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Do communities understand the impacts of unlawful bushmeat hunting and trade? Insights from villagers bordering Western Nyerere National Park Tanzania

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A R T I C L E   I N F O

A B S T R A C T

Assessing local people's understanding of the consequences of unsustainable bushmeat-related activities on conservation is an important step toward developing effective solutions to decrease unlawful hunting activities. The current study investigated the knowledge regarding the ecological and socioeconomic impacts of illegal bushmeat activities among villagers adjacent to western Nyerere National Park Tanzania. The two terminologies i.e., "hunting" and "trade" were collectively used herein as "bushmeat trade". We collected data from 261 households and 24 key informants using a semi-structured questionnaire and an interview guide, respectively. Results show that 84% of local residents know that bushmeat trade directly threatens wildlife by reducing the population of hunted species. Nearly half of the respondents also appreciate the benefits of wildlife conservation. Regarding the trend of bushmeat trade in the study area, the majority (80%) of the respondents stated that the activity is decreasing. Moreover, the study revealed that the knowledge variation regarding the impacts of bushmeat trade is significantly influenced by education level, age and proximity to the park boundaries. Interventions aimed at addressing the illegal bushmeat trade should consider demographic factors and ensure that conservation programmes are extended to both nearby and distant villages from the park boundaries for enhanced and impactful results.

1. Introduction

There has been widespread concern about the impacts of illegal bushmeat hunting on biodiversity conservation (Rija et al., 2020; Sackey et al., 2022). The consequences of unlawful hunting directly and indirectly affect the socioeconomic livelihoods of people (Price, 2017; Rogan et al., 2018). Yet, most local people in developing countries with vast wildlife resources engage in illegal bushmeat hunting (Twinamatsiko et al., 2014; Peros et al., 2021; Nana et al., 2022). Numerous factors have been documented to contribute to the prevalence of illegal bushmeat activities. These factors encompass the absence of alternative livelihoods, the search for protein

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substitutes, the adherence to cultural practises and traditions, and individual preference behaviour (van Vliet and Mbazza, 2011; Nyaki et al., 2014; Chausson et al., 2019; Morrison-Lanjouw et al., 2021).

In various regions of Africa, the illegal killing of wildlife for the purpose of bushmeat trade and/or personal consumption is pre-dominant among communities residing near protected areas designated for wildlife conservation (Luiselli et al., 2019; Malik et al., 2019; Bannor et al., 2021; Torres et al., 2021). This unsustainable exploitation of wildlife by local communities has been identified as a contributing factor to the global decline in wildlife populations (Craigie et al., 2010; Ripple et al., 2016; Rija et al., 2020). The ecological ramifications of the bushmeat trade signal the importance of safeguarding the remaining wilderness areas, including those located within the protected lands in Africa (Lindsey et al., 2015; Wilkie et al., 2016; Sackey et al., 2022).

Similar to many other developing nations, Tanzania has set aside a substantial portion of its territory for wildlife conservation (URT, 2014; Kideghesho, 2016). Unfortunately, the majority of the country's protected areas have been identified as being threatened by illegal bushmeat hunting for consumption and income generation (Ceppi and Nielsen, 2014; Fischer et al., 2014; Rogan et al., 2017; Manyama et al., 2019). Given the consequences associated with illegal wildlife activities, such as loss of revenue, loss of employment opportunities, increased conservation expenditures through anti-poaching patrols, and other related reinforcements (Lindsey et al., 2011; Rogan et al., 2015; Price, 2017), it is evident that such illegal activity negatively affects the socioeconomic well-being of people.

The Tanzania Wildlife Policy of 2007 (URT, 2007) highlighted the importance of undertaking necessary measures to safeguard wildlife and its habitats as a means to counteract the rising trend of illegal wildlife activities. To achieve this goal, a series of con-servation initiatives have been implemented, focusing on providing conservation education and supporting community development projects (Sungusia, 2010; Mwakaje et al., 2013; URT, 2015; Mawi and Mashenene, 2020). However, despite the implementation of these initiatives to enhance conservation knowledge, research studies have revealed the persistence of unlawful hunting and bushmeat operations in areas where these approaches have been employed (Kiffner et al., 2015; Rogan et al., 2017). This underscores the need for further research to obtain a comprehensive understanding of people's knowledge regarding various aspects of conservation, including the ecological and socioeconomic impacts associated with unsustainable bushmeat hunting and trade. So far, there is a substantial body of literature that extensively covers the detrimental effects of illegal hunting activities within and beyond Tanzania's protected areas (e.g., Bitanyi et al., 2012; Gandiwa et al., 2014; Ariffin et al., 2018; Angwenyi et al., 2021; Foya et al., 2023). Nevertheless, indigenous knowledge of the ecological and socioeconomic implications of bushmeat hunting and trafficking in com-munities surrounding protected areas is yet to be investigated. By tapping into the insights and perspectives of local communities, it becomes possible to pinpoint the gaps in current conservation efforts and develop targeted strategies that align with the specific needs and concerns of the communities involved. This approach fosters a more inclusive and holistic approach to conservation, enhancing
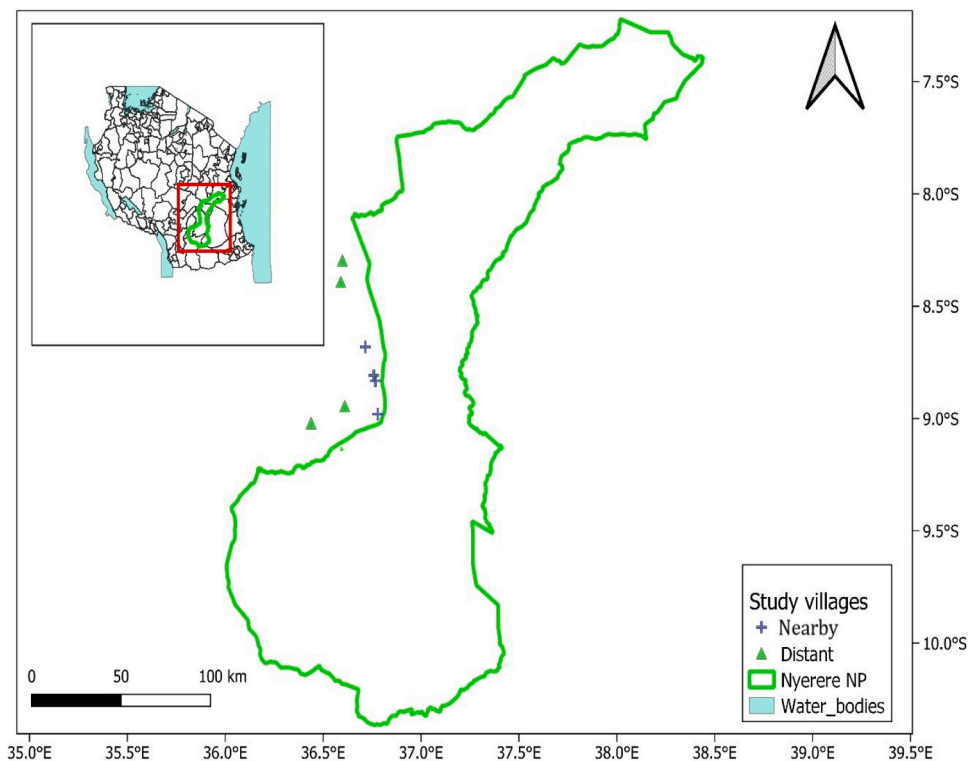
Fig. 1. A map showing Nyerere National Park and the villages where this study was conducted. The plus signs indicate villages located within 15 km of the WNNP boundary, herein classified as "nearby villages" while the triangle signs indicate villages beyond 15 km, herein classified as "distant villages". Both distant and nearby villages were also selected based on their involvement in illegal bushmeat hunting and trading activities. On the top left corner is the map of Tanzania showing the location of Nyerere National Park (in rectangle).

the overall effectiveness of conservation initiatives (Wali et al., 2017; Ntuli et al., 2019).

Therefore, the current study aimed to address the existing knowledge gap concerning the ecological and socioeconomic impacts of illegal bushmeat hunting and trade (hereafter referred to as "bushmeat trade") on both conservation efforts and local communities. Specifically, the study aimed to focus on (i) the knowledge of local people on the negative impacts of bushmeat trade on wildlife populations and trend of bushmeat trade over the past five years (2014–2019); (ii) the knowledge of local people regarding the socioeconomic importance of wildlife conservation; and iii) the demographic and distance factors (nearby and distant) that might influence conservation knowledge among respondents. In this study, local people's knowledge was gathered through the administration of several sets of subject-related questions to respondents. This approach is consistent with the methodologies and insights provided by both Hunt (2003) and Matoková (2016).

2. Methods

2.1. Study area

The Nyerere National Park, covering an area of 30,893 km^2, is the largest national park in Africa. It was formed after the former Selous Game Reserve (SGR) was divided into two parts; one section retained the SGR name, while the larger portion was renamed as the "Nyerere National Park". This park is located between 7.75° and 10.5° South and 36.0° and 38.7° East (Fig. 1). The area has annual rainfall ranging between 750 and 1300 millimetres (Baldus and Hahn, 2009). The park is home to several wild animals, including threatened species such as the endangered (EN) African elephant (Loxodonta africana), near threatened (NT) African Cape buffalo (Syncerus caffer), the vulnerable (VU) Hippopotamus (Hippopotamus amphibius), the critically endangered (CR) African wild dog (Lycaon pictus), several other predators, and a variety of antelopes (UNEP-WCMC, 2011; Tawiri, 2019). Extensive miombo forest characterized by Brachystegia sp, Julbernadia sp, Isoberlinia sp, Afzelia quanzensis, and Pterocarpus angolensis dominates the region (Balus and Hhan, 2009).

The current study was conducted in eight out of 26 villages around the western part of the park, Ilonga (>7500 km^2), referred to henceforth as western Nyerere National Park (WNNP). The villages are in Ulanga District, southwest of Morogoro town. The WNNP is also close to Iluma Wildlife Management Areas (IWMA) and Kilombero Game Reserve, a protected area known to harbour a sizeable population of the Puku antelope, *Kobus vardonii* (Haule et al., 2002). In general, the research area receives a bimodal distribution of rainfall, with brief rains from November to January and long rains from March to May. Although the area is inhabited by several tribes, including Pogoro, Ndamba, Ngindo, Ndwewe, and Sukuma, Pogoro is the largest ethnic group. In the selected villages, households engage in diverse socioeconomic endeavors such as crop farming, poultry husbandry as well as operating small-scale businesses such as shops and local markets where they sell locally-produced products and items for household needs. Beside aforementioned activities, it was disclosed by key informants that illegal bushmeat operations are prevalent in these areas, with Hippopotamus *Hippopotamus amphibius*, Buffalo *Syncerus caffer* and Hartebeest *Alcelaphus buselaphus lichtensteinii*, being among the most hunted species for trade and household consumption.

2.2. Sampling of villages and respondents

The study villages were purposefully selected according to distance from the boundaries of the park (Wilfred et al., 2019). Following a preliminary conversation with conservation managers and other key informants in the area, eight villages where bushmeat hunting for household consumption and trade were identified and selected. The geographic coordinates for each village were recorded using a hand-held GPS device, and the data was subsequently imported into a computer and analyzed using ArcGIS software to determine the relative positions of villages and distances on a map. From a list provided by key informants, four villages directly bordering the WNNP boundary were chosen. These villages were located within 15 kilometres of the WNNP boundary, hence being classified as "nearby villages". Conversely, another set of four villages, identified by key informants as not directly bordering the WNNP boundary, were chosen. These villages were located more than 15 kilometres away from the WNNP boundary, hence being classified as "distant villages". However, because of the sensitivity of studies dealing with the unlawful use of wildlife, and to adhere to the ethical research requirements for conducting such studies, the identities of the communities were withheld (UNEP-WCMC, 2020).

To select the households, the names were randomly picked from the village record book in each village using an online random number generator (Georgiev, 2020). We also deliberately selected key informants from various levels, including the district, village, and conservation area authority, based on their roles. At the district level, we interviewed the District Game Officer, who acts as a liaison between the community and the government, and overseeing matters such as benefit sharing from natural resources. In each village, we interviewed the village executive officer and village chairperson, who, along with other officials, participate in supervising the community development projects. Additionally, conservation officers were interviewed to gather insights related to wildlife conservation in the area, including their responsibilities in ensuring that local communities benefit from wildlife conservation.

2.3. Data collection

The current study employed a cross-sectional approach, which permits the gathering of data within a limited time frame. The data was collected between January and March 2020. Prior to conducting household surveys in the sample villages, we pilot-tested our research instruments in two villages outside the primary study villages and then modified the questions accordingly (Chaudhary and Israel, 2014; Ikart, 2019). To ensure the consistency of our results, the two villages selected for pretesting had comparable

socio-demographic features. To meet the recommended number of responses for pretesting, a total of 32 individuals were polled (Perneger et al., 2015).

During our main household survey, at least 30 households from each village were interviewed, resulting in a total of 261 respondents. These respondents were selected from both nearby villages (137 respondents) and distant villages (124 respondents). We specifically selected the household head, a senior member, or any adult over the age of 18 who was present at home for the interviews. Most respondents (79%, n = 205) were males, while only 21% (n = 56) were females. The number of males was proportionally higher than females due to the nature of the study design, which relied on household heads, the majority of whom were men. The majority of respondents were between the ages of 29 and 39 (40%, n = 105), followed by the 40–50 age group (26%, n = 68), the 18–28 age group (23%, n = 59), and a smaller proportion were above the age of 50. Most of the respondents (77%, n = 202) had completed primary education, while 13% (n = 35) had secondary education, and 9% (n = 24) had informal education.

Due to the illegality of bushmeat in the study area, the questionnaire was developed to introduce the subject gradually. The first section of the questionnaire inquired about the respondents' demographic characteristics (gender, age, ethnicity, period of residency, level of education, and occupation). The second section of the questionnaire gathered data on the ecological and socioeconomic consequences of wildlife conservation. Therefore, we inquired about the negative consequences of illegal bushmeat hunting and trading on wildlife populations as well as the general trend of bushmeat trade in the study area during the past five years. In addition, we investigated respondent's knowledge about the benefits of wildlife conservation in the area and whether demographic factors and distance from the park boundary to villages accounted for poachers' involvement in the bushmeat trade.

Furthermore, we conducted semi-structured interviews with 24 key informants, including 16 village officers (one village executive officer and village chairperson, respectively, from eight villages), the District Game Officer, and seven conservation officers. This allowed us to gather secondary data, including records of community development initiatives and tourism-based activities. The interviews were done with the participants' informed consent, and anonymity and confidentiality were assured.

2.4. Data analysis

Data were analyzed using the R statistical software (R Core Team, 2020). For categorical data, the Chi-square test was used to assess differences in respondent frequencies in the aspects related to local people's knowledge of the negative impacts of bushmeat trade; the perceived trend of wildlife populations and bushmeat trade activities in the study area; and the socioeconomic importance of wildlife conservation to local communities. For binary variables, a Generalized Linear Model (GLM) with binomial error distribution was used to determine how distance from the park boundary affected the response probabilities of respondents who responded either yes or no based on the negative effects of bushmeat trade on wildlife population and trend. Finally, a GLM binomial model was used to assess the demographic characteristics that influenced variance among respondents on the effects of bushmeat trade on wildlife. All GLM binomial models were performed by selecting the family of binomial model distribution. The GLM binomial model that involved multiple demographic factors, and final model with parsimonious significant factors were determined by using step AIC function from the MASS package.
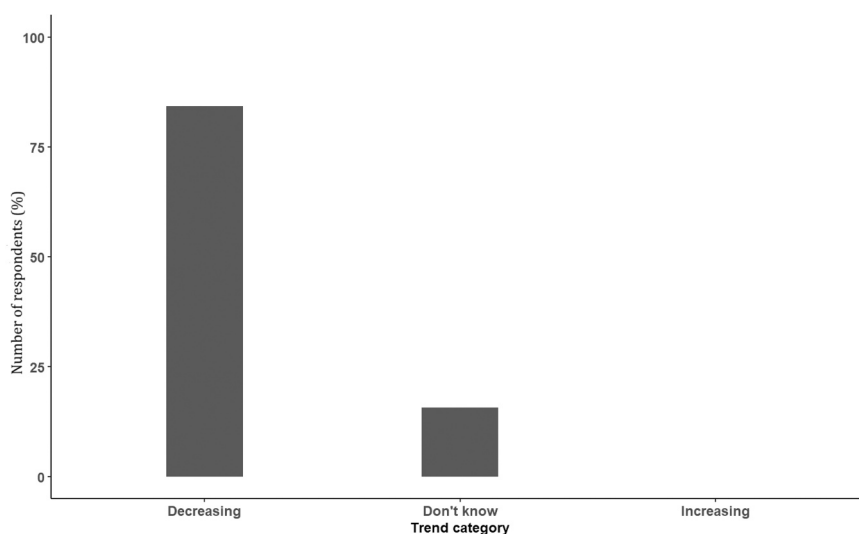

Fig. 2. Knowledge of local communities on the trend of illegal bushmeat trade irrespective of village distance from the park boundary. Category "Decreasing" (N = 220) represents respondents who said illegal bushmeat trade was decreasing while "Don't know" (N = 41) represents those who did not know the status. None of the respondent said illegal bushmeat trade is increasing.

3. Results

3.1. Negative impacts of bushmeat trade

When asked about the impact of bushmeat trade on wildlife populations irrespective of proximity to the park, a significantly higher proportion (84%) of respondents knew that bushmeat trade may diminish local wildlife populations while 16% had no such understanding ($\chi2 = 23.871$, df $= 2$, p < 0.0001). When asked to provide their views on the trend of bushmeat trade over the past five years, approximately 80% of respondents declared a significant decrease in illegal bushmeat trade compared to 20% who reported not being aware of the status whereas none reported an increase in illegal bushmeat trade ($\chi2 = 31.36$, df $= 1$, p < 0.0001, Fig. 2). The decrease in bushmeat trade was also supported by interviewed officials from TAWA, who formerly managed the area before it was gazetted as a national park in November 2019 (a year before the study period). When assessing variation in local knowledge about the trends of bushmeat trade with park proximity, we found a marginal difference between those living in nearby villages and those in distant ones (GLM, Estimate $= -0.6470 \pm 0.3477$SE, Z $= -1.861$, p $= 0.0628$, Fig. 3). The knowledge probability of the trend of bushmeat trade is high in villages near the park boundary and decreases further away from the park boundary.

3.2. Social-economic importance of wildlife conservation to local communities

The study assessed the differences between the positives (benefits) and negatives (costs) of wildlife conservation to local communities living adjacent to western Nyerere National Park and found that the proportion of respondents who acknowledged the advantages of wildlife conservation (48.7%) was quite close to the proportion of respondents who believed wildlife conservation provided no value (44%). Furthermore, the 44% (n = 54) out of 124 respondents from distant villages and 53% (n = 73) out of 137 respondents from nearby villages agreed that conservation is beneficial. The benefits mentioned by respondents who were positive about wildlife conservation included the; increased government funding and support for community development initiatives, the development and expansion of businesses in the villages, temporary employment, and community security. However, when we assessed the knowledge variation regarding the benefits of wildlife conservation with respect to proximity to the park, the study found a non-significant decrease in benefit probability for local communities living nearer to the park boundary compared to those who live in distant villages (GLM, Estimate $= -0.3885 \pm 0.2590$, Z $= -1.500$, p $= 0.134$).

When we interviewed village officers from nearby and distant villages, they acknowledged that their communities have been supported with funding derived from wildlife resources. While the level of support varied among villages, the key informants discussed some of the benefits associated with wildlife conservation. These benefits were derived from tourism companies and government funding, which stemmed from the sharing of benefits obtained from wildlife resources. For nearby villages, funds were provided for the construction of four classrooms, two toilet buildings, and the renovation of a nursery school, whereas for distant villages, funds were provided for the maintenance of a water borehole, the construction of two classrooms, 164 roofing sheets for three classrooms, 40 class chairs, and 40 tables for secondary schools. The District Game Officer reported that the district council has been receiving from the government part of the revenue accrued from the wildlife resources to support communities surrounding the WNNP, including the surveyed villages. The information reported by respondents was further reinforced by the conservation officers, who stated that apart from government revenue distribution to villages living adjacent to the WNNP, local tourism enterprises were obliged to contribute to the development of community projects each year.

3.3. Demographic and distance factors influencing respondents' knowledge

The observed variation among respondents about the impacts of bushmeat trade was significantly associated with the level of

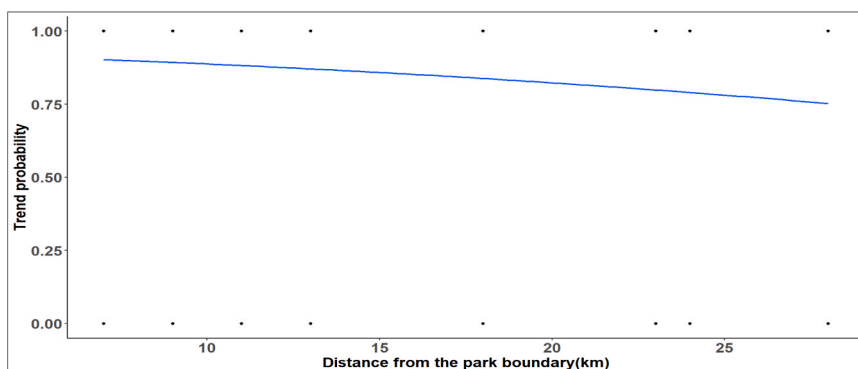**Fig. 3.** Knowledge probability level on the trend of bushmeat trade in the past five years between villages living near the park boundary and those living in distant ones. The representation indicates the knowledge variation of respondents regarding the trend of bushmeat trade with respect to distances. The blue line indicates the regression line generated from the Generalised Linear Model (GLM).

education and marginally associated with proximity to the park boundary and age of the respondents. The awareness probability increased considerably with education level (GLM, Estimate = 2.9737 ± 0.7603SE, Z = 3.911, p = 0.0001), in which respondents with at least primary education were more aware about the impacts of bushmeat trade than those with informal education levels. (Fig. 4A). Villages nearer to the park are more aware about the impacts of bushmeat trade and this pattern decreases marginally as the distance from the park boundary increases (GLM, Estimate = 0.033 ± 0.019SE, Z = - 1.661, P = 0.097, Fig. 4B). Furthermore, it was noted that individuals over the age of 40 demonstrated a higher level of awareness regarding the consequences of the bushmeat trade compared to the younger population (GLM, Estimate = 0.027 ± 0.014SE, Z = 1.926, P = 0.054, Fig. 4C).

4. Discussion

According to our findings, local residents in the study area were knowledgeable that the bushmeat trade may lead to the extinction of wild animals, demonstrating that they knew the impact of the illegal bushmeat trade on wildlife populations. Conservation officers have concurred with the observations of respondents, noting a decline in illegal bushmeat hunting and trading since 2014. This trend of diminished illegal bushmeat activities is also reflected in findings from other regions in Tanzania (Andimile and Floros, 2021). According to Tawiri (2019), the wildlife populations in the ecosystem encompassing the study area are now recovering as a result of a decrease in illegal wildlife activities over the past years. This appears to match what our respondents stated. Thus, our results suggest that local community knowledge can make a substantial contribution to giving a comprehensive picture of the state of illegal wildlife operations in the protected area. Hence, their knowledge can be further explored to provide strategies for reversing illegal wildlife operations in protected areas.

The respondents had mixed feelings about the benefits of wildlife conservation, with approximately half of them being knowledgeable and the other half claiming to be unaware of the benefits. Our data showed that respondents' disagreement over the advantages of conservation may be attributable to the negative socioeconomic implications of human-wildlife interactions. Respondents contended that wildlife provides no advantage due to crops damage, livestock depredation, loss of life and injuries, and a lack of direct monetary benefit. However, our interviews with key informants including village officers revealed that wildlife conservation has supported various community development projects and provided job opportunities. This indicates that the lack of appreciation for wildlife conservation among certain community members does not necessarily imply their ignorance of the benefits. Instead, they might be hesitant to acknowledge these benefits due to the costs they have incurred through their close interactions with wildlife. These findings align with previous research, indicating that local residents may resist conservation efforts due to the socioeconomic burdens resulting from wild animals in their villages (Synman, 2011; Gemeda et al., 2016; Ochieng et al., 2021). On the other hand, the appreciation of benefits by some of the respondents and key informants from both nearby and distant villages is associated with their awareness that funds used to support community initiatives in their places are primarily dependent on the presence of wildlife (Rogan et al., 2015; Price, 2017). Such understanding has cultivated a positive attitude towards wildlife conservation, hence co-existence between people and wildlife. In this regard, it is critical for conservation management authorities to also conduct conservation programmes that focus on changing people's negative attitude towards wildlife conservation. This is particularly important because the viability of conservation projects is dependent on the attitudes and understanding of the local population (Mir et al., 2015; Nilsson
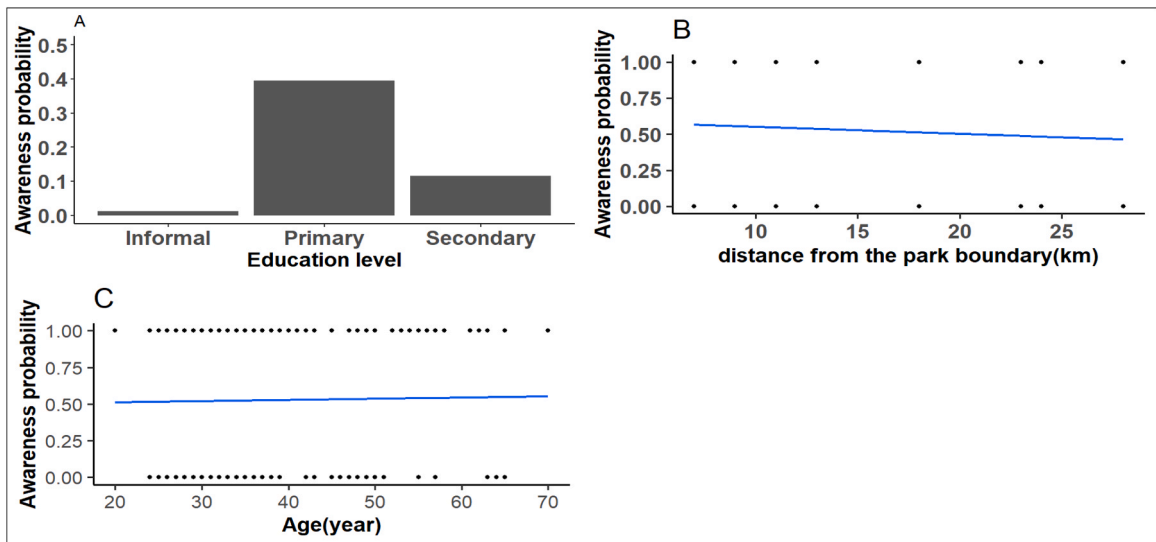
Fig. 4. Relationships of knowledge of local communities with education levels (A), distance from the park boundary (B)and respondents age (C). Dots on subplot B and C represent binary responses of local communities on which part of them were aware (shown by dots found perpendicular to number 1, and other part of respondents were not aware (shown by dots found perpendicular to number 0). The blue lines represent regression lines generated by Generalised Linear Models (GLM).

et al., 2020).

It has been established that the efficiency of conservation projects is dependent on demographic characteristics and other related elements impacting people's behaviour (Mgawe et al., 2012; Gandiwa et al., 2013). Our findings showed that, education level, age and proximity to park boundaries explain variance in the understanding of the consequences of bushmeat trade. We revealed that the chance of comprehending the impacts of bushmeat trade increased with education level. Local inhabitants with at least primary level of education were more aware about the impacts of bushmeat trade than those with informal education levels. This observation is consistent with the idea that formal education provides a platform for individuals to gain insights and knowledge about various environmental and conservation topics (Howe, 2009; de Oliveira et al., 2020; Desi et al., 2021). Thus, efforts aimed at including conservation topics into formal education system can create an early appreciation and respect for wildlife, ensuring that future generations remain dedicated to conservation efforts (Sterling et al., 2017; Kideghesho, 2019). However, our findings further imply that individuals with informal level of educations should be paid special attention when addressing the socioeconomic implications of bushmeat trade. In addition to education, the findings of this study revealed that individuals aged 40 and above exhibited a higher likelihood of understanding the consequences of the bushmeat trade compared to younger populations. This could be due to the older generation's prolonged exposure to the natural environment, allowing them to see directly the tangible impacts of illegal hunting practises on ecosystems and community livelihoods (Nuno et al., 2013). Our findings, however, imply that conservation education efforts should also prioritize younger generations, as they appear have limited awareness regarding the impacts of the bushmeat trade.

On the other hand, our study demonstrated that individuals residing near the park boundaries displayed a higher level of awareness regarding the consequences of illegal wildlife operations compared to those living at a greater distance from the park. The observed trend in the given study is in line with previous research that demonstrates communities living near protected areas are more likely to have a higher stake in the benefits derived from these areas (Abukari and Mwalyosi 2020; Mbise et al., 2021; Kegamba et al., 2023). However, our key informants in the study area further elaborated that people in the study area benefit from wildlife conservation regardless of their proximity to the park boundaries. This broader perspective reinforces the previous argument that the illegal bushmeat trade could negatively impact villages that are distant from the park boundaries as well. In light of this, effective conservation strategies should not only focus on the communities residing near the protected areas. Broad-based awareness campaigns and community interventions that cater to both nearby and distant villages should be formulated and executed to bridge the understanding gap and ensuring a more holistic approach to conservation (Andrade and Rhodes, 2012; Mogomotsi et al., 2020).

5. Conclusions and recommendation

The current investigation established local people's understanding of the effects of bushmeat trade. Local people in the study area are knowledgeable that illegal hunting for bushmeat and trade is endangering wildlife populations. Moreover, this study has noted that both nearby and distant villages could be negatively impacted by bushmeat trade. Therefore, it is necessary to address conservation issues in both villages located near and distant from the park boundaries, as well as taking demographic factors such as age and education levels into account.

The proportion of respondents who appreciate versus those who did not recognize the advantages of conservation is of special significance. Local communities that claimed the absence of benefits from wildlife conservation seemed to have a negative attitude towards wildlife and conservation. To counteract this, we urge that protected area managers seek people's thoughts and address them before the commencement of any development project in the village. This will increase the sense of ownership and support conservation activities targeted at minimizing bushmeat trade.

Ethics approval statement and declaration

This study followed the ethical research standards of the Sokoine University of Agriculture and the UNEP-WCMC Code of Practice on Ethical Standards in Research, and it was approved by the Trade, Development, and Environment Hub (TRADE Hub) Research Ethics Committee. Official permission to conduct research in the study regions was granted from the Morogoro Regional Office, Ulanga District Council, surveyed village Councils, and conservation authorities (TAWA and TANAPA). Prior to an interview, the purpose of the research was explained and informed consent was obtained from all respondents. Participants were assured of anonymity and confidentiality, and their participation was entirely voluntary; they were allowed to answer questions or quit an interview at any time.

Funding

Declaration of Competing Interest

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

Data availability

The data underlying this study are available from the authors upon reasonable request and with permission from the management of the TRADE Hub Research Project at Sokoine University of Agriculture and UNEP-WCMC.

Disclosure of conflict of interest

The authors declare no potential conflict of interest.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.gecco.2023.e02626.

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