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Household perceptions regarding bats and willingness to pay for their conservation within Mount Elgon Biosphere Reserve of Uganda

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Introduction: Bats play critical roles not only in sustaining ecosystems but also human livelihoods across different scales. Despite such values, their populations continue to be threatened mainly by human activities causing their decline. Moreover, recent zoonotic diseases outbreaks have increased negative attitudes towards this taxon further threatening their populations. This study sought to contribute to bat conservation programs by providing scientific data on community willingness to pay for bat conservation within Mount Elgon Biosphere Reserve in Uganda.

Methods: We employed cross-sectional survey design using semi structured interview questionnaires to gather data on the willingness to pay for bat conservation as well as factors associated within Mount Elgon Biosphere Reserve of Uganda. Households were the unit of analysis and were sampled using simple random sampling techniques. Data collected was analyzed using descriptive and relational analyses.

Results: Respondents indicated their willingness to contribute a mean monetary value of UgX 794.97 (~ USD 0.21 *Oanda rates as of September 03rd, 2024*). This bid amount was associated with household size (p = 0.02) and lower education levels (p = 0.01). Increased household size as well as higher education levels undermined willingness to pay for conservation of bats. Gender and years lived in the area had a positive effect on willingness to pay for bat conservation. In terms of knowledge of bats, this study indicated understanding of some aspects of bats e.g., role in pollination and reproduction. However, there was poor knowledge on other aspects e.g., seed dispersion and other ecological values. Regarding the general environment, communities indicated environment to play critical roles in their livelihoods and ought to be protected.

Discussion: Human communities within Mount Elgon have positive attitudes towards bats and are willing to contribute to their conservation, including monetary terms. Interventions targeting bat conservation thus ought to integrate human dimensions. This will contribute to restoring bat populations and local, regional and global scales.

KEYWORDS

bats, willingness to pay, welfare, economics, indigenous knowledge, traditional knowledge, benefits, social ecosystem

1 Background

With 1,487 species globally and over a fifth of them in Africa, bats have been indicated to play a significant role in the provision of ecosystem services (Burgin et al., 2018; Simmons and ALC, 2025). Such services include pest control, pollination, and seed dispersal among others benefiting both plant and animal populations (Kunz et al., 2011; McCracken et al., 2012; Mainea and Boylesa, 2015; Ramírez-Fráncel et al., 2022). These ecosystem services have significant implications for the socioeconomic aspects of human welfare and can influence decisions on their conservation interventions (Low et al., 2021; Aggrey et al., 2024a). The benefits associated with bats are substantial and globally reported, contributing significantly to human livelihoods (Aggrey et al., 2024a). For instance, in North America, bats predate on agricultural pests, saving costs of up to $3.7 billion per year (Boyles et al., 2011). Similarly, surveys in Texas indicated an annual value of $741,000 per year for pest control services provided by bats (Cleveland et al., 2006). In Chile, bats yield an economic value of US$188 to $248 per hectare per year due to their predation services (Rodríguez-San Pedro et al., 2020). In Indonesia, bats significantly reduce pest infestation on cacao trees, leading to higher productivity (Maas et al., 2013). Experiments around South African macadamia farms showed that bats can reduce tortricid moth damage by more than 35% (Bouarakia et al., 2023). These contributions to pest control and agricultural productivity are crucial for human livelihoods and can positively shape people's perceptions regarding bats as well as their conservation. Such positive attitudes towards bats can yield significant conservation outcomes across different scales. Indeed, studies have shown that community-led conservation programming has a higher chance of being successful compared to those that have limited community engagement (Brooks et al., 2013). However, for such success to be effectively realized, opportunities like willingness to pay for conservation ought to be understood so as to limit costs of the interventions (Esmail et al., 2023). Such opportunities have been demonstrated in Greece and Mauritius, where residents valued bats and indicated monetary and labor contributions to support their conservation (Chandr Jaunky et al., 2021; Liordos et al., 2021). This partly contributed to sustaining the bat populations within these areas. Measuring such values attached to bats (across different scales) is critical, as it provides an improved understanding of pathways to influence societal change, public policies, and decision-making (Ferrato et al., 2016). It's also critical to undertake such assessments across different scales as perceptions and values of bats are often shaped by socioeconomic factors that are highly context dependent (Sen, 1999). Such context dependency can cause heterogeneity in the conservation interventions across space and time.

The occurrence of zoonotic diseases has increased recently, necessitating enhanced and strategic public health communication to mitigate related impacts (Decker et al., 2012; Quinn et al., 2014; Holmes, 2022; Vora et al., 2022). While these interventions are critical in safeguarding human populations, they can sometimes undermine conservation efforts for vertebrate taxa (e.g., bats) that have been associated with certain diseases (Davis et al., 2017; MacFarlane and Rocha, 2020; Osofsky et al., 2023). For instance, the recent COVID-19 pandemic has exacerbated negative attitudes towards bats (Ejotre et al., 2022; Nanni et al., 2022), which has detrimental implications for community support for bat conservation actions in some areas. Notably, community members will have less morale to support actions that contribute to restoring and, or sustaining bat populations as evidenced in Nigeria (Adeyanju et al., 2023) and New York (Siemer et al., 2021). Because such perspectives are highly context-dependent, i.e., vary across space and time (Olko and Radding, 2024), it is crucial to analyze community perspectives (in hard to reach areas like Mount Elgon) regarding such species to understand potential barriers to bat conservation (Geijzendorffer et al., 2017; Christie et al., 2020). Such analysis contributes information that can be used to design interventions to sustain ecosystems across different scales, as bats occupy wide ecological niches (Denzinger and Schnitzler, 2013; Ramírez-Fráncel et al., 2022; Dai et al., 2023). This is particularly relevant in Uganda, where agriculture is the main source of livelihood and involves the conversion of natural habitats into farmland, posing serious consequences for bat populations (Uganda Bureau of Statistics, 2014; Frick et al., 2020).

Abbreviations: CVM, Contingent Valuation Method; WTP, Willingness to Pay; NEP, New Ecological Paradigm; OLS, Ordinary Least Squares; UBOS, Uganda Bureau of Statistics.

To halt or reverse threats to bat populations, adequate scientific and location-specific assessments should be conducted (Frick et al., 2020). Unfortunately, such assessments are yet to be conducted, especially in developing countries, including Uganda. This gap needs to be filled, as Uganda's location within the tropics would be ideal for a high diversity of bats (Brown, 2014). This is reflected in a recent modeling study indicating Uganda to lie within a belt of high bat diversity and abundance (Alves et al., 2018). Similarly, anecdotal records indicate new species of bats that continue to be discovered in different parts of Uganda reflecting the potential of various ecosystems in sustaining bat populations. This study aimed to contribute to the design of interventions to sustain bat populations by assessing perspectives regarding bats and willingness to pay for their conservation.

2Materials and methods

2.1 Study area

This study was undertaken within Mount Elgon Biosphere Reserve, Uganda with focus on the Sebei subregion. The Sebei subregion comprises three districts; Kapchorwa, Kween and Bukwo. It is bordered by Kween District to the northeast and east, Sironko District to the south, and Bulambuli District to the west and northeast (Figure 1). Anecdotal records indicate Kapchorwa district to host more diverse economic activities than other districts.

The district is majorly inhabited by the indigenous communities of Sebei, estimated to be 300,000 people in Uganda (Uganda Bureau of Statistics, 2014). In the past, the Sebei were nomadic pastoralists owning mostly cattle. They practiced a livestock management system with families relying mainly on milk rather than meat for nutrition, selling animals to get cash for other economic needs, and building herd sizes to accrue social status, wealth, and provide a buffer against risks such as severe droughts (Baxter and Goldschmidt, 1976). Until they were resettled outside the forest reserve in the 1980s, they lived on open grassy areas inside the montane forest [see (Sassen et al., 2013)].

2.2 Study approach

The Contingent Valuation Method (CVM) was utilized to assign an economic value to the bats around the Mount Elgon Biosphere Reserve in Uganda. This method is widely employed in valuing environmental goods by asking respondents how much they would be willing to pay for a specific environmental service or good (Hong et al., 2024; Lee and Kim, 2024). The Contingent Valuation Method (CVM) is often used to assign value to a species through willingness-to-pay surveys (Martín-López et al., 2007). This

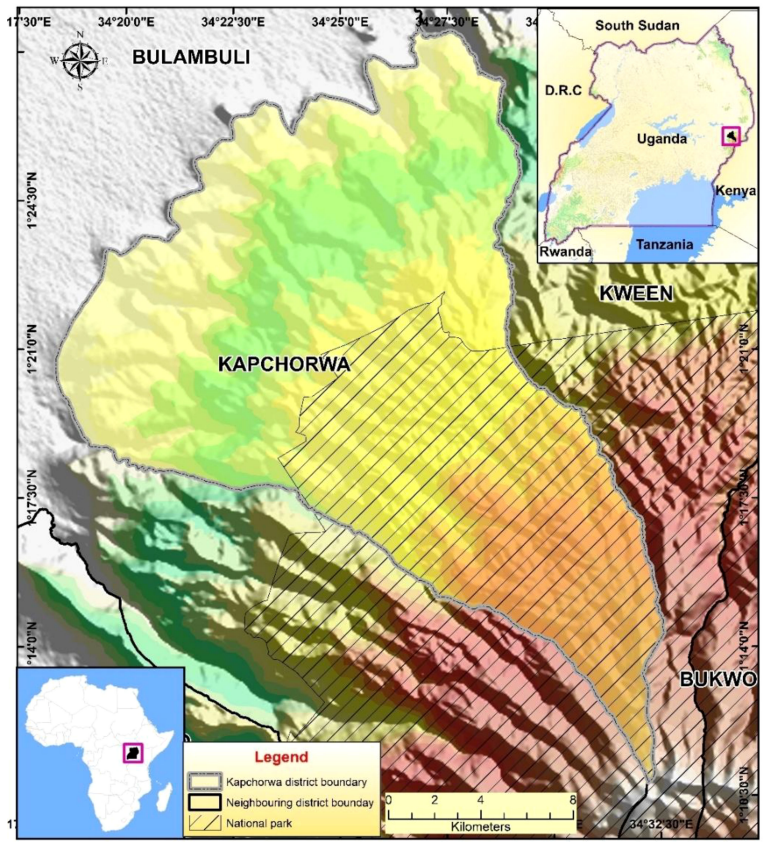

FIGURE 1
Location of the study area.

approach provides an understanding of the economic aspects by assigning a monetary figure to a particular species (Solomon et al., 2004), which is vital for designing effective conservation actions (Martín-López et al., 2007; Zander et al., 2014).

To improve our analysis, we included an examination of how the New Ecological Paradigm (NEP), knowledge, and attitudes towards bats influenced the willingness to support bat conservation (Figure 2) (Dunlap and Van Liere, 1978; Catton and Dunlap, 1980). This approach was adopted from a similar survey on the Mauritius flying fox (Chandr Jaunky et al., 2021). The NEP is a survey-based metric used to measure environmental concerns within a given group of people (Tonin and Benedetto, 2024). It consists of a 15-question survey instrument where respondents indicate their level of agreement or disagreement with various statements (Anderson, 2012; Dunlap, 2012). We adapted this framework and contextualized it for bats and the human communities within the Mount Elgon region of Uganda. This adaptation was crucial as the NEP framework allows for measuring pro-environmental beliefs, behavioral intentions, and actual pro-environmental behaviors (Derdowski et al., 2020; Marcineková et al., 2024). It thus provides an opportunity for improved understanding of people's perspectives regarding bats which form part of the overall ecosystems.

2.3 Sampling and data collection

Data was collected from household level across Kapchorwa district. This was done for a total of 380 randomly selected households. This sample (N=380 households) was derived using Krejcie and Morgans method of sample determination (Krejcie and Morgan, 1970). Additionally, sampling was based on the 2014 Uganda National Census (UBOS, 2014). Simple random sampling techniques were applied during the household selection process. Notably, a list of households formed the sampling frame. Sampling randomly included starting with one household and the next with selection of every k^{th} element (Equation 1) from then onwards.

$$k = \frac{population\ \ size}{sample\ \ size} \tag{1}$$

Data was collected using a semi-structured interview questionnaire (Supplementary File 1) at household level, targeting household heads from selected households. In cases where the household head was not available, the next senior person or an adult (over 18 years) was interviewed. The questionnaire comprised four sections. Section A addressed the sociodemographic characteristics of the respondents. Section B assessed the respondent's knowledge about bats and captured data regarding their willingness to contribute to bat conservation. Section C appraised the respondent's attitudes towards bats. Finally, Section D amassed information about the respondent's self-image and data related to the New Ecological Paradigm (NEP) (Dunlap et al., 2000; Dunlap, 2012). By structuring the questionnaire in this manner, we ensured a comprehensive collection of data covering sociodemographic information, knowledge, attitudes, and ecological beliefs, all of which are crucial for understanding the factors influencing conservation efforts. The collected data was later entered into Microsoft Excel prior to analysis.

2.4 Data analysis

Descriptive statistics were conducted to summarize sociodemographic characteristics, NEP components, and respondents' knowledge of bats. Proportions were used to present categorical variables, while summary statistics were applied to continuous variables. The contingent valuation method (CVM) was employed to assess households' willingness to pay (WTP) for bat conservation (Venkatachalam, 2004; Carson and Hanemann, 2005). The mean WTP for bat conservation was estimated using the approach outlined by Boyle (2017) (Equation 2):

$$Mean\ \ WTP = \frac{\sum_{i=1}^{n} WTP_I}{n} \tag{2}$$

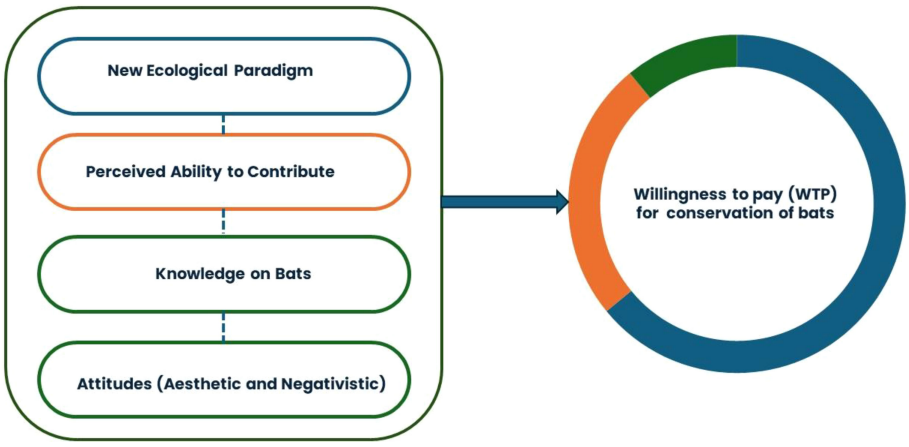

FIGURE 2
Conceptual model for determining willingness to pay for bat conservation Source: Modified from Chandr Jaunky et al. (2021), with permission.

where WTP is the amount, each respondent is willing to pay for bat conservation in Uganda shillings (UGX), and n is the total number of observations. This calculation provided an estimate of the maximum WTP expressed by the respondents. To examine the determinants of WTP, a probit regression model was used, given that the dependent variable (willingness to contribute to conservation) was binary. The model specification was as follows (Equation 3):

$$\Pr(response = 1) = \phi(\beta_0 + \beta_1 bid\quad amount + \beta_2 Household\quad size + \beta_3 gender + \beta_4 educational\quad level + \beta_5 Work\quad type + \beta_6 years\quad lived\quad in\quad area + \varepsilon) \tag{3}$$

where represents ϕ the cumulative distribution function of the standard normal distribution. The independent variables included bid amount, household size, gender, education level, work type, and years lived in the area. The mean WTP was further estimated using the formula (Equation 4):

$$Mean\ \ WTP = -\frac{\beta_0}{\beta_1} \tag{4}$$

A probit regression model was employed to determine the relationship between willingness to pay and various socioeconomic attributes. This model was selected because the dependent variable is binary (whether a respondent is willing to contribute or not), making it more appropriate than linear regression models that may generate biased estimates when applied to categorical outcomes (Halstead et al., 1991). The probit model assumes that the probability of willingness to contribute follows a standard normal cumulative distribution function, allowing for a more accurate estimation of factors influencing respondents' decisions. The choice of the probit model over other potential econometric models, such as the Tobit model, was based on the nature of the data. However, in this study, the primary focus was on whether respondents were willing to contribute to bat conservation rather than the specific amount they were willing to pay. Given this, the probit model was deemed the most suitable analytical approach.

To assess the model's fit, the likelihood ratio test was employed. This test evaluates the significance of the overall model by comparing it to a null model without predictors (Halstead et al., 1991). Likelihood ratio was used to evaluate the fit of the model and analysis was conducted at 5% significance level (He et al., 2020). Details of the model characteristics are presented in tables within the Supplementary Files (Supplementary File 2). All statistical analyses were performed using Stata version 18 (StataCorp, 2023). All analysis was done at 5% significance level.

3 Results

In terms of sociodemographic characteristics, all respondents lived and worked in the area and indicated to have bats in their neighborhood. In terms of gender, the male and female respondents engaged were almost equal (Table 1). Regarding education levels, the majority of respondents had completed secondary level education (Table 1). Crop cultivation was the most common work done within the study site (Table 1). In comparison to the total population of the site, most respondents were at primary level (57%) indicating lower education levels within the study site. Similarly, crop cultivation was the main source of livelihood with 70% of the respondents engaged in it (Table 1).

3.1 Proportions of NEP

Respondents generally agreed with the different questions regarding the New Ecological Paradigm (Table 2). This indicated a general pro-bat conservation within the general public. For instance, over three quarters (n=0.965) of the respondents agreed that the balance of nature is very delicate and easily upset (Table 2). Similarly, majority of the respondents (n=0.981) agreed that if things continue on their present course, we will soon experience a major ecological catastrophe.

3.2 Knowledge about bats

Respondents had poor knowledge regarding some aspects of bats in terms of being environmental indicators, vulnerability to environmental degradation and their ecological roles (Table 3). For instance, 92% of them agreed to the statement that bats lay eggs which is not correct.

3.3 Willingness to pay for bat conservation and associated factors

The mean WTP was UgX 794.97 (~ USD 0.21 *Oanda rates as of September 03rd, 2024*) representing the average maximum amount that respondents were willing to pay for bat conservation. The mean WTP was notably influenced by extreme values, with some bids reaching up to UGX 5,000 (~ USD 1.321) (Figure 3). Given the skewed distribution (skewness = 3.56), the median WTP of UGX 500 (~ USD 0.132) provides a more robust measure of central tendency. This suggests that half of the respondents were willing to contribute up to UGX 500 (~ USD0.132) annually, while a smaller proportion indicated substantially higher amounts (Figure 3).

Overall, the WTP values indicate a positive willingness to pay for bat conservation activities by the community members. In relation to the median monthly household income (as of March 2020) within this region, this bid amount represents 0.4%. The coefficient for bid amount was −0.00007 and was not statistically significant (p = 0.40) (Table 4). This suggested that the amount of the bid does not have a significant impact on the decision to pay, within the range of bid amounts used. Household size and education level among other factors studied significantly influenced willingness to pay for bat conservation (Table 4). Notably, lower household sizes (p = 0.02) and lower education levels (p = 0.01) had significant negative association on the bid amount (Table 4). Notably, increase in household size reduced the amount that households were willing to pay for bat conservation

TABLE 1 Sociodemographic characteristics of respondents (N=380).

Variable	Category	Sample proportion	SE	95% CI	Population proportion	Source
Gender (N = 750)	Male	0.51	0.02	[0.47 – 0.54]	0.49	2014 Uganda National Census (UBOS, 2014)
	Female	0.49	0.02	[0.46 – 0.53]	0.51	2014 Uganda National Census (UBOS, 2014)
Education Level (N = 748)	Primary	0.21	0.01	[0.18 – 0.24]	0.57	2014 Uganda National Census (UBOS, 2014)
	Secondary	0.77	0.02	[0.74 – 0.80]	0.35	2014 Uganda National Census (UBOS, 2014)
	Undergraduate	0.02	0.01	[0.01 – 0.03]	0.02	2014 Uganda National Census (UBOS, 2014)
	Graduate	0.01	0.00	[0.00 – 0.02]	0.02	2014 Uganda National Census (UBOS, 2014)
Type of Work (N = 742)	Crop cultivation	0.80	0.01	[0.76 – 0.82]	0.70	2014 Uganda National Census (UBOS, 2014)
	Business	0.12	0.01	[0.10 – 0.15]	0.15	2014 Uganda National Census (UBOS, 2014)
	Livestock farming	0.04	0.01	[0.03 – 0.06]	0.20	2014 Uganda National Census (UBOS, 2014)
	Off-farm income	0.02	0.01	[0.01 – 0.03]	0.15	2014 Uganda National Census (UBOS, 2014)
	Salaries and wages	0.02	0.00	[0.01 – 0.03]	0.25	2014 Uganda National Census (UBOS, 2014)
	Carpentry	0.00	0.00	[0.00 – 0.01]	0.05	2014 Uganda National Census (UBOS, 2014)
Familiarity with Flora/Fauna (N = 746)	Very familiar	0.99	0.00	[0.99 – 1.00]	N/A	N/A
	Slightly familiar	0.01	0.00	[0.00 – 0.01]	N/A	N/A

(Coefficient = −0.11). Similarly, higher education levels reduced the amount that households were willing to pay for bat conservation (Table 4).

4 Discussion

This study indicated respondents had a positive attitude towards bats and environmental aspects that would undermine population of these mammals. They were also knowledgeable about some aspects of bats and were willing to contribute for their conservation. The positive attitude towards bats can be attributed to the values that people derive from these mammals either directly or indirectly. Such values can be linked to the entire ecosystem that provides opportunities (directly and indirectly) for accessing key livelihood assets. For instance, the respondents in this study noted bats to contribute guano for enhancing soil fertility. Others also indicated bats to consume pests for crops, livestock contributing to food availability. These are critical values that can support food production systems sustaining human populations. Indeed, over three quarters of the respondents in the study area practiced small scale agriculture as the main source of livelihood. This livelihood strategy relies heavily on the health of ecosystems across different scales (Power, 2010; Richardson, 2010; Frison et al., 2011; White et al., 2021; Crespin et al., 2023). Therefore, ecological imbalances would severely undermine the livelihood strategies employed by communities within such areas prompting for interventions for sustainability. For instance, climate change has been shown to severely affect agriculture through drought, pests and diseases among others (Javadinejad et al., 2021; Kim and Lee, 2023). Such incidences undermine food security and other welfare assets of communities driving them to explore interventions (e.g., nature based solutions) to sustain their livelihoods (Sonneveld et al., 2018; Aggrey et al., 2024b; Dunlop et al., 2024). Therefore, the positive attitudes attached to bats directly and indirectly in this study indicates the value that communities attach to this mammalian group. Similar results have been obtained in other areas like the Battambang Province in the northwest of Cambodia (Shapiro et al., 2021). Notably, respondents had a positive attitude towards cave roosting bats. This was attributed to the benefits that people associated with bats e.g., hunting them for meat, provision of guano etc (Shapiro et al., 2021). While the study site of Battambang Province in the northwest of Cambodia may not be similar to the one for our study, such results provide opportunities

TABLE 2 Proportion of the responses on the different aspects of the new ecological paradigm (NEP) regarding bats (N=380).

Questions	Responses				
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
The balance of nature is strong enough to cope with the impacts of modern industrial nations	0.005	0.009	0.008	0.957	0.02
Humans have the right to modify the natural environment to suit their needs	0.007	0.007	0.005	0.971	0.011
Plants and animals have as much right as humans to exist	0.004	0.005	0.001	0.973	0.008
Despite our special abilities, humans are still subject to the law of nature	0	0.12	0.007	0.965	0.016
Humans were meant to rule over the rest of nature	0	0.007	0.009	0.977	0.007
The earth is like a spaceship with very limited room and resources	0.001	0.007	0.005	0.979	0.008
When humans interfere with nature it often produces disastrous consequences	0	0.004	0	0.976	0.015
We are approaching the limit of the number of people the earth support	0.001	0.005	0.007	0.976	0.011
The earth has plenty of natural resources if we just learn how to develop them	0	0.008	0.004	0.972	0.016
Humans are severely abusing the environment	0.003	0.007	0.007	0.973	0.0107
Humans' ingenuity will ensure that we do not make the world unlivable	0.003	0.007	0.005	0.976	0.008
If things continue on their present course, we will soon experience a major ecological catastrophe	0	0.004	0.008	0.981	0.007
Humans will eventually learn about how nature works to be able to control it	0.005	0.005	0.007	0.977	0.004
The so-called "ecological crisis" facing humankind has been greatly exaggerated	0.007	0.868	0.003	0.119	0.003
The balance of nature is very delicate and easily upset	0.003	0.013	0.004	0.965	0.015

for enhancing conservation programming within communities. This is critical in the current era of emerging and remerging infectious diseases with the potential of fueling bat persecution (Lu et al., 2021). Indeed, this has been evidenced in northern parts of Uganda calling for interventions to educate the public about how to live safely with bats (Ejotre et al., 2022). However, while such negative attitudes are increasing because of diseases traced to bats, there is still an opportunity to raise awareness which has been shown to be effective in enhancing positive attitudes towards bats. This has been demonstrated by Bosco and colleagues indicating informational stimuli to increase the positive attitudes towards bats (Boso et al., 2021; Ejotre et al., 2022).

In terms of knowledge of bats, respondents had poor knowledge of these mammals in terms of being environmental indicators, their vulnerability to environmental degradation and their ecological roles e.g., seed dispersal. However, some were knowledgeable on some aspects of the mammalian group. Notably, some respondents indicated bats to support seed dispersal and forest regeneration. Additionally, some indicated bats inhabit caves and trees and are vulnerable to environmental degradation. This discrepancy can be associated with poor access to information regarding the biology and ecological aspects of bats. This result is similar to that obtained in Southwestern parts of Uganda indicating community members have poor knowledge of the public health threats associated with bats (Ninsiima et al., 2024). Similarly, a study in the northern parts of the country showed varied knowledge regarding bats e.g., physical features, biology among others (Ejotre et al., 2022). Meanwhile, elsewhere in countries like Mauritius, it has been shown that community members have poor understanding of the reproductive biology of bats (Chandr Jaunky et al., 2021). Access to information regarding bats would not only improve the community understanding of mammalian group but also enhance positive attitudes (Boso et al., 2021; Ejotre et al., 2022). This would support conservation planning across different scales contributing to sustainability.

Regarding the willingness to pay for bat conservation, respondents indicated monetary contributions that they would make to support conservation actions for bats. This value was equivalent to 0.4% of the median monthly household income for the Elgon region as per the previous household census conducted within this area (UBOS, 2021). Similarly, comparing this bid amount to the monthly consumption expenditure per household

TABLE 3 Knowledge of respondents regarding bats (N=380).

Questions	Percentage (%) of answers that agreed with the question or statement posed	Correctness of the statement
Bats lay eggs	92	Not correct
Bats are the only mammals in your area	94	Not correct
Bats are vulnerable to environmental degradation	9	Correct
Bats are an indicator of how healthy the environment is	5	Correct
Bats do not play an important role as pollinator	92	Not correct
Bats contribute to the regeneration of forest	9	Correct
Bats play a crucial role in seed dispersion in your area	8	Correct
Bats inhabit caves and trees in your area	8	Correct

in rural areas of Eastern Uganda equated to 0.3% (UBOS, 2021). This value thus reflects potential of enhancing bat conservation within Mount Elgon Biosphere Reserve. While this result may have been improved with integration of man hours (labor contributions), it provides a useful understanding of the value that community members attach to bats. Such value attached to bats can be driven by the livelihood assets derived from the mammalian group e.g., guano, sociocultural and spiritual benefits among others. These benefits are widespread across different communities and vary across space and time (Aggrey et al., 2024a). This is also partly reflected in the level of knowledge and the attitudes towards bats as revealed in this study. In relation to other studies, the result obtained in this study is similar to that obtained in Mauritius reflecting potential of community participation in bat conservation (Chandr Jaunky et al., 2021). Notably, community members indicated a monetary contribution to support conservation of Mauritian flying fox. This was associated with the better knowledge about bats and higher aesthetic value the communities attach to bats (Chandr Jaunky et al., 2021). In our study, results indicated education level and household size to be significantly associated with willingness to pay for conservation of bats. Specifically, lower education levels and smaller household sizes positively influenced willingness to pay for conservation of bats. In general, this result reflects the effects of sociodemographic factors in influencing bat conservation programming. Notably, education levels can have a bearing on the level of understanding of the values of bats. People who have spent their life working in a natural setting and observing the benefits provided by bats instead of pursuing higher education were more inclined to support bat conservation, as opposed to people who have become more disconnected from spending time in nature. This consequently influences attitudes regarding such species. This has been evidenced in Greece with community members' willingness to pay for bat conservation influenced by education among other factors (Liordos et al., 2021). Notably, community members with lower education levels were more willing to support bat conservation compared to those with higher education levels. Conversely, a study in Nigeria indicated community members with higher education levels to value the bats more compared to those with lower education (Adeyanju et al., 2023). While there maybe differences in the

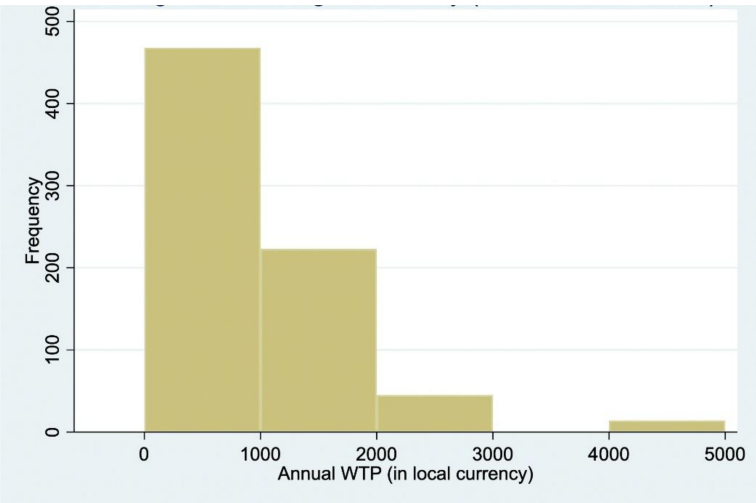

FIGURE 3
Histogram on willingness to pay (in UgX) for bat conservation.

TABLE 4 Willingness to contribute to conservation of bats and factors associated.

Variable	Coefficient	Std. error	z	p-value	95% Confidence interval
Bid amount	−0.00007	0.00008	−0.84	0.40	[−0.0002, 0.00009]
Household size	−0.110	0.049	−2.28	***0.02****	[−0.206, −0.015]
Gender – male (ref: female)	0.184	0.108	1.71	0.09	[−0.027, 0.395]
Education – Secondary (ref: primary)	−0.458	0.166	−2.77	***0.01****	[−0.782, −0.133]
Education – Undergraduate (ref: primary)	−1.022	0.517	−1.98	0.05	[−2.036, −0.009]
Education – Graduate (ref: primary)	−0.477	0.654	−0.73	0.47	[−1.759, 0.806]
Work type – farming (ref: non-farming)	−0.068	0.200	−0.34	0.73	[−0.461, 0.324]
Years lived in area	0.005	0.008	0.64	0.52	[−0.011, 0.022]
Constant	0.051	0.508	0.10	0.92	[−0.945, 1.047]

* and bold values indicate significance at 5% confidence level.

contexts between existing studies and ours, the results elucidate the role of education and local traditional knowledge in bat conservation. Our study contradicts the general expectation that higher education levels improve understanding of the values and increase motivations to pay for its conservation. This can be associated with the recent occurrences of diseases associated with these mammals fueling negative attitudes towards its conservation. This has recently been evidenced in Northern parts of Uganda (Ejotre et al., 2022). Although not significant, years lived in the area was associated with willingness to pay for bat conservation. This can be explained by the improved knowledge of the existing natural resources and their value especially during limited alternative resources (Boafo et al., 2016; Abdullah and Khan, 2023). Similar result has been indicated in a study conducted in Mauritius indicating age of the respondents to be significantly associated with willingness to pay for bat conservation (Chandr Jaunky et al., 2021). Additionally, in Greece, older persons were noted to be willing to pay for bat conservation (Liordos et al., 2021). Regarding gender, while there was no significant association with willingness to pay for bat conservation, there was a positive relationship. This result is similar to that in the Mauritius study that indicated gender to have a positive influence on bat conservation by community members (Chandr Jaunky et al., 2021). This result is also similar to that obtained on Mexican free tailed bat that indicated females to be willing to pay for its conservation (Haefele et al., 2018). These factors provide avenues for leveraging human dimensions of bat conservation with Mount Elgon region of Uganda.

5 Conclusion and recommendations

This study indicated willingness to pay for bat conservation within Mount Elgon Biosphere Reserve of Uganda. Education level and household size were the key factors associated with the willingness to pay. Years lived in the area also had a positive influence on the willingness to pay for bat conservation. While this study could have been improved with integration of methods for analyzing man hours that respondents maybe willing to contribute, it provides an understanding of how communities are willing to engage in bat conservation programming. Future conservation programs targeting bats are thus likely to succeed in this area given the positive attitudes associated with these mammals. We recommend longitudinal studies to explicitly understand contributions of communities to bat conservation while analyzing factors associated with such contributions. This should be done in different areas of Uganda as well as Africa and the globe so as to support conservation programs targeting this mammalian group. Lastly, education programs on the values of bats as well as ways of living safely with these creatures should be initiated within this region. Such education programs should integrate community members of different education levels.

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 humans were approved by Makerere University College of Agricultural and Environmental Sciences Research and Ethics Committee. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

SA: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft. IR: Conceptualization, Supervision, Writing – review & editing. ES: Conceptualization,

Supervision, Writing – review & editing. RMK: Conceptualization, Supervision, Writing – review & editing. CM: Conceptualization, Supervision, Writing – review & editing. RCK: Conceptualization, Funding acquisition, Project administration, Resources, Supervision, Writing – review & editing.

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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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The author(s) declare that no Generative AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcosc.2025.1527844/full#supplementary-material

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