 2019; Gurnell et al., 2009; Brazier et al., 2020). A Beaver Management Strategy Framework has been published to help inform decisions regarding the long-term management of beavers in Devon (River Otter Beaver Trial Steering Group, 2020). However, there is a need for a National Beaver Strategy for any further releases that incorporates all these aspects and social concerns and establishes an effective management process for free-living beaver populations, as suggested by the English Beaver Strategy Working Group (in preparation).

5 Conclusions

The Eurasian beaver was portrayed as a popular species among many inhabitants of Kent, emotionally engaging a broad segment of the public. Most survey respondents recognised the value of beaver to ecosystems, perceiving their impacts to be essentially beneficial in all of the areas analysed by the study. Still, a positive correlation between greater distance from release site and positive attitudes towards the beavers requires further investigation. Attitudes may change as beaver density and distribution changes, therefore longitudinal studies over time may help understand these dynamics.

Should wildlife managers wish to generate more acceptance for beavers, communication strategies for any future consultation over proposed reintroduction plans could be based on the positive feelings associated with beavers and focused on the potential environmental benefits they can provide. Reintroduction projects need to be clear and carefully designed, while also devising and disseminating accurate information as a mean to raise public support for the conservation of the Eurasian beaver in England.

These study findings suggest the need to strengthen cooperation between nature conservationists and local communities and incorporate public views on beaver management decision-making process, in order to prevent potential future conflicts from establishing. Indeed, in beaver reintroduction, management decisions can and should be made proactively before conflicts arise (Auster et al., 2019). As there is no evidence of strong beaver-human conflict in Kent, there is an opportunity to design an effective strategic approach for tackling challenges head-on and promote human-beaver coexistence.

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 Faculty Ethics Committee, Faculty of Social and Applied Sciences, Canterbury Christ Church University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

SO designed and carried out the research and wrote up the main body of the writing as part of an MSc dissertation thesis. PB provided the original idea for the study and provided initial industry contacts and initial direction of the research. He also supervised the research and re-structured the thesis into a shorter final paper for submission. AC-M provided substantial help to structure the questionaire, supervised the research and provided expertise on framing the research to maximise

consideration of the human dimensions of european beaver re-introduction into the UK. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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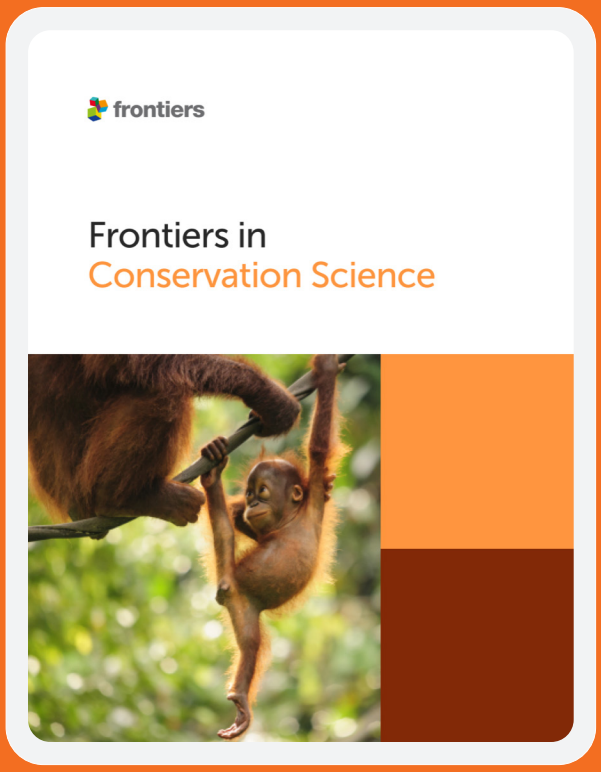

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