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Low-intensity environmental education can enhance perceptions of culturally taboo wildlife

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Abstract. Traditional cultural beliefs influence perceptions of animals and can result in persecution of wildlife. In Africa, stigmas against species associated with witchcraft can act as a barrier to the uptake of sustainable practices such as reducing crop damage through reliance on indigenous predators rather than pesticides to control rodent agricultural pests. One way of enhancing perceptions of wildlife to increase participation in ecologically based rodent management schemes is through environmental education. Low-intensity programs can produce positive attitudinal shifts, but their impact has not been assessed for species strongly associated with witchcraft. We tested whether a presentation on the natural history of owls in the Limpopo Province of South Africa could improve perceptions of these species and increase willingness to participate in the installation of owl boxes to increase owl populations and reduce rodent populations and crop damage. We used a pre- and post-survey to assess the perceptions of owls of 340 learners aged between 12 and 18 in four schools before and after listening to the presentation. Respondents that watched the presentation had more positive perceptions of owls than those that had not watched the presentation and were more willing to put up owl boxes near their home. Despite this shift, negative perceptions of owls still dominated responses due to cultural associations with the occult. These findings indicate that even low-intensity programs can be effective at enhancing perceptions of taboo wildlife. We suggest that environmental education programs featuring culturally taboo species should adopt a culturally sensitive approach to focus on the benefits these species provide.

Key words: ecologically based pest management; environmental education; owl; rodent; taboo wildlife; witchcraft.

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Introduction

Perceptions of animals are often based on cultural constructions rather than direct involvement (Garibaldi and Turner 2004, Becken et al. 2013, Risiro et al. 2013). Information can spread through media campaigns, oral histories, and other avenues to create widely adopted characterizations of an animal (Gullo et al. 1998, Peace 2002). However, cultural perceptions of animals seldom remain static, nor are they unanimously adopted throughout society (Gullo et al. 1998, Marvin 2005). Positive and negative cultural perceptions of animals can have significant implications for wildlife conservation, especially when they result in human actions that either protect or endanger species (Dickman 2010, Madden and McQuinn 2014). Even cultural perceptions of imaginary creatures can impact wildlife conservation (Holmes et al. 2018).

Perceptions of predators can have complex and contradictory interpretations within and among cultures. For example, dingoes (*Canis lupus dingo*) in Australia are consider simultaneously as pests and protected species, feral and native, and either pure or hybrid (Hytten 2009), while gray wolves (*Canis lupus*) in the USA represent popular characters in folklore, creatures to be feared, and as idealizations of wilderness (Kellert 1985, Jones 2011). They are often valued at a global scale for their role in biodiversity and their charismatic nature, but on a local level, they may be despised and feared due to conflict and the financial losses they impose (Dickman et al. 2011). Equally disliked are dirty animals such as rats and mice which inhabit human spaces and can spread disease (Arluke and Sanders 1996). In Africa, some predators, nocturnal species, and animals considered dangerous such as owls (order Strigiformes), hyenas (family Hyaenidae), cats (family Felidae), or snakes (suborder Serpentes) are commonly associated with the occult and consequently feared (Niehaus et al. 2001, Cumes 2004). Ironically, in Africa some predator species most heavily persecuted due to associations with witchcraft provide valuable ecosystem services to rural communities such as controlling agricultural pests, disease regulation, and waste disposal (Muñoz-Pedreros et al. 2018, O'Bryan et al. 2018, Williams et al. 2018).

Historically, cultural interpretations of nature have been overlooked in conservation strategies (Binnema and Niemi 2006, Drew and Henne 2006, Tyrrell 2010). However, recent research highlights the futility of pursuing a purely biologically based conservation agenda that does not address relevant cultural considerations, especially in situations of human–wildlife conflict (Dickman 2010, Peterson et al. 2010, Madden and McQuinn 2014). Consequently, conservationists are beginning to recognize the need to integrate social science perspectives into their work and adopt a more interdisciplinary approach (Mascia et al. 2003, Balmford and Cowling 2006, White and Ward 2011), although uptake can be slow (Montgomery et al. 2018).

We present a case study to examine the effectiveness of using a low-intensity environmental education program to shift negative perceptions and highlight the ecological benefits of a culturally stigmatized group of animals, owls, in rural South Africa. Although negative associations between animals and the supernatural are not a consideration for wildlife management across all societies, findings from this study are transferable to species perceived as taboo for a multitude of other reasons elsewhere in the world.

A broad range of beliefs, attitudes, and behaviors embedded in indigenous and local knowledge systems can instill positive and negative conservation outcomes for specific species (Holmes et al. 2018). Indigenous and local knowledge systems are understood as a "cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes 2012). Local and indigenous knowledge embodies both practice (how people carry out their resource use activities) and culture (a set of belief regarding how knowledge and practices relate to ecosystems; Berkes 2012). Together, these form a nested "knowledge–practice–belief" complex that represents a mix of past tradition and present innovations driven by historical, cultural, and social processes (Berkes 2012). There is a growing body of research highlighting the positive role of African cultural practices and beliefs as an important complement to biodiversity conservation. For

example, in some cultures, certain animal and plant species are valued as totems and protected through taboos that prohibit them from being hunted, killed, or consumed (Kideghesho 2009, Constant and Tshisikhawe 2018). However, in this particular study, we consider cultural beliefs embedded in indigenous and local knowledge systems that pose challenges to conservation (Holmes et al. 2018).

In South Africa, land displacement, poverty, and marginalization of certain groups including communities neighboring protected areas have resulted in widespread attitudes that wildlife is prioritized over local needs, and is therefore, of little or no value (Griffiths 2017). This divide between people and wildlife is compounded by cultural beliefs prevalent across many African cultures linking witchcraft and the occult to animals' species (Geschiere 1997, Kesby 2003, Dickman et al. 2013). Belief in witchcraft and supernatural powers is widespread in South Africa but is more commonplace in impoverished areas, specifically parts of Limpopo and Eastern Cape provinces (Ashforth 1996, Niehaus et al. 2001, Kohnert 2003). In South Africa, witches are defined as human beings consumed by jealousy, greed, malice, and antisocial tendencies who use supernatural powers to harm others (Niehaus et al. 2001, Ashforth 2005, Hickel 2014). Some people believe witches use animals in multiple ways: Animals may signify a witch's presence; animals can act as a witch's familiar (an accompanying spirit often in an animal form); animal parts are used in muthi (traditional medicine); and after death, animals may become a vessel for the witch's spirit to spread further malevolence (Morris 2000, Niehaus et al. 2001). Animals associated with witches are often killed as a precautionary measure or for use in traditional medicine (Mikkola and Mikkola 1997, Williams et al. 2013). Historically, in South Africa, witchcraft has been recognized by the state through law and through state practices that officialize witch-hunting (Kohnert 2003). A belief in the magical properties of animals and occult practices that harness the harmful properties of magical creatures, such as witches using owls to attack their victims, can also impede the use of such predators as forms of biological control agents, but also their tolerance by local communities (Constant et al. 2020).

Thus, cultural beliefs about species can act as a barrier to the acceptance of using the pest control ecosystem services offered by these species (Williams et al. 2018). Smallholder agriculture supports the majority of impoverished people in rural areas (World Bank 2007, Tscharntke et al. 2012), but one of the key constraints on food production to smallholder farmers is crop damage caused by pests such as rodents (Swanepoel et al. 2017). Existing pest control in these areas tends to rely heavily on chemical control, but such practices cause environmental contamination, poisoning of non-target species, and resistance to the products used (Buckle and Smith 2015). To overcome these problems, an alternative approach termed ecologically based rodent management (EBRM) was developed (Singleton et al. 1999), which emphasizes more sustainable pest management solutions such as biological control by native species such as mammalian carnivores (order Carnivora; Williams et al. 2018) or avian predators such as owls (Labuschagne et al. 2016). Environmental education schemes have been successfully applied to increase rates of EBRM adoption, boosting crop yields as a result (Flor and Singleton 2011). Long-term education initiatives are expensive, with lack of funding being the major constraint on many programs (McDuff and Jacobson 2001), and there are increasing calls to ensure that conservation strategies such as environmental education programs are cost effective (Naidoo et al. 2006, Cook et al. 2017). Although carefully crafted short-term once-off environmental education programs (referred hereafter as low-intensity programs) can successfully increase knowledge and foster positive environmental perceptions (Farmer et al. 2007, Rakotomamonjy et al. 2015, Leeds et al. 2017), it is yet to be determined if low-intensity environmental education can sensitively and cost effectively enhance perspectives of culturally taboo species. In this study, we examined young people's perceptions of owls in two rural South African communities before and after conducting a low-intensity environmental education program and willingness to take part in a future EBRM trial to help reduce agricultural damage from rodent pests by installing owl nest boxes. Young people were targeted because environmental education may be more effective at changing attitudes when people are exposed to concepts

earlier in life (Caro et al. 1994), and they can also successfully change attitudes of other family members (Meyer 2008, Marchini and Macdonald 2012). In addition, schools provide a large and easily accessible pool of respondents to test attitudinal shifts toward culturally stigmatized species. We hypothesized that attitudes toward owls would show a moderate improvement in response to the environmental education scheme, but improvements may be limited by the low intensity of the program and how deeply entrenched such cultural beliefs tend to be.

Methods

Study site

We assessed the influence of a low-intensity environmental education program on perceptions of owls in Ka-Ndengeza (S23.31003 E30.40981) and Vyeboom (S23.15174 E30.39278), two rural villages in Limpopo Province, South Africa (Fig. 1). Vyeboom, located in Makhado Municipality, has a population of approximately 5000; the most commonly spoken language is Tshivenda (Statistics South Africa 2019*a*), and the poverty level (percentage of the population living below the national poverty line) in this municipality is 19.8% (Statistics South Africa 2016). In Ka-Ndengeza, Greater Giyani municipality, the population of around 3500 predominantly speak Xitsonga (Statistics South Africa 2019*b*) and the municipality's poverty level is 17.4% (Statistics South Africa 2016).

Local residents of both villages practice small-scale crop farming and livestock farming (Williams et al. 2018). Similar to other small holder farmers across Africa (Swanepoel et al. 2017), rodents represent significant pests in these two villages through household damage, crop losses, and attacks on small stock, while the threat of rodents as carriers of zoonotic diseases is less prevalent (Constant et al. 2020). To address such

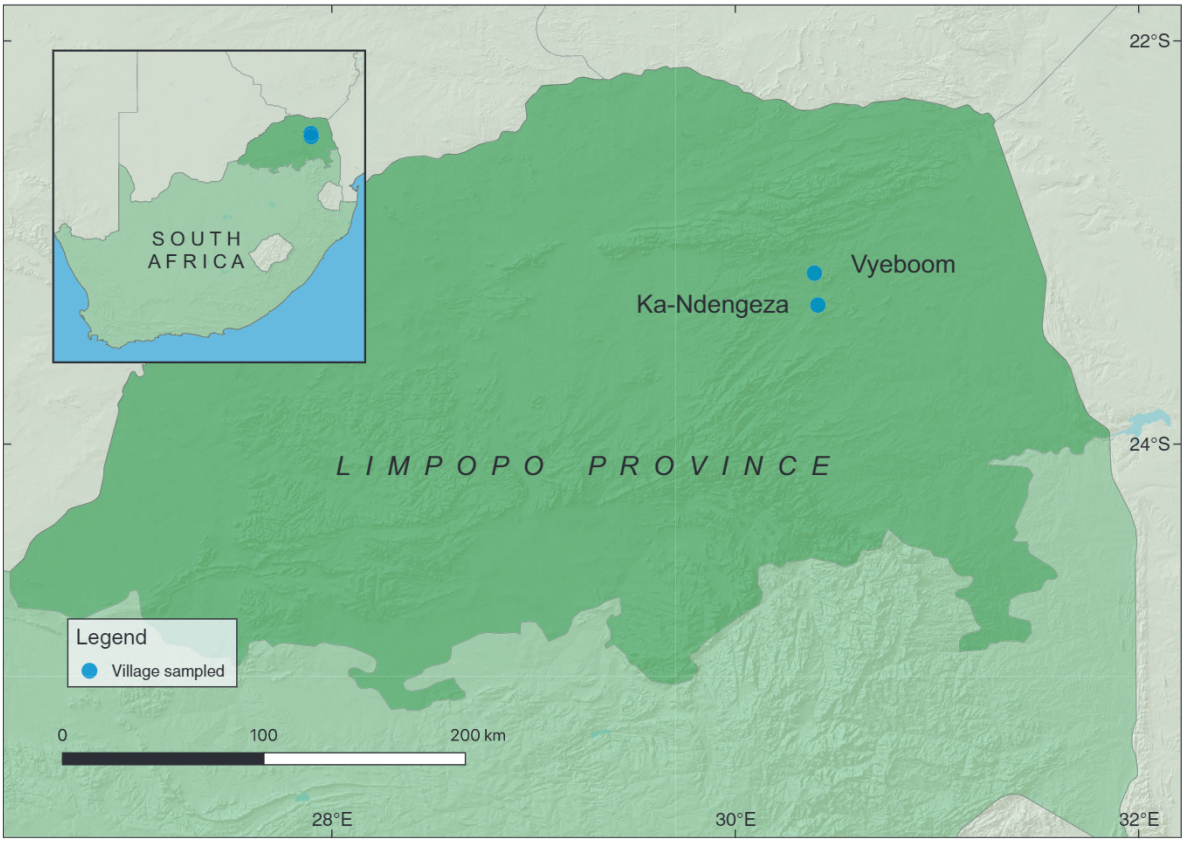

Fig. 1. Map of the study sites showing the location of the villages included in the study.

losses, several projects have been initiated in these areas to increase knowledge on biological control of rodent pests through mammalian predation (Williams et al. 2018) as well as species conservation (Foord et al. 2018). Therefore, the promotion of avian predators is the next logical step toward mitigating rodent pests in these villages. The study area presented an ideal opportunity to investigate the promotion of owls since four owl species are found at the study sites: the western barn owl *Tyto alba*, spotted eagle-owl *Bubo africanus*, Verreaux's eagle-owl *Bubo lacteus*, and pearl-spotted owlet *Glaucidium perlatum* (Hockey et al. 2005). The four species are listed as least concern on the IUCN Red List of Threatened Species (BirdLife International 2016*a*, *b*, 2019*a*, *b*), and the barn owl is considered an ideal species to mitigate rodent pests (Labuschagne et al. 2016).

Data collection

In each village, we visited learners in one primary school (grade 6/7; ages 12–13) and one secondary school (grade 11/12; ages 17–18). In August 2016, we administered a survey (Appendix S1) to a total of 283 learners at the two primary schools and two secondary schools from the two villages (Appendix S1). We then delivered a 20-min presentation on the natural history of owls (slides shown in Appendix S1). The presentation included information on the mean number of rodents eaten by a western barn owl and a spotted eagle-owl in a night (Verreaux's eagle-owl is uncommon, and pearl-spotted owls are largely insectivorous). The students were involved in the presentation by being asked to calculate, based on the information provided, how many rodents an individual owl could potentially eat in a year. We administered a very similar survey (Appendix S1) to 340 learners at the same four schools in November 2016 to assess whether perceptions had changed over the intervening three months. Seventy-four of the learners that completed surveys in the follow-up survey had not been present for the presentation, and individuals belonging to this group were used as a control group. It was not possible to collect baseline data on the control group due to unreliability of school attendance in rural villages. The presentation and surveys were conducted in English and were translated into Tshivenda and Xitsonga by a local interpreter. The survey questions and responses used in the analysis are shown in Table 1. Informed consent was obtained from the principal of each school and the teachers of each class, who gave permission to participate in the study after discussing the surveys in detail and answering any questions they had. The teachers were also present when the surveys were administered.

This research received ethical approval from the University of Venda (SMNS/14/ZOO/03/2802) and was conducted under a research permit issued by the Limpopo Department of Economic Development, Environment and Tourism (LEDET; reference number ZA/LP/88067).

Data analysis

We coded categorical data in such a way that more positive responses regarding perceptions of owls and coexisting with owls were given more positive values to facilitate interpretation of the

Table 1. Questions and available responses used in the survey.

Question	Response
1. Would you like to have an owl nesting near your home?	Yes/no
2. Would you like to have an owl nesting in the roof of your home?	Yes/no
3. Would you put up an artificial nest for owls to nest in, in your yard (compound) near your home?	Yes/no
4. Which of the three choices best describes your feeling towards owls?	Not like/no feeling/like
5. Which of the three choices best describes your response to seeing an owl?	Not afraid/very afraid/terrified
6. What do you do if an owl lands on the roof of your home?	Nothing/run away/chase the owl away/try and kill the owl
7. What did you do the last time you saw an owl?	Nothing/run away/try and kill the owl
8. What do you believe is going to happen if an owl lands on the roof of your home?	Open response
9. What problem, if any, do rats and mice cause for you and your family?	Open response

results. For example, we coded "Yes" responses to the question, "Would you like to have an owl nesting near your home?" as a 1 and coded "No" as a 0. We modeled responses to each question separately, using responses to each question as response variables, using stage (either before or after watching the presentation) as fixed effects, and village and grade as random effects. We tested for differences in responses to questions with binary responses (questions 1–3) by fitting generalized linear mixed models with binomial distributions to the data using the glmer function in the lme4 package (Bates et al. 2015) in R version 4.0.2 (R Development Core Team 2019). We used the conditional log–log link functions to allow for more asymmetry in the distributions. To test for differences in responses to questions with multiple ranked responses (questions 4–7), we fitted mixed ordinal logistic regression models, using the clmm function in the package ordinal (Christensen 2019). We used Akaike's information criterion (AIC) to compare models including responses from the treatment group against null models and models including responses from the control group against null models. We selected the model with the lowest AIC, considering models with $\Delta AIC < 2$ to have equal support. Plots were created using ggplot2 (Wickham 2016). For open questions 8 ("What do you believe is going to happen if an owl lands on the roof of your home?") and 9 ("What problem, if any, do rats and mice cause for you and your family?"), we synthesized the main themes emerging in the responses to the open questions 8 and 9 and extracted representative quotes. Furthermore, we categorized responses to question 8 into those that mentioned traditional cultural beliefs around owls and those that mentioned impacts of owls on controlling rodents. We compared the proportions of responses falling into these categories between respondents before and after watching the presentation, sub-divided between students that did see the presentation and those that did not watch the presentation. All data and R code are publicly available (Williams et al. 2019).

Results

Perceptions of owls were generally negative both before and after listening to the presentation (Figs. 2, 3). But while perceptions toward owls were still negative overall after watching the presentation, responses to questions 1–6 were less negative after watching the presentation than before watching the presentation, supporting our hypothesis (Table 2). For question 7 (What did you do the last time you saw an owl?), the responses did not differ before or after watching the presentation. For the majority of the models, the responses of the control group to each question did not fit the data any better than the null models (excluding questions 4 and 6), suggesting that any differences in the treatment group were linked to listening to the presentation. For questions 4 and 6, there was some support that stage of survey administration (pre- or post-presentation) affected the frequency of responses (Table 2). However, on closer inspection the odd ratios (questions 4 and 6), the treatment and control group remained constant, suggesting that the stage of survey administration had a minor effect on the frequency of responses (Appendix S1).

The dominant theme in responses to the open questions on perceptions of owls was the involvement of owls in witchcraft and the negative consequences that this will have for those that live in areas with owls. When asked "What do you believe is going to happen if an owl lands on the roof of your home?", typical responses include "Someone going to die," "That someone is about to bewitch me," "I believe that it is sent by witches," or "Nothing happy, I will chase it away." Some respondents also expressed more utilitarian views such as "It will help me killing rats" or "I will just try to kill it because it make a problem—noise." In contrast, when asked "What problem, if any, do rats and mice cause for you and your family?", respondents were less likely to share supernatural beliefs, again focusing on utilitarian impacts such as "Eat food, clothes, baby, door, everything," "[Make me] sick," or "Bring owl and snakes at home." After watching the presentation, answers given in response to the question "What do you believe is going to happen if an owl lands on the roof of your home?" shifted. Prior to the presentation, 52.6% of responses ($n = 228$) expressed that the owl was sent by witches and would bring bad omens upon their household, and 13.2% of responses suggested that the owl would kill rodents. Other responses such

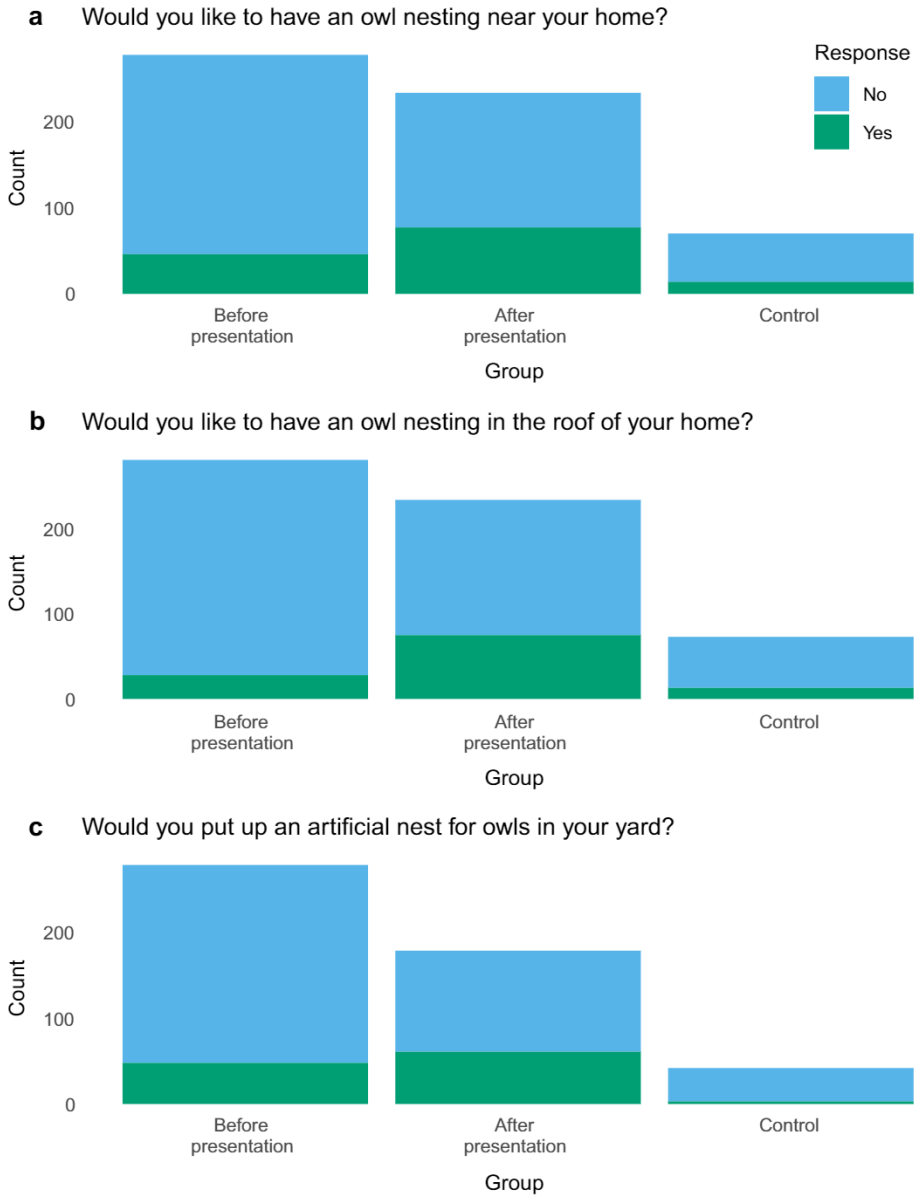

Fig. 2. Responses to questions with binary responses (a) question 1, (b) question 2, and (c) question 3 of three groups of learners: before watching a presentation on the natural history of owls (left); after watching the presentation (middle); and a control group that did not watch the presentation (right). Number labels show sample sizes.

as utilitarian concerns and worries about owls making noises comprised the remainder of responses. Following the environmental education program, 20.7% of responses given by presentation attendees ($n = 92$) pertained to witchcraft and ill omens while 27.1% of responses focused on predation of mice and rats by owls.

Discussion

Perceptions of owls were less negative after watching the presentation than before watching the presentation. Despite this shift, perceptions of owls still remained negative overall, which was linked to their associations with witchcraft,

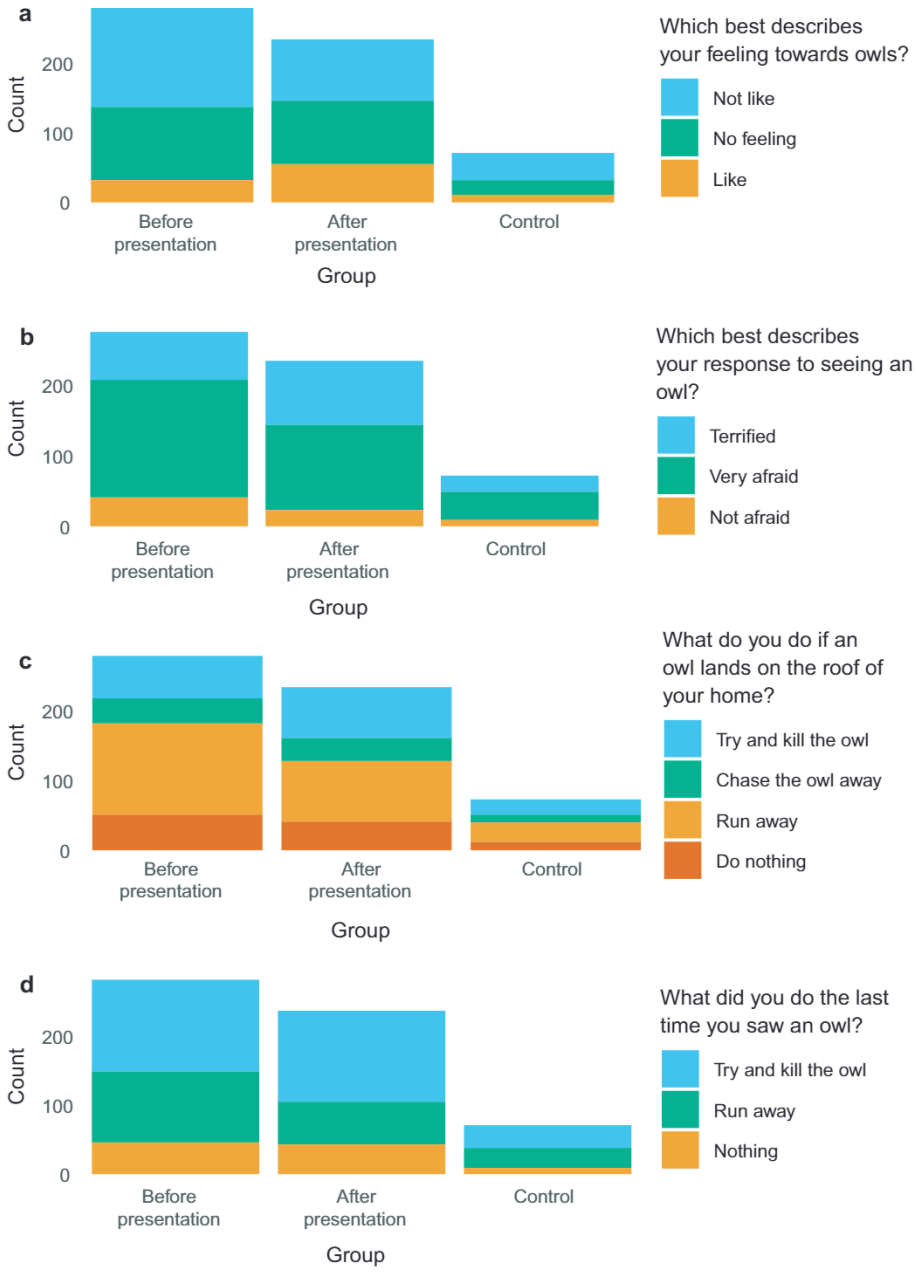

Fig. 3. Responses to questions with more than two responses (a) question 4, (b) question 5, (c) question 6, and (d) question 7 of three groups of learners: before watching a presentation on the natural history of owls (left); after watching the presentation (middle); and a control group that did not watch the presentation (right). Number labels show sample sizes.

although the prevalence of responses relating to a negative association between owls and witchcraft appeared to be lower among respondents that had seen the presentation than those that had not. This is not surprising given how strongly held beliefs in the supernatural tend to be (Dickman and Hazzah 2016) and the low intensity with which the education program was

Table 2. Summary of models of responses to questions on perceptions of owls.

Question	Model type	Model name	AIC	ΔAIC	df	2.5% CI	97.5% CI	Odds ratio
Q1. Would you like to have an owl nesting near your home (Yes/No)?	Binomial GLMM	**Treatment**	**542**	**0.0**	**3**	**0.42**	**1.16**	**2.19**
		Treatment null	558.5	15.9	2			
		Control	317.7	0.0	3	−0.52	0.69	1.95
		Control null	318.6	0.8	2			
Q2: Would you like to have an owl nesting in the roof of your home? (Yes/No)	Binomial GLMM	**Treatment**	**481.8**	**0**	**4**	**0.88**	**1.75**	**3.68**
		Treatment null	519.4	37.6	2			
		Control	257.8	NA	3	0.02	1.96	2.53
		Control null	**Model failed to converge*					
Q3: Would you put up an artificial nest for owls to nest in, in your yard (compound) near your home? (Yes/No)	Binomial GLMM	**Treatment**	**491.8**	**0**	**3**	**0.41**	**1.18**	**2.21**
		Treatment null	506.6	14.8	2			
		Control	291.5	3.5	4	−1.95	0.16	0.47
		Control null	288.1	0	1			
Q4: Which of the three choices best describes your feeling towards owls? (Like/No feeling/Not like)	Mixed ordinal logistic regression	**Treatment**	**1043.0**	**0**	**4**	**1.42**	**2.8**	**1.99**
		Treatment null	1057.2	14.3	3			
		Control	**664.3**	**0**	**4**	**1.16**	**4.33**	**2.24**
		Control null	668.1	3.8	3			
Q5: Which of the three choices best describes your response to seeing an owl? (Not afraid/ Very afraid/Terrified)	Mixed ordinal logistic regression	**Treatment**	**957.5**	**0**	**4**	**0.36**	**0.72**	**0.51**
		Treatment null	969.8	12.3	3			
		Control	659.5	0.3	4	0.32	1.29	0.64
		Control null	659.2	0	3			
Q6: What do you do if an owl lands on the roof of your home? (Run away/Nothing/ Try and kill the owl/Chase the owl away)	Mixed ordinal logistic regression	**Treatment**	**1341.4**	**0**	**5**	**0.48**	**0.92**	**0.67**
		Treatment null	1349.7	28.3	4			
		Control	**983.5**	**0**	**5**	**0.24**	**0.75**	**0.42**
		Control null	900.2	6	4			
Q7: What did you do the last time you saw an owl? (Run away/Nothing/Try and kill the owl)	Mixed ordinal logistic regression	Treatment	1041.7	0	4	0.53	1.039	0.74
		Treatment null	1042.3	0.6	3			
		Control	721.6	1.5	4	0.46	1.45	0.81
		Control null	720.1	0	3			

Notes: AIC, Akaike's information criterion; CI, confidence interval; df, degrees of freedom; GLMM, generalized linear mixed model. Treatment or control models with ΔAIC of 2 or greater relative to null models are shown in bold.

implemented. But these findings nevertheless demonstrate that even modest educational programs that involve the delivery of only a single presentation can reduce negative perceptions of culturally stigmatized wildlife. A more intensive environmental education program involving more sessions would be likely to improve perceptions of wildlife further (Kruse and Card 2004), and although these can be costly and time-intensive to implement (Leisher et al. 2012), a longer-term approach is recommended for species with strong negative cultural associations. A successful example of this approach in semi-urban area in Gauteng province, South Africa, was a multi-pronged environmental education program that included the construction of owl boxes (Meyer 2008). Following the experience, both the students involved and their families replaced superstitious beliefs about owls with more positive perspectives (Meyer 2008).

The improved attitudes of participants toward owls fit well with previous findings that participation in an environmental education scheme involving talks and activities about lemurs (superfamily Lemuroidea) in Madagascar during a single day was sufficient to improve knowledge and attitudes of school children in relation to these species (Rakotomamonjy et al. 2015). Similarly, an environmental education program that centered on screening three 20-min educational films on the threats posed to mountain gorillas *Gorilla beringei beringei* and chimpanzees *Pan troglodytes schweinfurthii* for school children in Uganda was able to improve attitudes toward great apes and knowledge of conservation actions (Leeds et al. 2017). Indigenous

knowledge systems also play an important role in conservation and education. Their integration can be advantageous, especially if traditional beliefs benefit wildlife and communities (Maila and Loubser 2003, Risiro et al. 2013). In our study area, there is also a growing body of research describing the incidental synergies between indigenous and local knowledge systems and conservation goals. Certain animals such as leopards (*Panthera pardus*), lions (*Panthera leo*), and caracals (*Felis caracal*) resemble domestic cats, and their predatory behavior and their ability to kill and eat humans prohibit them from being hunted and eaten by the Vhavenda (Khorommbi 2001). The association of taboos with particular tree species that have been protected by the Vhavenda is well documented. For example, the marula *Sclerocarya birrea* is protected for its edible fruits during times of drought, medicines, and shade (Constant and Tshisikhawe 2018). Taboos associated with *S. birrea* are enforced through beliefs where individuals or the community experiences illnesses or other punishments emanating from the violation of certain cultural protocols. For example, *S. birrea* fruits can only be harvested when they have fallen to the ground; otherwise, the culprits were believed to experience a fever or snakes would appear in their homesteads (Constant and Tshisikhawe 2018). The Vhavenda carry out a number of practices that seek to promote sustainable harvesting practices, for example, extraction of the bark from the eastern side of a tree due to a belief that bark harvested on this side of this tree is more potent for medicinal purposes (Constant and Tshisikhawe 2018). Other researchers have suggested that this method prevents ring barking of the tree (Magoro et al. 2010). Plant propagation through the cultivation of valuable plants has played a role in the conservation of indigenous vegetation; for example, the Kei Apple (*Dovyalis caffra* (Hook.f. & Harv.) Sim) and Oval Kei Apple (*Dovyalis zeyheri* (Sond.) Warb) persist in areas of the Soutpansberg that were previously occupied by the Vhavenda (von Breitenbach and Brietenbach 1989). The Tsonga also demonstrate an extensive knowledge and utilization of natural resources and animal species (Anthony and Bellinger 2007), where cultural practices associated with the protection of the environment include prohibitions against killing insects, wild animals, and not cutting down trees that bear fruit (Anthony 2006). The Tsonga worldview is defined by the concept of ntumbuloko where social norms, cultural practices, and traditional institutions influence ethics for engaging with the natural world in a respectful manner (Anthony et al. 2011). These examples highlight the opportunities indigenous knowledge systems might serve when cultural practices are interlinked with conservation messages. For example, in the Amazon, indigenous stories and myths of the Tsimané have been shared at exhibitions highlighting the role cultural taboos play in regulating subsistence hunting (Fernández-Llamazares et al. 2017). However, not all forms of indigenous knowledge systems lead to sustainable actions particularly when certain beliefs pose challenges to human–wildlife coexistence.

Traditional practices and beliefs may be inconsistent with conservation such as rite of passage ritual killings of animals for prestige (Hazzah et al. 2009), trade in endangered species for traditional medicine (Williams et al. 2013), and persecution of animals associated with bad omens or demonstrating taboo behaviors (Forth 2007). In our study area and in other examples, negative perceptions of owls can result in damage to ecosystems and missed opportunities for farming communities to benefit from ERBM programs (Mikkola and Mikkola 1997, Ogada and Kibuthu 2008, Constant et al. 2020).

Environmental education programs need to identify barriers that limit stakeholder engagement and carefully consider strategies to overcome these (Offord-Woolley et al. 2016). A culturally sensitive approach is required when addressing concepts surrounding deeply entwined beliefs associated with witchcraft (Ashforth 1996, Cumes 2004). Local beliefs associated with animals should not be considered as isolated issues, based on their impact on conservation goals, but as part of a complex system or worldview (Berkes 2012, Holmes et al. 2018). There is an inherent danger of oversimplifying how to manage different belief systems for conservation by promoting only those beliefs that are beneficial to conservation and inhibiting that are not compatible (Fernández-Llamazares and Cabeza 2018, Holmes et al. 2018). This ignorance of local realities and perspectives can have unforeseen negative

consequences for human well-being and culture (Dickman et al. 2015).

Tackling conservation issues involving taboo wildlife therefore necessitates a need to undertake contextual research on place-based relationships between people and biodiversity by uncovering the hidden rationales behind human behavior. Cultural beliefs associated with certain animals and witchcraft are embedded in social, cultural, and political dimensions that require further investigation of local perspectives. Outsiders may fail to grasp the dynamic and modern applications of witchcraft and cause offense by ignoring or misrepresenting the concept's sensitive and secretive characteristics (Geschiere 1997). Such understandings require further investigation of witchcraft from disciplines such as anthropology, and ethnoecology that are well versed in studies of human behavior and irrationality (Drury et al. 2011). This requires conservationists to engage with methodologies such as ethnography and qualitative research which generally explore locally specific understandings within their cultural context (Drury et al. 2011). If possible, conservation organizations should include community members in the design and implementation of environmental education programs to guarantee that locally specific cultural perspectives and priorities are incorporated (Jacobson et al. 2015, Offord-Woolley et al. 2016). For owls and many other species, a wide variety of contradictory beliefs are associated with the species globally (Glickman 1995, Enriquez and Mikkola 1997, Forth 2007), demonstrating the importance of ascertaining a local perspective in conservation initiatives. Hence, our environmental education program partnered with a local translator and focused on ecology and ecosystem services of owls, rather than attempting to dissuade participants from beliefs in witchcraft.

It is also important to allow time for people to readjust to new information and perceptions of a historically disliked species (Linnell et al. 2003), especially when perceptions have existed in communicative memory and cultural memory for long periods (Assmann and Czaplicka 1995). An interesting extension of this study would be to assess the program's longer-term effectiveness on changing perceptions. Furthermore, delivery of the education program by teaching staff at the schools may prove more effective than delivery by an external scientist, as this could signal that the message was socially accepted (Marchini and Macdonald 2020).

In addition to superstitious views of owls, respondents tended to frame positive and negative views pertaining to owls and rodents in utilitarian terms. This is not surprising, as lower income communities have a more pressing urgency to fulfill basic needs than higher income groups and are consequently more likely to consider animals from a utilitarian perspective (Infield 1988). Wildlife perceived to be devoid of a useful purpose is seldom considered worthy of preservation by lower income communities (Griffiths 2017, Williams 2017). High levels of poverty and prevalent beliefs in witchcraft amplify owl vulnerability in Limpopo province. Environmental education schemes focusing on animals associated with witchcraft should assign these species with positive, sustainable, and accessible utilitarian values, such as those owls generate in the context of EBRM, to promote species conservation.

We suggest that in addition to enhancing perceptions of wildlife, environmental education could be also a useful tool to increase participation in community programs such as EBRM initiatives. Improving EBRM uptake is reliant on delivering education that stresses the benefits native species can provide and emphasizes the ecological interconnectedness between rodents, pesticides, and predators (Ogada and Kibuthu 2008, Makundi and Massawe 2011). Respondents that watched the presentation were more likely to say they would be willing to have an owl box installed in their yard, which could help reduce rodent densities in fields by increasing owl populations in agricultural areas (Paz et al. 2013). Although the animal welfare implications of using indigenous predators to control pests rather than relying on traditional wildlife control techniques have recently been questioned (Allen et al. 2019), there is little doubt that using ecosystem services provided by natural predators would be more ecologically sound and more sustainable than chemical rodenticides for community members farming in rural agro-ecosystems (Singleton et al. 1999).

We examined whether school children's attitudes toward a stigmatized species shift following exposure to an environmental education

presentation. We note, however, that while we observed increased theoretical willingness to participate in a future EBRM program involving erecting owl nesting boxes, further studies, especially those aimed at adults, are required to assess whether this would translate into actual increased participation after the launch of such a scheme, as this is not always the case (Parkin et al. 2006, Waylen et al. 2009, Young et al. 2013, Nilsson et al. 2020). Limitations preventing people who intend to adopt EBRM techniques from actual implementation should be explored and addressed (Nilsson et al. 2020). The successful widespread uptake of EBRM is dependent upon supportive political policies and directives from government; strong partnerships forged between government, implementing agencies, and community groups; the political will; leadership capacity of village leaders; and strong social cohesion, and cooperative community structures that support coordinated community action encourage enable the uptake of EBRM (Palis et al. 2015). Other economic considerations such as high maintenance and transaction costs for setting up EBRM methodologies may constrain adoption of relevant technologies (Constant et al. 2020). Consideration of local knowledge of the end users of EBRM technology must also not be overlooked as locally adapted approaches for EBRM are more socially acceptable and can be built upon instead of introducing entirely new approaches (Palis et al. 2011, 2015).

Furthermore, developing education programs that engage not only children but also family members from farming communities may diversify the impact of outreach activities. Recent studies have also shown that the education initiatives designed to reach the families of students and their communities also have the potential to cultivate conservation-friendly perceptions among family members toward species associated with human–wildlife conflict (Marchini and Macdonald 2020). This is because these species are actively present and culturally relevant in the minds of children and adults directly affected by them, and previous research shows that children can shape social norms in adults (Marchini and Macdonald 2020). Although we did not explicitly explore the transfer of knowledge and attitudes through our intervention from children to family members, this would offer an exciting avenue for future research. Another limitation of our study was the relatively small sample size and potential social desirability in students' answers where research participants change their answers to look better to others, to feel good about themselves, or to reinforce a particular identity (Larson 2019). Therefore, follow-up studies should aim to engage more participants and test for social desirability bias at the pilot stage of surveys to control potential effects.

In conclusion, our findings indicate that even a low-intensity environmental education program can improve young people's perceptions of a species associated with witchcraft and their willingness to undertake positive environmental actions. In Africa, beliefs in witchcraft and the supernatural have evolved in response to shifting politics and modernization (Niehaus et al. 2001, McEwan 2008). Through culturally sensitive and locally inclusive environmental education, negative perceptions of animals affiliated with witchcraft can also evolve to benefit communities, farmers, and wildlife.

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Data Availability

Data and code are available from the Figshare digital repository: https://doi.org/10.6084/m9.figshare.9734984

Supporting Information

Additional Supporting Information may be found online at: http://onlinelibrary.wiley.com/doi/10.1002/ecs2.3482/full