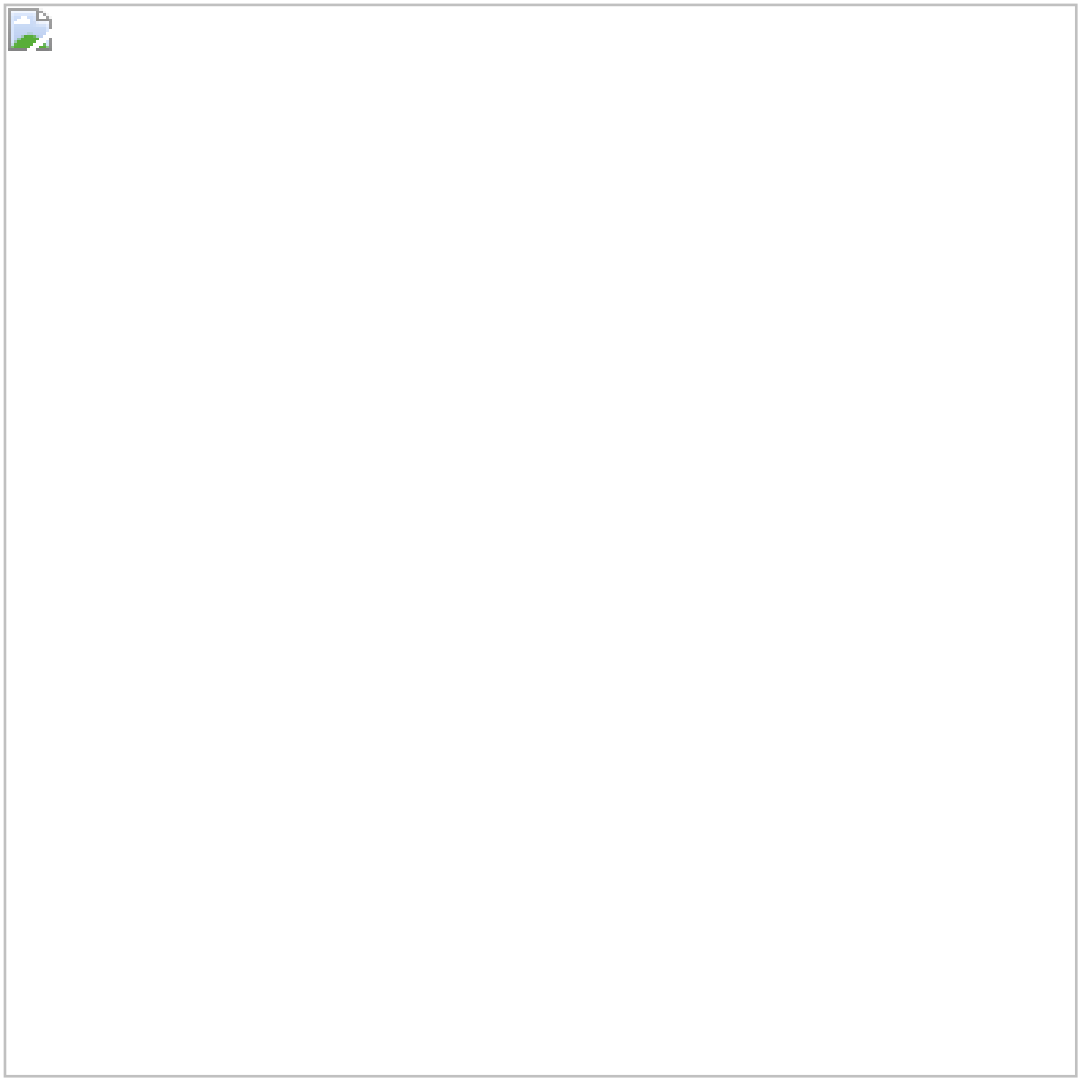

Perceptions on Barn Owls and Their Use in Rodent Control: A Case Study of Hwange District

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Review Article

Perceptions on Barn Owls and Their Use in Rodent Control: A Case Study of Hwange District

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Abstract

Background and Research Aims: Myths and beliefs shape the relationships that people have with different species. They lead to the protection of revered species and the persecution of negatively viewed species. In some instances, people fear these species resulting in a failure to tap into their benefits. This study investigates the possibility of using Barn Owls, a species largely linked to traditional beliefs, as a biological control for rodent pests.

Methods: Data was collected through a questionnaire survey. Chi-square tests were used to assess the links between socio-demographic variables and the people's attitude towards the use of owls in rodent control. A Generalised Linear Model was used to investigate the influence of the distance of the homestead from a protected area on their perceptions of owls.

Results: Although most respondents acknowledged that they had a rodent problem, 41% would not use owls for their control. More females than males did not want to use owls for fear of being labelled as witches, whilst males felt owls were good for rodent control and ecosystem balance. Level of education and age did not influence people's perceptions. People living closer to a protected area embraced the use of owls in rodent control and village of origin influenced perception of owls. Most teenagers displayed the same attitude towards owls as their mothers.

Conclusion: Gender and parental influence play a role in influencing the perceptions of the community on owls. There is need to further investigate the factors within a village which influence perceptions on owls.

Implications for Conservation: Cultural beliefs should be considered in conservation as the belief in witchcraft transcends age and education. There is need for conservation efforts to focus on improving ecological literacy of target groups to improve the conservation of feared species.

Keywords

perceptions, barn owl, biological control, rodent pests, biodiveristy conservation, belief systems

Introduction

Nature is highly regarded for the ecosystem services it provides, yet the disservices which mainly affect people living next to protected areas are often disregarded in the cost–benefit analysis of nature (Blanco, et al., 2019; Larson, et al., 2019). Ecosystem disservices are the 'perceived or actual negative impacts on human wellbeing' of ecosystem functions (Shackleton, et al., 2016). They impact on the economic and non-economic aspects of human life (Blanco et al., 2019). Where performed, human–wildlife conflict management by authorities in the African savanna often

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addresses challenges with predators and mega-herbivores and sometimes small-medium herbivores including baboons (*Papio* spp.) and wild pigs (*Potamochoerus porcus*) (Hill, 1997). The major culprits of crop damage, insects and rodents are often dealt with on a farm-to-farm basis (Makundi, et al., 2005) with major conservation efforts focusing on larger species (Arlet & Molleman, 2007) such as elephants (*Loxodonta africana*) and baboons.

Rodents are one the most numerous invasive species globally (Buckle & Smith, 1994), damaging maize crops (*Zea mays*) and other crops at different stages of growth, leading to great economic loss, threatening food security and the potential spread of diseases (Mayamba, et al., 2019). Rodents have mainly been controlled through the use of anticoagulants (which are hazardous to the environment and cause secondary poisoning on rodent-eating carnivores) (Mdangi, et al., 2016), traps (whose effectiveness is low as most of them catch a single rodent at any moment) and cats (which are low in numbers, hence their effectiveness on a large scale is low) (Mahlaba, et al., 2017). Further, domestic cats negatively impact wildlife through predation, harassment, disease transmission and hybridisation (Plaza, et al., 2019). Whilst livelihoods, culture and customs influence management of rodents amongst subsistence farmers (Brown, et al., 2018), the management is mainly based on economic reasons; hence, control is undertaken when there are crops in the fields (Makundi, et al., 2005).

There is a cost which comes with the chemical control of rodents, raising a further challenge for communities living adjacent to protected areas as they already suffer the most from living next to protected areas (Vedeld, et al., 2012). Thus, biological control of pests at no cost to farmers and the use of other locally available pesticidal plants with no cytotoxicity may be the most probable solution to rodent-crop damage for such communities (Mdangi, et al., 2016).

Barn Owls (*Tyto alba*) are widespread and their diet consists of 99.5% rodents (Kross, et al., 2018), thus a pair and their offspring eat at least 3000 rats a year (Endangered Wildlife Trust, 2006). Hence, they are potential controllers of the rodent population and their use reduces the risk of secondary poisoning on non-target species. Farmers in some parts of the world are using Barn Owls to control rodent populations with high success rates (Kan, et al., 2014; Meyrom, et al., 2009). This method has not been used widely in subsistence farms in Africa where owls are believed to be a bad omen, used in witchcraft (Enríquez-Rocha & Mikkola, 1997). This creates a challenge as other control methods, including other Ecologically Based Rodent Management (EBRM) strategies, are considered expensive and the continent lacks adequate expertise in their use (Makundi & Massawe, 2011).

Farmer's knowledge (Knowledge is a collection of experience and suitable information and expert understanding which offers a structure for assessing and integrating new experiences and information (Mohajan, 2016) of and perceptions (The way an individual observes, understands, interprets and evaluates a subject, an item or act (Bennett, 2016)) shape their attitudes and responses to crop raiding by wildlife (Anand, et al., 2018) and should be considered when introducing control methods (Hill, 2004; Mulungu, et al., 2015). Farmers' perception of damage determines the level of control that they are willing to engage. In a study of local people's perceptions of wildlife in northern Tanzania, Bencin et al. (2016) found that negative attitudes towards wildlife were associated with negative past experiences and fear and not associated with costs or socio-demographic variables. Thus, individuals who perceive higher negative interactions with particular species of wildlife want a reduction in their populations (Kross, et al., 2018). Livestock depredation and crop damage influence negative attitudes in farmers towards perceived problem animals (Noga, et al., 2018).

Cultural beliefs however, determine how people want species linked to their beliefs handled, with species linked to witchcraft being treated inhumanely and those linked to allegory, positive myths and totemic stand-ins being treated positively (Anand, et al., 2018; Buckland & Nattrass, 2019). Animals that are linked to witchcraft are feared in many communities (Enríquez-Rocha & Mikkola, 1997) with some of them used in traditional medicine either to ward off bad omen or bring good luck (Cocks & Møller, 2002; Soewu, 2008). Owls are amongst the negatively viewed animals as they are believed to be a messenger of death, to be used on magic medicine, a mythical creature created by witches and wizards and also believed to bring misfortune (Mikkola & Mikkola, 1997). There is clearly a trade-off between the regulatory services by Barn Owls and the cultural values linked to witchcraft and bad omen.

Rodent control to minimise populations, hence, to prevent losses in crop production, is a key strategy to achieving food security, agro-ecological sustainability and economic development amongst small-holder farms (Swanepoel, et al., 2017). In this study, we assessed the community's perceptions on owls and determined their willingness to adopt the use of Barn Owls as a possible biological control method for rodents. We investigated the effect that gender, age and level of education (Cailly Arnulphi, et al., 2017) and distance from the protected area had on the people's attitude towards the use of owls in rodent control. The effect of village of origin on attitude towards rodents and owls was also assessed. Parental influence on the responses of teenagers was also tested (Clark, et al., 2017).

We expected that older people and less educated individuals would have negative attitudes towards owls as they are expected to be more influenced by traditional beliefs. The women in the household may also be more susceptible to witchcraft rumors as they seem to be more prone than men to accusation, in particular elderly women (Eboiyehi, 2017). The perceptions of parents were not expected to influence those of teenagers, in particular due to access to education as well as different sources of information. People from villages closer to the protected area were expected to have positive attitudes towards owls, either because they were more

exposed to awareness campaigns or because the effect of rodent-eating wild species may be more visible closer to the conservation area.

Methods

Study Area

The study was conducted in the communal areas of Ward 14 and 15, bordering gazetted protected areas within Hwange District in northwest Zimbabwe, an area which is part of the south-eastern section of the KAZA Trans-frontier Conservation Area (TFCA) in Zimbabwe. This area of study borders Hwange National Park, Main Camp area (HNP) (14 561 km^2), centred on 19°00'S, 26°30'E (Tarakini, et al., 2018) and Sikumi Forest Area (SFA) (544 km^2), a photographic and hunting area, both protected by legislation through the Parks and Wildlife Act (Chapter 20:14) and the Forest Act (19:04), respectively.

Neither protected area is fenced, but nevertheless separated from the communal land by a small buffer zone being a railway line and a road, respectively (Figure 1), thus likely resulting in the high numbers of reported human–wildlife conflict cases (Le Bel, et al., 2010; Loveridge, et al., 2017). Rodent crop damage was not reported as conflict, although rodents generally occur in the area and outbreaks occur almost on a decade cycle (Leirs, et al., 2010; Mazarire, 2016). Although the area is prone to conflict from mega-fauna and primates, local communities still practise subsistence farming. The need for this is also exacerbated by the unstable Zimbabwean economy which has threatened livelihoods and left many persons partly dependent on natural resources to buttress their livelihoods (Chirau, et al., 2014). The Hwange District as a whole has adopted the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE), although the programme has been crippled by repeated political and economic crises in the last two decades.

The area under study falls within natural eco-regions IV and V, which are semi-arid areas with a mean annual rainfall of 600 mm or less in the wet season (Chamaillé-Jammes, et al., 2006). The area is characterized by Kalahari sands (Childes & Mundy, 2001), and as a result the crop yield is minimal although people in these communal areas rely on subsistence farming with the main crops being maize, sorghum (*Sorghum bicolor*) and pearl millet (*Pennisetum glaucum*) (Guerbois, et al., 2013). The threat to livelihoods is thus further affected by crop raiding and livestock preying by wild animals. The area has historically been inflicted with bubonic plague, a zoonotic disease transmitted through rodent fleas from both indigenous and exotic rodents and has experienced rodent outbreaks which have caused problems to subsistence farmers (Munyenyiwa, et al., 2019). Rodent species that have been identified as carriers in southern Africa

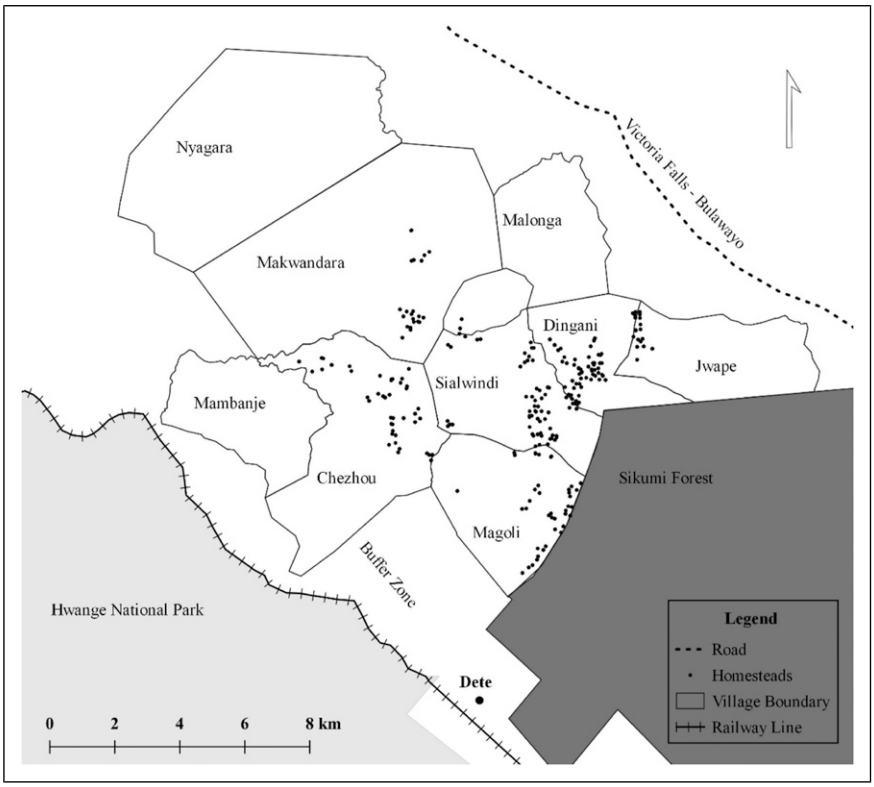

Figure 1. Map of the area where the survey was undertaken, showing the homesteads of respondents and protected areas.

include *Mastomys natalensis* and gerbil species (Munyenyiwa, et al., 2019).

While protected areas are viewed as source of wildlife, negatively affecting the crop fields, the economy of the area also relies on these protected areas through tourism activities (Guerbois & Fritz, 2017). The human population has been on the increase (Guerbois, et al., 2013), resulting in the creation of more homesteads and a reduction of grazing lands, thus negatively impacting on the natural vegetation. At the time of study, the areas had 1467 homesteads with a population of 7430 people. As a result, livestock is grazed 3 km into the SFA with permission from the Forestry Commission (Guerbois, et al., 2013).

Data Collection and Processing

Data on perceptions were collected through the stratified random administration of questionnaires and was targeted at people living within the designated study area. Permission to conduct the study was obtained from the District Administrator. Questionnaires were administered through trained assistants, who recorded all responses. A pilot study was conducted with assistants in the team to standardize the technique and thus, to reduce bias. Questions were asked in the language preferred by the respondent (Nambya, Ndebele, Tonga, Dombe or Shona). All visited homes were recorded using a Geographic Position System and their locations are shown in Figure 1.

Responses to open ended questions were recorded exhaustively to avoid recorder bias. In each homestead, everyone above the age of 14 years who was available took part in the survey, and each respondent was asked questions in the absence of other respondents to avoid duplication of responses. This was done to allow for the assessment of the effect of age on their responses. The effect of gender on the homestead's overall perceptions was also considered as household composition varied greatly (Webbink, et al., 2012). All responses were re-classified *a posteriori* to reduce the number of modalities in each variable while retaining as much information as possible. Thus, the results may partly be affected by our interpretation of the responses as qualitative analyses are always liable to researcher subjectivity (Guerbois, et al., 2013). The population in the area of study comprised mainly five ethnic groups namely, Nambya, Ndebele, Tonga, Dombe and Shona (Nhongo, 2014).

Socio-demographic data were collected through structured responses which allowed for easy categorisation into different variables in order to analyse their influence on perceptions by the study subjects (Table 1). The respondents were first asked if they were experiencing a rodent problem and the responses were binomial (yes/no). Once this was established, they were then asked if they would be comfortable with the use of Barn Owls in rodent control and this was also a binomial response variable (yes/no). Their responses to this question were categorised into articulated values, a way of classifying ecosystem services values across different analogies of human–nature relationships as suggested by Arias-Arévalo et al. (2018) (Table 1), although these authors only consider articulated values as positive gains from nature; the costs of nature to humans are ignored. In our case, the negatives were considered and were classified as a negative articulated value. The aim was to understand the depth of their myths and beliefs on owls. It was then investigated if age, gender, level of education, village of origin and distance of their homestead from a protected area, that is, either HNP or SFA influenced their perceptions on the use of Barn Owls as agents in rodent control. The effects of village of origin and homestead on attitudes towards owls were investigated. Parental influence on perceptions was assessed by comparing the perceptions of the parent with those of the teenagers in the homestead.

Data collection was done without prior knowledge of the village demarcations. Their accessibility determined the number of homesteads included in the survey in each village.

Data Analyses

Possible relationships between single socio-demographic variables (age, gender and education) and the attitude towards the use of owls in rodent eradication were tested using the χ^2 test (with $\alpha = 0.05$). A Moran's I test (Bivand & Wong, 2018) was used to check for spatial auto-correlation in the data linked to the attitude on the use of Barn Owls in rodent control. To understand the depth of the community's mythical beliefs with distance from the protected area, we assessed their perceptions on the use of owls in rodent control using a Generalised Linear Model (GLM) with a binomial error structure and a logit link function, that is, testing if the probability of saying 'yes' to the use of owls changed with distance to the protected area. Distances of each homestead from the nearest protected area (HNP or SFA) were computed as the distance from the centre of the homestead to the nearest edge of the protected area (Guerbois, et al., 2013).

The responses on why people had an issue/problem (i.e. did not want them used) with the use of Barn Owls in rodent control were classified into five articulated values, that is, ecological resilience, sacredness, moral duty, health and social cohesion (Table 1). A χ^2 test was used to assess if there was a relationship between gender and the articulated values expressed. We then performed a Multiple Correspondence Analysis (MCA) to visualize the relationship between, age, gender, education and whether people had an issue with the use of owls or not and the articulated values expressed on the use of owls in rodent control.

A χ^2 test was carried out to investigate the association between village of origin and the people's attitude towards the use of owls in their control. A pairwise nominal test was carried out to establish the relationship amongst villages. It was possible that the responses on how people felt about the use of owls in rodent control were nested within the village and homestead respectively, also acknowledging that

Table 1. Categorization of Informant's Socio-Demographic Variables and Attributes.

	Dimensions	Variable	Category	Description	Distribution of informants
Response variables	People's attitude towards the use of owls for rodent control (13 NAs)	Issue with the use of owls for rodent control	Yes	The question was 'Do you have an issue with the use of owls in rodent control'	258
			No		364
	On the reason whether to use or not owl and owl box for rodent control (319 NAs)	Use	Ecological resilience	Rodent control	69
			Moral duty	Ecosystem balance, children would tamper with them	14
		Not use	Health	Make noise at night	26
			Social cohesion	One would be labelled a witch for using owls for rodent control	29
			Sacredness	Used in witchcraft, fear, alternative methods of rodent control be used	178
Candidate variables	Spatial distribution	Distance to PA	Continuous	The closest distance from the centre of the homestead to either HNP or SFA boundary	Min: Max: Mean: 1st quartile Median: 3rd quartile:
		Village	Categorical (Chezhou, Dingani, Jwape, Magoli, Makwandara, and Sialwindi)	Six villages on a gradient distance to protected areas	See Figure 1
	Informants' socio-demographics	Homestead ID	The ID of the homestead	271 of 1467 homesteads were interviewed	
		Age	Teenager (#1)	Anyone within the age range of 15–20 years	135
			Young adult (#2)	Anyone within the age range of 21–30 years	136
			Thirty to forty (#3)	Anyone within the age range of 31–40 years	110
			Above forty (#4) (NAs 1)	Anyone whose age is greater than 40 years	253
		Gender	Male	This was based on the appearance of an individual	267
			Female		368
		Level of education	Minimal	Primary level or below of Zimbabwe system	310
			Secondary or tertiary	Education beyond primary level	325
	Farming	Storage (NAs 8)	House	Grain storage area	558
			Granary		69
		Harvest (74 NAs)	Less than 101 kg	Average yearly harvest, all grain crops combined	185
			Between 101 kg and 500 kg		267
			Between 501 kg and 1000 kg		68
			More than 1000 kg		41

NA refers to the number of respondents who did not respond to the question.

homestead and villages did not contribute equally to the data set analyses. Therefore, a Generalized Linear Mixed Model (GLMM) was run, with age, gender, education, storage and amount of harvest as response variables and village and homestead as random variables. Storage was either in a house or granary. Harvest was classified into 4 groups, that is, (i) 0–100 kg, (ii) 101–500 kg, (iii) 501–1000 kg and (iv) >1000 kg (Table 1).

To understand if the perceptions of the teenagers (aged 15–20) were influenced by those of either parent in the homestead a GLM was carried out for having an issue/problem with the use of owls in rodent control. The responses of teenagers were

compared with those of the adult female and male in the homestead respectively. The assumption was that this adult female or male was the parent or guardian of the teenage respondents. All statistical analyses were performed in the R statistical software (R Development Core Team, 2020).

Results

Socio-Demographic Variables

Altogether, 635 people (368 females and 267 males) from 271 homesteads were the survey population. The surveyed people were categorised according to age and their distribution was as follows: teenagers (21.3%), young adults (21.4%), 30 to 40 years (17.3%) and above forty (39.8%). One respondent refused to state his/her age group. Forty-nine percent of the respondents had minimum education whilst the rest had secondary or tertiary education (Table 1). The average distance of a homestead from a protected area was 2942 m (m), whilst the minimum distance was 0 m (on the boundary of SFA) and the maximum distance was 8170 m.

Use of Owls in Rodent Control

Of the respondents, 84% claimed to be facing a rodent problem as a result of the presence of rodents in the area. Fifty-seven percent of the surveyed people had no issue with the use of owls in rodent control, 41% had an issue and 2% did not respond to the question (Table 1). More female respondents had an issue with the use of Barn Owls in rodent control than males ($\chi^2 = 9.001$, df = 1, $p = .003$), that is, they did not want to use them. Level of education ($\chi^2 = 0.203$, df = 1, $p = .652$) and age ($\chi^2 = 2.51$, df = 3, $p = .474$) had no influence on their perception of the use of owls in rodent control. People had an issue with the use of owls in rodent control increasing with distance from the protected area (df = 573, Est. = 0.0001 ± 0.00,004, $p = .003$).

The articulated values expressed varied with gender (χ^2 =12.285, df = 4, $p = .015$) with more females expressing issues of sacredness and more males expressing ecological resilience as their answers on the use of owls in rodent control (Figure 2). Males against the use of owls mostly expressed health and social cohesion (Figure 2). More female respondents were further from the protected area than males (Figure 3).

The probability of both females and males wanting rodents eradicated and having an issue with the use of owls in rodent control increased with distance (Figure 3). There were more females wanting rodents eradicated than having an issue with the use of owls closest to the park. Yet amongst males, most of them had an issue with the use of owls than those wanting rodents eradicated. The probability of females in both cases was higher than that of males with distance.

The responses on whether people had an issue with the use of Barn Owls in rodent control or not were positively

Figure 2. The articulated values of the community on the use of owls in rodent control and the factors influencing them. The arrows show where related variables lie in relation to other attributes. Variables linked to certain articulated values lie close to those values. The articulated values were plotted as Resil. (ecological resilience), Sacredness (sacredness), Moral (moral duty), Health (health) and Soc. cohesion (social cohesion). The responses to whether people had an issue or not were plotted as IssuO.Yes (yes) and IssuO.No (no). Age was plotted as Age.U18 (teenager), Age.18–30 (young adult), Age.30–40 (30 to 40) and Age.A40 (above forty).

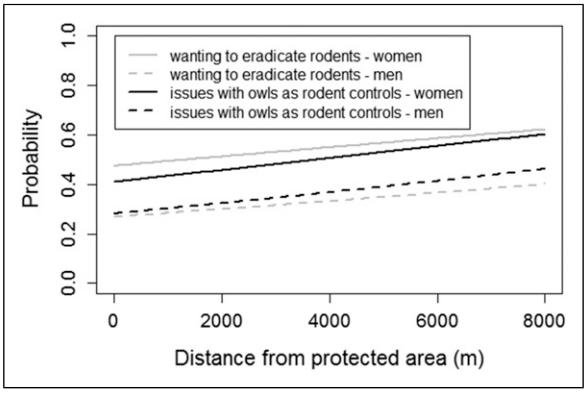

Figure 3. The results of a generalised linear model showing the effect of gender on the desire for rodent eradication and perception on the use of owls in their eradication. The lines represent the predicted probability in relation to the distance of the respondent's homestead to the protected area.

spatially correlated (statistic = 0.6039), observed rank = 575, $p = .0417$), suggesting a mild village or neighbour effect. Accordingly, there was a significant difference in how different villages felt about the use of owls in rodent control ($\chi^2 = 15.931$, df = 5, $p = .007$). The pairwise nominal test did not reveal the differences ($p > .05$) between villages. Nesting the variables within the homestead and village, respectively, in the GLMM showed that only gender influenced the attitude towards the use of owls

Table 2. Results From a Generalized Linear Mixed Model Showing Factors Influencing the Acceptance of the Owls in Rodent Control Within the Village and Homestead. Where σ^2 is the Residual Variance, $\tau 00$ is the Random Intercept Variance, the ICC is the Intraclass Correlation Coefficient N is the Total Number of Observations (i.e. Villages and Homesteads).

	Issue with the use of owls in rodent control		
Predictors	*Odds Ratios*	*CI*	*p value*
(Intercept)	0.52	0.29–.91	0.023
Young adult	1.14	0.65–2.00	0.654
Thirty to forty	0.74	0.41–1.36	0.337
Above forty	0.81	0.49–1.34	0.414
Gender [Female]	1.93	1.31–2.85	0.001
Storage [Granary]	1.02	0.56–1.88	0.940
Harvest [101–500 kg]	1.02	0.67–1.57	0.914
Harvest [501–1000 kg]	0.75	0.40–1.40	0.365
Harvest [+1000 kg]	0.68	0.31–1.48	0.327
Random Effects			
σ^2	3.29		
$\tau_{00\ homestead}$	0.19		
$\tau_{00\ Village}$	0.07		
ICC	0.08		
$N_{Village}$	6		
$N_{homestead}$	261		
Observations	543		
Marginal R^2/Conditional R^2	0.038/0.110		

(Table 2), with more females being against the use of owls than males.

Parental Influence

There was no relationship between the responses of teenagers and those of their fathers, yet their responses were significantly like those of their mothers (female: df = 68, Est. = 1.150 ± 0.511, $p = .021$; male: df = 33, Est = 0.300 ± 0.860, $p = .727$).

Discussion

This study focussed on understanding the perceptions of people living next to protected areas on rodent damage and the possible use of Barn Owls in the control of the rodents. It is important to consult and involve the people living with wildlife in the introduction of any strategies. Thus, the understanding of local ecological knowledge (LEK) (knowledge obtained through individuals' observations over their lifetimes (Gilchrist, et al., 2005)) and traditional ecological knowledge (Knowledge, practice and belief that pertains to the relationship of living beings and with their environment which is handed down through generations (Berkes, et al., 2000)) is key in the success of biodiversity conservation (Charnley, et al., 2007).

Witchcraft is a practice which is believed throughout most parts of Africa (Eboiyehi, 2017) and nocturnal animals are believed to be used as tools in the witches' trade. These animals include owls, Spotted Hyaena (*Crocuta crocuta*) and the Aardvark (*Orycteropus afer*) (Adeola, 1992). In believing in the practice of witchcraft, the people also believe in identifying witches, leading to witch hunts which have at times been fatal (Adinkrah, 2004). Elderly women are often on the receiving end of this practice in sub-Saharan Africa (Atata, 2019). A study in Kenya documented witch hunts in a month which resulted in 11 people (8 women and 3 men) being labelled witches (Federici, 2008).

Although environmental education has been around for over 30 years, it is only recently that it has started to involve women (Gough, 2006). Their participation in environmental issues is still lower than that of their male counterparts. This could also be a result of the limited time they have to attend awareness meetings as they are primarily responsible for the day to day running of their homes (Abdelali-Martini, 2011; Graham, et al., 2016). This limits the knowledge they have on environmental issues. Thus, it is not surprising that the women living next to Hwange National Park were reluctant to have owls being used to control rodents in the area. Most of them clearly stated they feared that if the owl was seen in their field or homestead, they would be 'labelled' a witch. As a result, more men than women express positive articulated values.

Level of education and age did not influence respondents' perceptions on owls. Other studies have shown that African people are generally a spiritual people, believing in the power of the spiritual and occult forces. A study focussing on the use of spiritual healing churches in Nigeria revealed that more educated people prefer spiritual churches whilst less educated people prefer traditional healers (Adegoke, 2007). This has also been found to be the case amongst people of other ethnicities. Thus, education does not impact on people's mythical beliefs and if these are to be overcome, various methods other than education must be employed (Pasachoof, et al., 1970). It has been proven that these beliefs in witchcraft work to the disadvantage of the poor as it affects the implementation of developmental projects and the improvement of livelihoods (Kohnert, 1996). This is seen even with the reluctance to adopt owls in rodent control without considering the benefits. Other studies still advocate for improved environmental education as a way of dealing with perceptions (Williams et al., 2021).

Human settlement areas can be good habitats for owls because they are good for commensal rodents, which can in turn benefit the farmers but the negative attitudes by farmers make it difficult to explore this (Ogada & Kibuthu, 2008). A study by Ogada and Kibuthu (2008) showed that 68% of a community did not identify with beliefs on owls yet their knowledge of owls did not positively impact their behaviour towards owls and the authors attribute this to a lack of ecological literacy and it is important that farmers understand

ecological processes. The belief of witchcraft transcends age and the beliefs are held across age groups.

The people living closer to protected areas were more in favour of the use of owls in rodent control. People living closer to protected areas experience more human wildlife conflict (Megaze, et al., 2017) and would be expected to have more negative attitudes towards wildlife. Environmental awareness programmes tend to focus on people living next to wildlife and as a result they exhibit more ecological literacy. The tourism industry in and around protected areas mostly hires from communities living next to protected areas, this not only influences their attitude towards wildlife but could also increase their ecological literacy (Digun-Aweto, et al., 2019). In some instances, people living furthest from protected areas have a positive attitude towards wildlife as they experience less loss due to wildlife conflict (Karlsson & Sjöström, 2007). Human wildlife conflict tends to be highest closest to protected areas and decreases with distance (Karlsson & Sjöström, 2007; Karanth et al., 2013), although in some cases the opposite is true as people living near protected areas are more involved in conservation oriented development projects and other ecotourism based benefits (Infield, 1988). Interestingly, a Human Elephant Conflict (HEC) survey (Sampson, et al., 2019) revealed that farmers living closest to the protected area, thus experiencing more conflicts, were most supportive to elephant conservation. Environmental education thus fosters a positive attitude towards wildlife as it imparts information on environmental values (Guerbois, et al., 2013).

Parents/guardians were found to have some influence on the perceptions of teenagers. The teenagers' perceptions on owls mirrored those of their mothers. This would suggest that when it comes to mythical beliefs children mirror the beliefs of the parent they spend more time with. Children have been shown to spend more time with their mothers who provide primary care (Pedersen, 2012). As a result, they feel they receive more positive treatment, emotions and closeness from their mothers, allowing them to learn more from them (Miller & Lane, 1991). It may also be that the fear of the unknown is more powerful than reason.

The environment in which people live tends to influence their perceptions. Gifford and Nilsson (2014) described the social influences on pro-environmental concern and behaviour and these include religion, local norms, social class, proximity to the problematic sites and cultural variations. The villages also varied in their attitudes towards the possible use of owls in rodent eradication. This could be a result of the differing levels of environmental and conservation consciousness, mostly influenced by effort put in raising awareness on conservation and proximity to problem sites (Gifford & Nilson, 2014). The pairwise analysis did not show these differences possibly due to low sampling effort in some areas.

The farmers' perceptions must be considered in the use of owls as they shape the attitudes and responses of the people to crop raiding by different species and to the negative beliefs on owls and witchcraft (Hill, 2004). Increased participation of the community in Ecologically Based Rodent Management through improved knowledge on rodent behaviour, their predators, environmental manipulation to deter rodents and improved attitudes could help deal with perceptions (Makundi & Massawe, 2011; Williams et al., 2021).

Implications for Conservation

There is a wealth of knowledge on wild animals believed to be used for witchcraft and on witchcraft in general. It is clear that these beliefs produce negative attitudes toward the animals (Enríquez-Rocha & Mikkola, 1997) to the detriment of the species or leading to a failure to harness ecosystem services offered by the species in question. It is therefore important that conservation cautiously approaches these misconceptions in an effort to break them. Communities in Chile have positive perceptions of owls which are based on aesthetical and ethical values but not serviceable ones (Godoy-Güinao et al., 2017). The expressed values allow for the conservation of the birds, hence allowing the communities to benefit also from the ecosystem services they provide without necessarily being aware of them. This highlights the need for improved education and awareness even in areas where owls are not persecuted to create a better appreciation of their value.

The study highlights the factors influencing attitudes towards owls (with Barn Owls used as a proxy in this study), thus indicating to conservationists the important aspects to consider in efforts to confront the myths on these birds. The study shows that in Zimbabwe, like other countries women are the most vulnerable to witchcraft labels (Atata, 2019; Eboiyehi, 2017) and any conservation efforts aimed at dealing with these issues needs to be strategized accordingly. The study also highlights the need to effectively distribute awareness programmes as educating only those closest to the protected area does not effectively protect the wildlife. The findings call for a deeper understanding of people's relationship with certain species. Values and relationships are complex and need to be investigated further. Other factors that need to be investigated include ethnic group and religion.

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The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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References

Abdelali-Martini, M. (2011). Empowering women in the rural labor force with a focus on agricultural employment in the Middle East and North Africa (MENA). Expert paper. Expert group meeting: Enabling rural women's economic empowerment: Institutions, opportunities and participation. *Expert paper prepared for the Expert Group Meeting "Enabling Rural Women's Economic Empowerment: Institutions, Opportunities and Participation"*, *Accra*, *Ghana*, *20–23 September 2011*.

Adegoke, T. G. (2007). Socio-cultural factors influencing the use of spiritual healing churches in Ibadan Metropolis, Nigeria. *The Anthropologist*, *9*(3), 225-232. https://doi.org/10.1080/09720073.2007.11891004.

Adeola, M. O. (1992). Importance of wild animals and their parts in the culture, religious festivals, and traditional medicine of Nigeria. *Environmental Conservation*, *19*(2), 125–134. https://doi.org/10.1017/S0376892900030605

Adinkrah, M. (2004). Witchcraft accusation and female homicide victimization in contemporary Ghana. *Violence Against Women*, *10*(4), 325–356. https://doi.org/10.1177/1077801204263419

Anand, S., Binoy, V. V., & Radhakrishna, S. (2018). The monkey is not always a God: Attitudinal differences toward crop-raiding macaques and why it matters for conflict mitigation. *Ambio*, *47*(6), 711–720. https://doi.org/10.1007/s13280-017-1008-5

Arias-Arévalo, P., Gómez-Baggethun, E., Martín-López, B., & Pérez-Rincón, M. (2018). Widening the evaluative space for ecosystem services: A taxonomy of plural values and valuation methods. *Environmental Values*, *27*(1), 29–53. https://doi.org/10.3197/096327118X15144698637513

Arlet, M. E., & Molleman, F. (2007). Rodents damage crops more than wildlife in subsistence agriculture on the northern periphery of Dja Reserve, Cameroon. *International Journal of Pest Management*, *53*(3), 237–243. https://doi.org/10.1080/09670870701418994

Atata, S. N. (2019). Aged women, witchcraft, and social relations among the Igbo in south-eastern Nigeria. *Journal of Women & Aging*, *31*(3), 231–247. https://doi.org/10.1080/08952841.2018.1436415

Bencin, H., Kioko, J., & Kiffner, C. (2016). Local people's perceptions of wildlife species in two distinct landscapes of northern Tanzania. *Journal of Nature Conservation*, *34*, 82-92. https://doi.org/10.1016/j.jnc.2016.09.004.

Bennett, N. J. (2016). Using perceptions as evidence to improve conservation and environmental management. *Conservation Biology*, *30*(3), 582–592. https://doi.org/10.1111/cobi.12681

Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications*, *10*(5), 1251–1262. https://doi.org/10.1890/1051-0761(2000)010[1251:roteka]2.0.co;2

Bivand, R. S., & Wong, D. W. S. (2018). Comparing implementations of global and local indicators of spatial association. *TEST*, *27*(3), 716–748. https://doi.org/10.1007/s11749-018-0599-x

Blanco, J., Dendoncker, N., Barnaud, C., & Sirami, C. (2019). Ecosystem disservices matter: Towards their systematic integration within ecosystem service research policy. *Ecosystem Services*, *36*, Article 100913. https://doi.org/10.1016/j.ecoser.2019.100913

Brown, P. R., Aplin, K. P., Hinds, L. A., Jacob, J., Thomas, S. E., & Ritchie, B. J. (2018). Corrigendum to: Rodent management issues in South Pacific islands: A review with case studies from Papua New Guinea and Vanuatu. *Wildlife Research*, *45*(2), 193. https://doi.org/10.1071/WR17104_CO

Buckland, A., & Nattrass, N. (2019). Understanding preferences for humane and cruel treatment of pest rodents in Site C, Khayelitsha, South Africa. *Journal of Applied Animal Welfare Science*, *16*(3), 1–10. https://doi.org/10.1080/10888705.2019.1666008

Buckle, A. P., & Smith, R. H. (1994). *Rodent pests and their control*. Oxford University Press.

Cailly Arnulphi, V. B., Lambertucci, S. A., & Borghi, C. E. (2017). Education can improve the negative perception of a threatened long-lived scavenging bird, the Andean Condor. *PLoS One*, *12*(9), Article e0185278. https://doi.org/10.1371/journal.pone.0185278

Chamaillé-Jammes, S., Fritz, H., & Murindagomo, F. (2006). Spatial patterns of the NDVI -rainfall relationship at the seasonal and interannual time scales in an African savanna. *International Journal of Remote Sensing*, *27*(23), 5185–5200. https://doi.org/10.1080/01431160600702392

Charnley, S., Fischer, A. P., & Jones, E. T. (2007). Integrating traditional and local ecological knowledge into forest biodiversity conservation in the Pacific Northwest. *Forest Ecology and Management*, *246*(1), 14–28. https://doi.org/10.1016/j.foreco.2007.03.047

Childes, S., & Mundy, P. (2001). Important bird areas of Zimbabwe. In L. D. C. Fishpool, & M. I. Evans (Eds), *Important bird areas in Africa and associated Islands: Priority sites for conservation* (pp. 1025–1042). Pisces Publications and Birdlife International.

Chirau, T. J., Nkambule, S., & Mupambwa, G. (2014). Rural livelihoods in Zimbabwe: Heterogeneity, diversification and vulnerability. *International Journal of Innnovation and Applied Studies*, *5*(1), 5–15. doi=10.1.1.674.6832&rep=rep1&type=pdf

Clark, K. E., Cupp, K., Phelps, C. L., Peterson, M. N., Stevenson, K. T., & Serenari, C. (2017). Household dynamics of wildlife value orientations. *Human Dimensions of Wildlife*, *22*(5), 483–491. https://doi.org/10.1080/10871209.2017.1345022

Cocks, M., & Møller, V. (2002). Use of indigenous and indigenised medicines to enhance personal well-being: A South African case study. *Social Science & Medicine*, *54*(3), 387–397. https://doi.org/10.1016/S0277-9536(01)00037-5

Digun-Aweto, O., Fawole, O. P., & Saayman, M. (2019). The effect of distance on community participation in ecotourism and conservation at Okomu National Park Nigeria. *GeoJournal*, *84*(5), 1337–1351. https://doi.org/10.1007/s10708-018-9922-z

Eboiyehi, A. (2017). Convicted without Evidence: Elderly women and witchcraft accusations in contemporary Nigeria. *Journal of International Women's Studies*, *18*(4), 247–264. https://doi.org/10.4018/978-1-5225-9531-1.ch019

Endangered-Wildlife-Trust (2006). *Owls and farmers*. Omnia.

Enríquez-Rocha, P. L., & Mikkola, H. (1997). Comparative study of general public owl knowledge in Costa Rica, Central America and Malawi, Africa. In J.R. Duncan, D.H. Johnson, & T.H. Nicholls (Eds), *Biology and conservation of owls of the northern hemisphere* (pp. 160–166). USDA Forest Service.

Federici, S. (2008). Witch-hunting and feminist solidarity in Africa today. *Journal of International Women's Studies*, *10*(1), 21–35.

Gifford, R., & Nilson, A. (2014). Personal and social factors that influence pro-environmental concern and behaviour: A review. *International Journal of Psychology*, *49*(3), 141–157. https://doi.org/10.1002/ijop.12034

Gilchrist, G., Mallory, M., & Merkel, F. (2005). Can local ecological knowledge contribute to wildlife management? Case studies of migratory birds. *Ecology and Society*, *10*(1), 20. https://doi.org/10.5751/es-01275-100120

Godoy-Güinao, J., Díaz, I. A., Llanos-Pineda, M., & Alò, D. (2017). Feeding habits and people's perception of the Barn owl (Tyto alba tuidara, J.E. Gray 1829) in urban settings of southern Chile: Implications for conservation. *Gayana*, *81*(1), 9–16. https://doi.org/10.4067/s0717-65382017000100009

Gough, A. (2006). Recognising women in environmental education Pedagogy and research: Toward an ecofeminist post-structuralist perspective. *Environmetal Education Research*, *5*(2), 143–161. https://doi.org/10.1080/1350462990050202

Graham, P., Hirai, M., & Kim, S.S. (2016). An analysis of water collection labor among women and children in 24 sub-Saharan countries. *PloS one*, *11*(6), Article e0155981. https://doi.org/10.1371/journal.pone.0155981

Guerbois, C., Dufour, A., Mtare, G., & Fritz, H. (2013). Insights for integrated conservation from attitudes of people toward protected areas near Hwange National Park, Zimbabwe. *Conservation Biology*, *27*(4), 844–855. https://doi.org/10.1111/cobi.12108

Guerbois, C., & Fritz, H. (2017). Patterns and perceived sustainability of provisioning ecosystem services on the edge of a protected area in times of crisis. *Ecosystem Services*, *28*(Part B), 196-206. https://doi.org/10.1016/j.ecoser.2017.11.010.

Hill, C. M. (1997). Crop-raiding by wild vertebrates: The farmer's perspective in an agricultural community in Western Uganda. *International Jurnal of Pest Manangement*, *43*(1), 77–84. https://doi.org/10.1080/096708797229022

Hill, C. M. (2004). Farmers' perspective of conflict at the wildlife-agriculture boundary: Some lessons learned from African subsistence farmers. *Human Dimensions of Wildlife*, *9*(4), 279–286. https://doi.org/10.1080/10871200490505710

Infield, M. (1988). Attitudes of a rural community towards conservation and a local conservation area in Natal, South Africa. *Biological Conservation*, *45*(1), 21–46. https://doi.org/10.1016/0006-3207(88)90050-x

Kan, I., Motro, Y., Horvitz, N., Kimhi, A., Leshem, Y., Yom-Tov, Y., & Nathan, R. (2014). Agricultural rodent control using Barn Owls: Is it profitable? *American Journal of Agricultural Economics*, *96*(3), 733–752. https://doi.org/10.1093/ajae/aat097

Karanth, K. K., Gopalaswamy, A. M., Prasad, P. K., & Dasgupta, S. (2013). Patterns of human-wildlife conflicts and compensation: Insights from Western Ghats protected areas. *Biological Conservation*, *166*, 175–185. https://doi.org/10.1016/j.biocon.2013.06.027

Karlsson, J., & Sjöström, M. (2007). MHuman attitudes towards wolves, a matter of distance. *Biological Conservation*, *137*(4), 610–616. https://doi.org/10.1016/j.biocon.2007.03.023

Kohnert, D. (1996). Magic and witchcraft: Implications for democratization and poverty-alleviating aid in Africa. *World Development*, *24*(8), 1347–1355. https://doi.org/10.1016/0305-750X(96)00045-9

Kross, S. M., Ingram, K. P., Long, R. F., & Niles, M. T. (2018). Farmer perceptions and behaviors related to wildlife on-farm conservation actions. *Conservation Letters*, *11*(1), Article e12364. https://doi.org/10.1111/conl.12364

Larson, K. L., Corley, E. A., Andrade, R., Hall, S. J., York, A. M., Meerow, S., Coseo, P., Childers, D. L., & Hondula, D. M. (2019). Subjective evaluations of ecosystem services and disservices; an approach to creating and analyzing robust survey scales. *Ecology and Society*, *24*(2), Article art7. https://doi.org/10.5751/ES-10888-240207

Le Bel, S., Taylor, R., Lagrange, M., Ndoro, O, Barra, M., & Madzikanda, H. (2010). An easy-to-use capsicum delivery system for crop-raiding elephants in Zimbabwe: Preliminary results of a field test in Hwange National Park. *Pachyderm*, *47*(1), 80–89.

Leirs, H., Sluydts, V., & Makundi, R. (2010). Rodent outbreaks in sub-Sahara Africa. In G.R. Singleton, S.R. Belmain, P.R. Brown, & B. Hardy (Eds.), *Rodent outbreaks: Ecology and impacts* (pp. 269–280). International Rice Research Institute.

Loveridge, A. J., Kuiper, T., Parry, R. H., Sibanda, L., Hunt, J. H., Stapelkamp, B., Sebele, L., & Macdonald, D. W. (2017). Bells, bomas, and beefsteak: Complex patterns of huma-prdator conflict at the wildlife-agropastoral interface in Zimbabwe. *PeerJ*, *5*, Article e2898. https://doi.org/10.7717/peerj.2898

Mahlaba, T. A. M., Monadjem, A., McCleery, R., & Belmain, S. R. (2017). Domestic cats and dogs create a landscape of fear for pest rodents around rural homesteads. *PLoS One*, *12*(2), Article e0171593. https://doi.org/10.1371/journal.pone.0171593

Makundi, R. H., Bekele, A., Leirs, H., Massawe, A., Rwamugira, W., & Mulungu, L. (2005). Farmer's perceptions of rodents as crop pests: Knowledge, attitudes and practices in rodent pest management in Tanzania and Ethiopia. *Belgian Journal of Zoology*, *135*(supplement), 153–157.

Makundi, R. H., & Massawe, A. W. (2011). Ecologically based rodent management in Africa: Potential and challenges. *Wildlife Research*, *38*(7), 588–595. https://doi.org/10.1071/WR10147

Mayamba, A., Byamungu, R. M., Makundi, R. H., Kimaro, D. N., Isabirye, M., Massawe, A. W., Kifumba, D., Nakiyemba, A., Leirs, H., Mdangi, M. E., Isabirye, B. E., & Mulungu, L. S. (2019). Species composition and community struture of small pest rodents (Muridae) in cultivated and fallow fields in maize growing areas in Mayuge district, Eastern Uganda. *Ecology and Evolution*, *9*(13), 7849–7860. https://doi.org/10.1002/ece3.5371

Mazarire, G. C. (2016). The burrowed earth: Rodents in Zimbabwe's environmental history. *Critical African Studies*, *8*(2), 109–135. https://doi.org/10.1080/21681392.2016.1242235

Mdangi, M., Sibuga, P. K., Massawe, A. W., Magadula, J. J., Ngowo, V., Mrosso, F. P., Mkangwa, Z. C., Kilonzo, B. S., & Mulungu, L. S. (2016). Farmer's knowledge, attitude and perceptions on the use of locally available plant material to prevent rodent damage to maize crop in Eastern Tanzania. *African Journal of Agricultureal Research*, *11*(48), 4902-4910. https://doi.org/10.5897/AJAR2016.11715.

Megaze, A., Balakrishnan, M., & Belay, G. (2017). Human-wildlife conflict and attitude of local people towards conservation of wildlife in Chebera Churchura National Park, Ethiopia. *African Zoology*, *52*(1), 1–8. https://doi.org/10.1080/15627020.2016.1254063

Meyrom, K., Motro, Y., Leshem, Y., Aviel, S., Izhaki, I., Argyle, F., & Charter, M. (2009). Nest-box use by th Barn Owl Tyto alba in a biological pest control program in the Beit She'an valley, Israel. *Ardea*, *97*(4), 463–467. https://doi.org/10.1080/15627020.2016.1254063

Mikkola, H., & Mikkola, H. (1997). General public owl knowledge in Malawi. *Society of Malawi Journal*, *50*(1), 13–35.

Miller, J. B., & Lane, M. (1991). Relations between young adults and their parents. *Journal of Adolescence*, *14*(2), 179–194. https://doi.org/10.1016/0140-1971(91)90030-u

Mohajan, H. K. (2016). Knowledge is an essential element at present world. *International Journal of Publication and Social Studies*, *1*(1), 31-53. https://doi.org/10.18488/journal.135/2016.1.1/135.1.31.53.

Mulungu, L. S., Mrosso, F. P., Katakweba, A., Mdangi, M. E., Tesha, P. P. H., Ngowo, V., Mchomvu, M., & Kilonzo, B. S. (2015). Farmer's knowledge, attitude and practice on rodent manangement in lowland irrigated rice in cenral-eastern Tanzania. *International Research Journal of Plant Science*, *6*(1), 7–14.

Munyenyiwa, A., Zimba, M., Nhiwatiwa, T., & Barson, M. (2019). Plague in Zimbabwe from 1974 to 2018: A review article. *PLoS Neglected Tropical Diseases*, *13*(11), Article e0007761. https://doi.org/10.1371/journal.pntd.0007761

Nhongo, R. (2014, September 22–26). *Tracing the historical experiences of the Nambya people through their toponyms and antroponyms*. Paper presented at NSA. Victoria Falls, Zimbabwe.

Noga, S. R., Kolawole, O. D., Thakadu, O. T., & Masunga, G. S. (2018). 'Wildlife officials only care about animals': Farmers' perceptions of a Ministry-based extension delivery system in mitigating human-wildlife conflicts in the Okavango Delta, Botswana. Niehaus, I. (1995). Witches of the Transvaal Lowveld and their familiars. Conceptions of duality, power and desire. *Cahiers d'Etudes Africaines*, *35*(139), 513–540. https://doi.org/10.3406/cea.1995.1458

Ogada, D. L., & Kibuthu, P. M. (2008). Conserving Mackinder's eagle owl in farmlands of Kenya: Assessing the influence of pesticide use, tourism and local knowledge of owl habits in protecting a culturally loathed species. *Environmental Conservation*, *35*(3), 252–260. https://doi.org/10.1017/S0376892908005006

Pasachoof, J., Cohen, R. J., & Pasachoff, N. W. (1970). Belief in the supernatural among Harvard and west African university students. *Nature*, *227*(5261), 971–972. https://doi.org/10.1038/227971a0

Pedersen, D. E. (2012). The good mother, the good father, and the good parent: Gendered definitions of parenting. *Journal of Feminist Family Therapy*, *24*(3), 230–246. https://doi.org/10.1080/08952833.2012.648141

Plaza, P. I., Speziale, K. L., Zamora-Nasca, L. B., & Lambertucci, S. A. (2019). Dogs and cats put wildlife at risk. *The Journal of Wildlife Management*, *83*(4), 767–768. https://doi.org/10.1002/jwmg.21637

R Development Core Team (2020). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing.

Sampson, C., Leimgruber, P., Rodriguez, S., McEvoy, J., Sotherden, E., & Tonkyn, D. (2019). Perception of human–elephant conflict and conservation attitudes of affected communities in Myanmar. *Tropical Conservation Science*, *12*, 1–17. https://doi.org/10.1177/1940082919831242

Shackleton, C. M., Ruwanza, S., Sinasson Sanni, G. K., Bennett, S., De Lacy, P., Modipa, R., Mtati, N., Sachikonye, M., & Thondhlana, G. (2016). Unpacking Pandora's box: Understanding and categorising ecosystem disservices for environmental management and human wellbeing. *Ecosystems*, *19*(4), 587–600. https://doi.org/10.1007/s10021-015-9952-z

Soewu, D. A. (2008). Wild animals in ethnozoological practices among the Yorubas of southwestern Nigeria and the implications for biodiversity conservation. *African Journal of Agricultural Research*, *3*(6), 421–427. https://doi.org/10.5897/AJAR.9000765

Swanepoel, L. H., Swanepoel, C. M., Brown, P. R., Eiseb, S. J., Goodman, S. M., Keith, M., Kirsten, F., Leirs, H., Mahlaba, T. A. M., Makundi, R. H., Malebane, P., von Maltitz, E. F., Massawe, A. W., Monadjem, A., Mulungu, L. S., Singleton, G. R., Taylor, P. J., Soarimalala, V., & Belmain, S. R. (2017). A systematic review of rodent pest research in Afro-Malagasy small-holder farming systems: Are we asking the right questions? *PLoS One*, *12*(4), Article e0174554. https://doi.org/10.1371/journal.pone.0174554

Tarakini, T., Guerbois, C., Wencelius, J., Mundy, P., & Fritz, H. (2018). Integrating local ecological knowledge for waterbird conservation: Insights from Kavango-Zambezi Transfrontier conservation area, Zimbabwe. *Tropical Conservation Science*, *11*, 1-17. https://doi.org/10.1177/1940082918803810.

Vedeld, P., Jumane, A., Wapalila, G., & Songorwa, A. (2012). Protected areas, poverty and conflicts: A livelihood case study of Mikuni National Park, Tanzania. *Forest Policy and Economics*, *21*, 20-31. https://doi.org/10.1016/j.forpol.2012.01.008.

Webbink, E., Smits, J., & de Jong, E. (2012). Hidden child labor: Determinants of house and family business work of children in 16 developing countries. *World Development*, *40*(3), 631–642. https://doi.org/10.1016/j.worlddev.2011.07.005

Williams, S. T., Williams, K. S., Constant, N., Swanepoel, L. H., Taylor, P. J., Belmain, S. R., & Evans, S. W. (2021). Low-intensity environmental education can enhance perceptions of culturally taboo wildlife. *Ecosphere*, *12*(7). DOI:10.1002/ecs2.3482.