



# Vulture perceptions in a socio-ecological system: a case study of three protected areas in KwaZulu-Natal, South Africa

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## Abstract

Vultures are presently the most threatened raptor guild in the world. Threats to vultures are numerous and mainly anthropogenic. Understanding human communities' relationship with threatened species can guide and strengthen conservation initiatives. We assessed the awareness, benefits, beliefs, threats, and conservation perspectives of people surrounding protected areas accommodating the few remaining vulture strongholds in KwaZulu-Natal, South Africa. We conducted a total of 450 semi-structured interviews and seven focus group discussions. Respondents demonstrated a strong awareness of vultures and reportedly derived benefits from having these avian scavengers in their localities. The most cited benefit (65%) was carrion removal. A predominant belief amongst local people was that vultures are potent in traditional medicine (66%); this was regarded by the majority of respondents (79%) as the main driver for the illegal killing of vultures. Most participants (84%) viewed vulture populations to have declined. Overall, local people demonstrated complex but predominantly positive perceptions towards vultures. Mounting evidence of the use of vultures in traditional medicine compels urgent action. We recommend co-learning-based engagements between resource users and conservation scientists.

**Keywords** Local ecological knowledge · Awareness · Traditional medicine · Threatened species conservation · Ecosystem services

## Zusammenfassung

**Die Wahrnehmung von Geiern in einem sozio-ökologischen Kontext: Eine Fallstudie über drei Schutzgebiete in KwaZulu-Natal, Südafrika.** Geier sind derzeit die am stärksten bedrohte Greifvogelgruppe der Welt. Die Bedrohungen für Geier sind zahlreich und hauptsächlich anthropogen bedingt. Wenn man die Beziehung von Menschen zu bedrohten Arten versteht, kann man Schutzinitiativen anleiten und stärken. Wir untersuchten das Bewusstsein, den Nutzen, die Überzeugungen, die Gefahren und die Vorstellung bezüglich Schutzmaßnahmen von Menschen in der Umgebung von

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Schutzgebieten, welche die wenigen verbliebenen Geierhochburgen in KwaZulu-Natal, Südafrika, beherbergen. Wir führten insgesamt 450 halbstrukturierte Interviews und sieben Fokusgruppendifkussionen durch. Die Befragten zeigten ein großes Bewusstsein für Geier und gaben an, dass sie von der Anwesenheit dieser Aasfresser in ihrer Umgebung profitierten. Der am häufigsten genannte Nutzen war die Beseitigung von Aas (65%). Ein vorherrschender Glaube unter den Einheimischen war, dass Geier in der traditionellen Medizin wirksam sind (66%). Dies wurde von der Mehrheit der Befragten als Hauptgrund für das illegale Töten von Geiern angegeben (79%). Die meisten Teilnehmer (84%) waren der Ansicht, dass Geierpopulationen zurückgegangen sind. Insgesamt zeigten die Einheimischen eine komplexe, aber überwiegend positive Wahrnehmung von Geiern. Die zunehmenden Beweise für die Verwendung von Geiern in der traditionellen Medizin zwingen zu dringendem Handeln. Wir empfehlen daher ein kooperatives, auf Erfahrungsaustausch basierendes Zusammenwirken von Ressourcennutzern und Naturschutzwissenschaftlern.

## Introduction

Populations of Old-world vultures have declined dramatically in recent decades because of multiple environmental and anthropogenic threats (Prakash et al. 2003; Ogada et al. 2012; Botha et al. 2017; McClure et al. 2018; Safford et al. 2019). Threats to vultures worldwide include land-use change, food shortages, direct hunting, poisoning, energy infrastructure, and possibly climate change (Virani et al. 2011; Odino et al. 2014; Pomeroy et al. 2015; Botha et al. 2017; Safford et al. 2019). In sub-Saharan Africa, both intentional and unintentional poisoning incidents have been chiefly responsible for most vulture mortalities in the last three decades (Kruger et al. 2015; Botha et al. 2017; Monadjem et al. 2018). In parts of Africa, vultures have been found poisoned, with body parts removed, particularly their heads and feet, and evidence links this to their use in belief-based practices (McKean et al. 2013; Mashele et al. 2021a,b). The ethnomedicinal consumption of vultures is reportedly well-established in South Africa (McKean et al. 2013; Williams et al. 2014; Pfeiffer et al. 2015; Botha et al. 2017). A recent study has indicated that African traditional healers use up to 800 vultures annually in the Kruger to Canyons Biosphere Reserve (Mashele et al. 2021b), which covers an area of about 20 000 km<sup>2</sup> (Coetzer et al. 2010).

Protected areas play a significant role as refugia for vultures (Morales-Reyes et al. 2017), but these avian scavengers are wide-ranging, and their activities cover vast areas, including those unprotected, where their vulnerability to mortality is heightened (Kruger et al. 2015; Oliva-Vidal et al. 2022). For example, communal and agricultural lands attract vultures by providing food in the form of livestock and ungulate carcasses (Pfeiffer et al. 2015; Delgado-González et al. 2022). Addressing anthropogenic threats and mortality risks to vultures solely from a protected area standpoint may be ineffective, as vultures cannot be physically confined within the boundaries of protected areas (Kane et al. 2022). Mashele et al. (2021b) reported that vultures used by traditional health practitioners in the Kruger to Canyons Biosphere Reserve were sourced from protected areas and

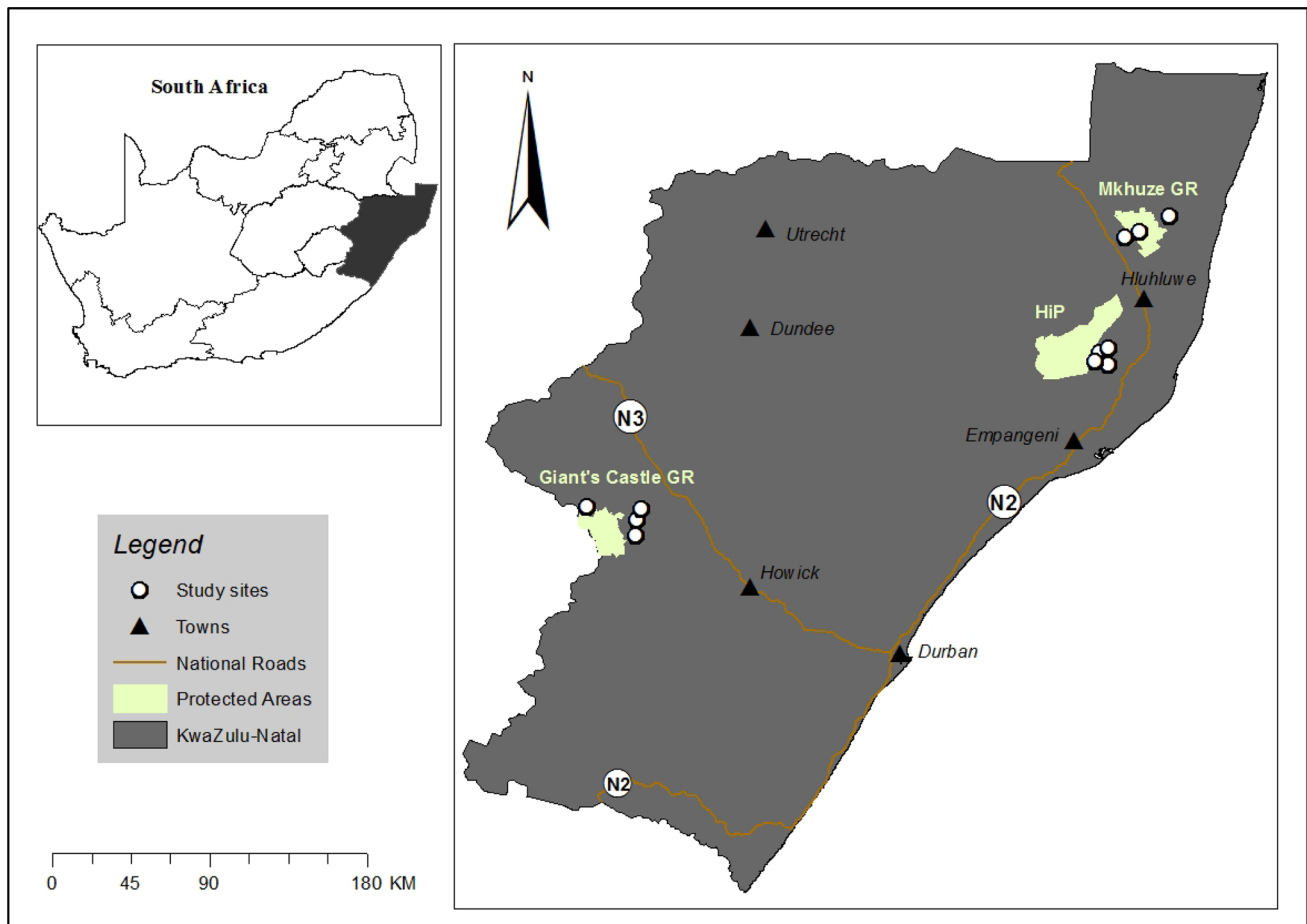
communal rangelands. This, therefore, highlights the importance of considering relationships between local communities and vultures if threats to these species are to be reduced. Data on psycho-social dynamics that directly and indirectly affect vulture conservation can be used to strengthen the effectiveness of conservation initiatives and tools.

Research concerning human–vulture relations provides a rich and unique perspective that is complementary to ecological vulture conservation strategies (Morales-Reyes et al. 2018; Lambertucci et al. 2021; Garcia-Jimenez et al. 2022). However, such research is generally lacking in the context of South Africa (but see Pfeiffer et al. 2015; Mashele et al. 2021a), particularly in KwaZulu-Natal although this province hosts a relatively high diversity of vulture species occurring in the country (Rushworth et al. 2007, 2018; McKean et al. 2013; Kruger et al. 2015). Social sciences provide tools for assessing human dimensions of environmental phenomena (Bennett et al. 2017). Through multidisciplinary approaches, scholars in the field of environmental management have been able to ascertain how local people perceive and adapt to environmental changes (Below et al. 2015). But more importantly, studies of human perceptions, attitudes, beliefs and knowledge have a way of revealing existing and potential threats to species as well as opportunities for improving the conservation of threatened species (Bennett 2016; Nash et al. 2016; Cailly-Arnulphi et al. 2017; Thondhlana and Cundill 2017). Our study investigated the awareness, benefits, beliefs, threats and conservation perspectives of people residing adjacent to three protected areas, housing the remaining vulture strongholds in KwaZulu-Natal, South Africa.

## Methods

### Study sites

The present study involved communities bordering three protected areas, in KwaZulu-Natal, namely Giant's Castle Game Reserve, Hluhluwe-iMfolozi Park (HiP) and Mkhuzi Game Reserve (Fig. 1).



**Fig. 1** Map showing study sites adjacent to three protected areas in KwaZulu-Natal, South Africa

Giant's Castle, situated in Maloti Drakensberg Park (MDP), is a World Heritage Site situated on the western boundary of KwaZulu-Natal, forming the border between South Africa and Lesotho (Fig. 1). Giant's Castle is home to the Bearded (*Gypaetus barbatus*) and Cape (*Gyps coprotheres*) Vultures. Both are cliff-nesting species and have sustained dramatic population declines over the last few years. The species have lost large proportions of their home ranges as anthropogenic land uses expanded over time (Brown 1991; Kruger et al. 2015). Bearded and Cape Vultures are globally listed as Vulnerable and Near-Threatened, respectively (Birdlife International 2021a, b). Notably, there is a sharp contrast between the global and regional status of the Bearded Vulture, as this species is listed as Critically Endangered in southern Africa (Kruger et al. 2015).

Mkhuze and HiP are located in uMkhanyakude District Municipality, north of KwaZulu-Natal. This area supports the majority of tree-nesting vulture species remaining in the province (Rushworth et al. 2018), Lappet-faced Vulture (*Torgos tracheliotos*), globally listed as Endangered as well as the White-backed (*Gyps africanus*) and White-headed

(*Aegyptus occipitalis*) Vultures, both listed as Critically Endangered (BirdLife International 2021c, d, e). The three protected areas are surrounded by isiZulu-speaking communities of Nguni descent, whose livelihoods are predominantly centred around agro-pastoralism. Conservation, tourism, agriculture and trade are other economic activities and sources of employment common in the areas studied (Nsukwini and Bob 2016).

### Data collection and analyses

The communities included in this study were located within 15 km of the reference protected areas (Fig. 1). Data were collected between May and August 2019 through household interviews coupled with focus group discussions (FGD). Approval of the ethical appropriacy of the research instrument was granted by the University of KwaZulu-Natal, Ethics committee (Reference: HSS/1089/108D). Permission to conduct research was sourced from the respective traditional authorities in each study area. The research team spent a maximum of 10 days in each study area, during

which further analyses of the sites, participation in local events and pilot studies were conducted. The pilot study outcomes helped rephrase some questions and remove those that were considered sensitive such as the level of education. We observed that some participants would suggest that they could not participate in the study because they either never went to school or had low educational attainment. To proceed, we explained that the purpose of the study was to solicit experience-based knowledge.

We followed a simple random sampling technique (Cohen et al. 2017), where every second closest household was selected. This is because rural settlements do not always follow a linear structure. The interviews were semi-structured, consisting of closed and open-ended questions (Dawson 2007; Supplementary information Table S1). The interviews were conducted in isiZulu, mostly at the homesteads of the participants and in the company of trained local research assistants. Interviews lasted between 15 and 45 min. Verbal consent was obtained from each study participant before the interviews were administered. Only participants 18 years and older were invited to participate, and both gender groups were incorporated.

A total of 450 household interviews and seven focus group discussions were conducted. Data were supplemented with observations and informal conversations with key informants working in the conservation sector. The focus group discussions consisted of 12 to 14 members and were non-gender specific (Dawson 2007). Participants were recruited with the assistance of traditional authorities and local field assistants. We hosted seven groups in total, with discussions lasting for up to 1.5 h. Apart from socio-economic and demographic attributes, questions were mainly centred around familiarity with vultures, encounters, benefits, beliefs, threats and conservation perspectives. Data were captured and analysed using Excel© and the Statistical Package for the Social Sciences© (SPSS). Analyses included descriptive statistics, regressions (i.e. ordinal and multinomial) and Chi-Squared tests of significance.

Of the 450 interviews, 430 (96%) qualified for analyses. The interviews that were excluded from the analyses ( $n=20$ ) were incomplete, and these mainly included interviews where the participant opted out before the interview was finalised; mainly because of other commitments.

## Results

### Study composition and respondents' demographic attributes

A summary of the sample composition, study participants' demographic information, and socioeconomic attributes is shown in Table 1. Fifty-six per cent ( $n=240$ ) of the study participants were male, whilst 44% ( $n=190$ ) were female.

The majority (30%,  $n=127$ ) of respondents were between the ages of 42 and 50 years, whilst those between the ages of 18 and 25 years constituted the smallest fraction of our sample (5%,  $n=22$ ). The unemployment rate within the study group was high (57%,  $n=245$ ). Other respondents were pensioners (20%,  $n=85$ ), self-employed individuals (7%,  $n=28$ ) and scholars (3%,  $n=14$ ).

Most households (52%,  $n=198$ ) were involved in agropastoralism (a combination of livestock and crop farming) (Table 1). They kept goats and cattle and produced beans, maize, a variety of vegetables, and cotton for subsistence. Livestock ownership and crop farming constituted 24% ( $n=91$ ) and 20% ( $n=77$ ) of the listed activities, respectively. Natural resource collection was less prevalent across all study sites (4%,  $n=14$ ). Resources collected were plant material for craft, firewood, wild fruits and bushmeat. All activities were small-scale and predominantly subsistence-based.

### Local people's awareness and familiarity with vultures

The present study was conducted in two geographically distinct regions of Maloti Drakensberg Park and northern KwaZulu-Natal, with different vulture species occurring in them. Most participants (84%,  $n=361$ ) reported encountering vultures within 12 months of the study. A standard-resolution image list was provided for respondents to identify the species they had seen. The list contained images of six vulture species, five resident, and one locally extinct (Supplementary Information Table S1). Respondents (89%,  $n=320$ ) accurately identified species in relation to their local geographic distribution. Encounters were reflective of species' population densities. For example, respondents reported more sightings of White-backed (47%,  $n=150$ ) and Cape (40%,  $n=128$ ) Vultures in comparison with Bearded Vultures (2%,  $n=6$ ) (Fig. 2a). Vulture awareness amongst the participants was strong (95%,  $n=408$ ), albeit at different levels (Fig. 2b). To gauge awareness levels, we considered responses to encounter (Yes/No), species encountered, site of encounter and activity of the species during encounter (Fig. 3).

Respondents who demonstrated a high level of awareness were many (57%,  $n=323$ ). Study site and gender were found to be significant in predicting awareness and familiarity with vultures. Respondents living around Giant's Castle GR were likely to fall within the high level of awareness category (Wald = 25.3,  $P=0.0001$ ) and were 6.2 times more likely to exhibit high awareness than participants living near Mkhuze. With reference to gender, males were 1.7 times more likely to demonstrate high levels of awareness than female participants (Wald = 4.3,  $P=0.039$ ) (Supplementary information Table S2).

**Table 1** Sample composition, demographic and socioeconomic attributes of the study participants

Region		Maloti DP	Northern KwaZulu-Natal		Total
Protected areas		Giant's Castle	Mkhuze	Hluhluwe iMfolozi Park	
Number of respondents		139 (32%)	188 (44%)	103 (24%)	
<i>Gender</i>	Female	62	74	54	190
	Male	77	115	48	240
	<b>Total</b>				<b>430</b>
<i>Age</i>	18–25	7	11	4	22
	26–33	21	41	19	81
	34–41	29	49	30	108
	42–50	39	59	29	127
	> 50	43	29	20	92
	<b>Total</b>				<b>430</b>
<i>Occupation</i>	Employed	16	26	16	58
	Self-employed	14	8	6	28
	Scholar	3	9	2	14
	Pensioner	38	29	18	85
	Unemployed	68	117	60	245
	<b>Total</b>				<b>430</b>
<i>Livelihood activity</i>	Agro-pastoralism	59	91	48	198
	Livestock ownership	25	42	24	91
	Crop farming	33	31	13	77
	Natural resource coll	4	6	4	14
	<b>Total</b>				<b>380</b>

Note: Participants who were not engaged in any traditional livelihood activity during the study (13%,  $n=58$ ) were excluded from the summary table above. Participants who practised multiple activities (2%,  $n=8$ ) were included in the table and all activities listed were incorporated

## Benefits derived by local people from having vultures in their localities

Most (82%,  $n=354$ ) participants derived benefits from coexisting with vultures. The majority of respondents (65%,  $n=199$ ) appreciated vultures for feeding on carcasses in the fields, thus keeping the environment clean (regulatory services). Northern KwaZulu-Natal participants gave accounts of the past few years when they experienced severe drought conditions in the region and cattle mortality was high. Respondents stated that carcass management would have been a major challenge to livestock owners had it not been for vultures coming into communal lands and consuming the dead cattle. They further reported that the environment would have been uninhabitable because of the smell of rotting carcasses if vultures had not fed on them. Vultures were also admired for helping residents find livestock that had gone missing (20%,  $n=71$ ). In rural areas, cattle often graze unattended and can die without anyone knowing their whereabouts. Vultures flying in circles over an area is indicative of a carcass presence. Farmers find their missing and dead cattle by following vulture movements. Furthermore, 14% ( $n=49$ ) of the participants admired vultures for their

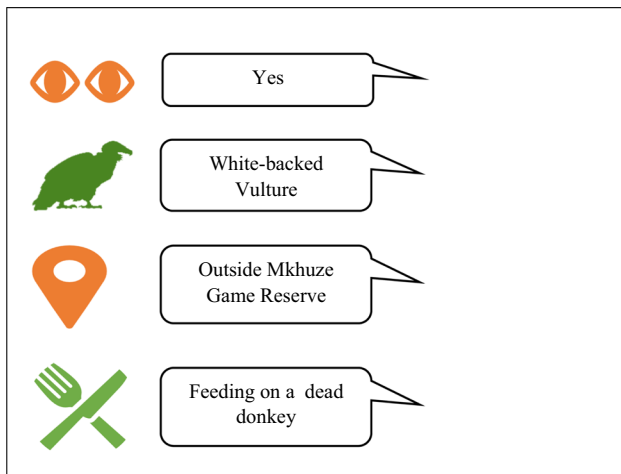
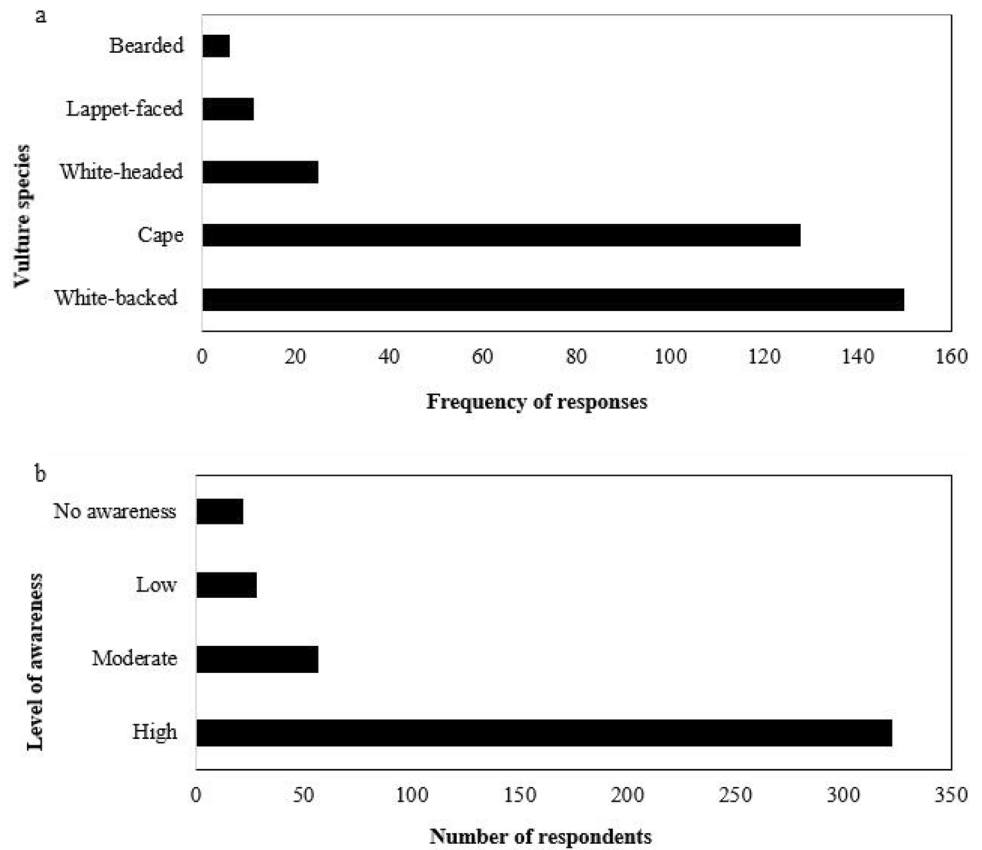
importance as constituents of local natural heritage – to be preserved for future generations. Tourism and bushmeat were the least mentioned benefits associated with vultures in the communities visited (1.4% and 1%, respectively).

Gender was significant in predicting benefits perceived by local people. Male participants were 2.1 times more likely to cite a benefit from carcass removal than females (Wald = 7.6,  $P=0.006$ ). These respondents were also 3.4 times more likely to benefit from the location of missing livestock than their female counterparts (Wald = 12,  $P=0.0001$ ). In addition, natural heritage was a benefit mostly mentioned by males 3.7 times more than females (Wald = 11,  $P=0.001$ ) (Supplementary information Table S3).

## Locally shared beliefs about vultures

Only 25% ( $n=108$ ) of the study participants presented beliefs about vultures (Fig. 4). The most predominant belief was associated with vultures having traditional medicine properties (66%;  $n=71$ ). In addition, a sighting of vultures circling over one's property was believed to indicate an impending great misfortune (20%;  $n=22$ ). A small proportion of respondents believed vultures to be bearers of rain

**Fig. 2** Frequency of responses to **a** vulture species encountered and **b** levels of awareness expressed by respondents



**Fig. 3** A scenario in which a respondent would be assigned High Awareness (4/4). Symbols: 1st=encounter, 2nd=Species, 3rd=location, 4th=activity during encounter

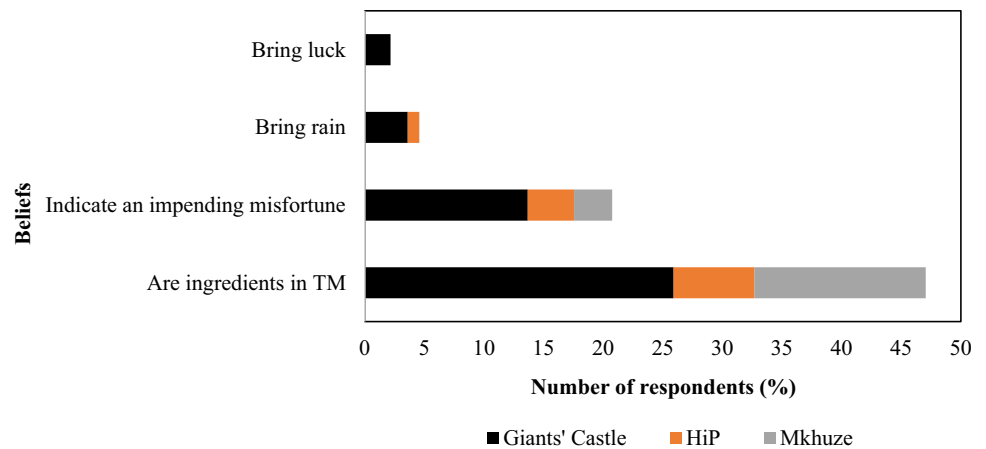
and luck (11% and 3%, respectively). Again, beliefs about vultures were best explained by gender. Male participants were 8.2 times more likely to believe in vultures as having a value in traditional medicine rather than indicators of misfortune than females (Wald = 12.8,  $P = 0.0001$ ) (Supplementary information Table S4).

## Threats to vultures

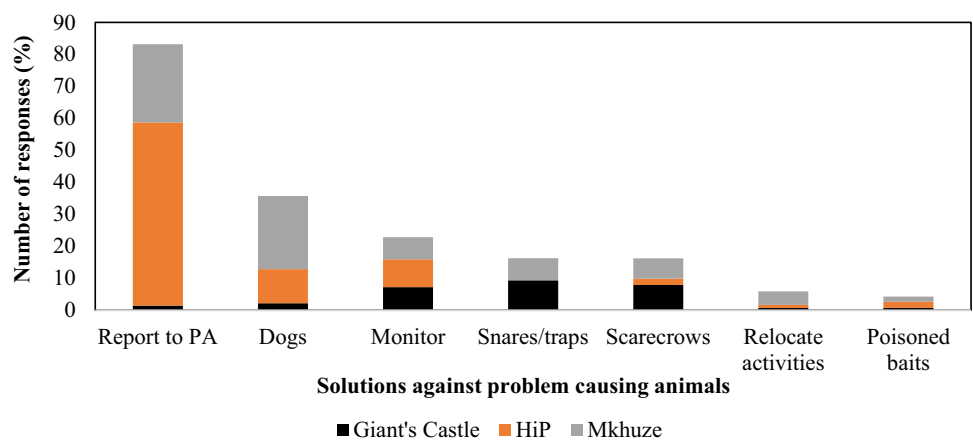
### Indirect threats: solutions to problem-causing animals

Results from our pilot study highlighted that wildlife invasions in communal lands frequently occurred. To ascertain whether vultures were exposed to indirect poisoning in the form of problem-causing animal control, we asked the participants about their management of damage-causing wild animals. Wild animals reported to cause problems in communal lands were Leopard (*Panthera pardus*), Spotted Hyaena (*Crocuta crocuta*), Black-backed Jackal (*Canis mesomelas*), Serval (*Serval leptailurus*), Chacma Baboon (*Papio ursinus*), Pied Crow (*Corvus albus*) and eagles. Damages caused were mainly livestock depredation and occasional crop raiding. The reporting of incidents to protected area authorities was the most common response to problem-causing animals (37%,  $n = 107$ ) (Fig. 5). The second most predominant response was retaliation through hunting with dogs (30%,  $n = 87$ ). Other respondents cited the use of snares/traps (11%,  $n = 32$ ). The use of poisoned baits was less common in the surveyed areas (2%,  $n = 6$ ) (Fig. 5). Some respondents reported moving their activities to areas with less wildlife interference.

**Fig. 4** Local people’s beliefs about vultures reported per study site (TM :Traditional Medicine)



**Fig. 5** Summary of responses to problem-causing animals adopted by local communities reported per study area



**Direct threats: What drives the killing of vultures by residents?**

Forty-five per cent ( $n = 193$ ) of the respondents expressed awareness of factors that motivated the hunting of vultures in their local areas. Traditional medicine use was the most reported driver for hunting vultures (93%,  $n = 181$ ). Vultures were rarely hunted for sport or bushmeat (3% and 2%, respectively). Similarly, the killing of vultures as a result of conflict with humans was almost non-existent (2%,  $n = 2$ ) (Fig. 6).

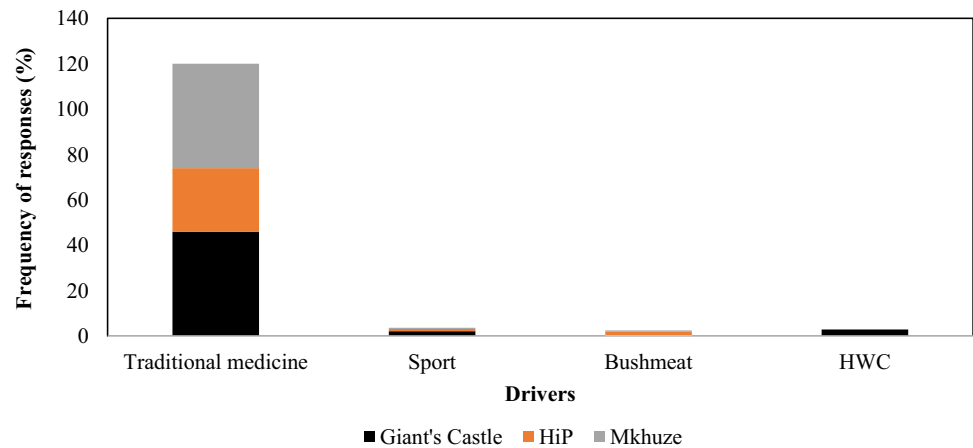
**Local people’s culture conservation perspectives**

We investigated the status of vulture populations from the local people’s perspective. Many participants had noticed changes in vulture populations over the last 10 years (63%,  $n = 272$ ). Most (84%,  $n = 228$ ) believed that vulture populations were in decline (Table 2). The majority of respondents (83%,  $n = 357$ ) stated that vultures should be protected mainly through collaborative efforts between conservation agencies and local communities. However, a significant proportion of respondents (33%,  $n = 117$ ) perceived that

vultures were better off in the hands of conservation agencies (Table 2).

Support for the protection of vultures was determined by study site, gender and age. Giant’s Castle residents were 2.8 times more likely to support vulture protection than Mkhuze respondents (Wald = 6.9,  $P = 0.009$ ). Similarly, HiP residents were even more (5.6 times) likely to favour vulture protection than their neighbours in Mkhuze (Wald = 20.7,  $P = 0.0001$ ). Male respondents were reportedly less likely (0.3 times) to support vulture protection than females (Wald = 13,  $P = 0.0001$ ) (Supplementary information Table S5). The latter finding is contradictory to perceptions expressed by male participants throughout this study. Furthermore, our analyses showed that the oldest members of our study, respondents over 50 years, were more likely to support vulture protection than all other age groups represented in the study.

**Fig. 6** Drivers of the illegal killing of vultures as reported by respondents per study site (*HWC* Human-Wildlife Conflict)



**Table 2** Study participants' vulture conservation perspectives

Have you noticed any change in vulture populations over the last 10 years	No. of responses	%
Yes	272	63
No	143	33
I have no idea	15	3
<i>If yes, what is the direction of this change ?</i>		
The local population has declined	228	84
The local population has increased	40	14
The population increases and decreases	1	0
I am not sure	3	2
<i>Should vultures be protected?</i>		
Yes	375	83
No	73	17
<i>Who should take on the task of making sure that vultures are protected?</i>		
Conservation agencies	117	33
Local communities	77	22
Both conservation agencies and local communities	127	36
I do not know	54	15

## Discussion

### Local people's awareness and familiarity with vultures

The present study builds on assessments of public perceptions about vultures conducted in parts of southern Africa (Mdhlano et al. 2018; Craig et al. 2018; Mashele et al. 2021a) and southwest Europe (Cortés-Avizanda et al. 2018; Morales-Reyes et al. 2018; Oliva-Vidal et al. 2022). It is the first of its kind in KwaZulu-Natal, an important ecological zone for vultures.

Many respondents reported encounters with vultures and could identify the species they had seen from the image list provided. The majority of encounters were related to species' local spatial distribution. For example, Giant's Castle respondents were more familiar with Cape and Bearded

vultures, whereas respondents from Mkhuze and HiP were familiar with White-backed, Lappet-faced and White-headed vultures. Moreover, encounters with vultures were in accordance with species' relative abundance (Rushworth et al. 2018). More common species, such as White-backed and Cape vultures, were frequently cited as species encountered contrary to species with lower population numbers. Local people demonstrated considerable awareness of vultures. When awareness was tested at different levels, more than half of the respondents obtained the highest score.

Awareness was best predicted by study site and gender. Respondents residing adjacent to Giant's Castle were more likely to demonstrate increased familiarity with vultures. This can be attributed to greater visualisation in Giant's Castle as the vultures in this area occupy mountain cliffs surrounding villages and are seen almost on a daily basis flying in and out of their roosts. Furthermore, high awareness levels were predominantly observed in male rather than in female



participants. Numerous narratives about vultures were willingly shared by men, often with great passion. Other studies have shared similar observations (Ehlers-Smith et al. 2021; Hariohay et al. 2022). According to Pam et al. (2018), people often learn better about nature through personal encounters. The assignment of duties is often governed by traditional gender roles, especially in rural agro-pastoralist communities (Pokou et al. 2021). Accordingly, men spend most of their time in the wilderness rearing livestock, hunting and gathering various raw materials (Hariohay et al. 2022). Spending time in the wilderness facilitates exposure to wildlife, enhancing familiarity and increasing knowledge about resident wildlife (Clamsen and Roskaft 2013; Pokou et al. 2021). From a conservation perspective, adequate awareness amongst local people is admirable as studies show that where awareness is limited, misinformation prevails, posing a threat to species, especially those with peculiar behaviours such as vultures (Margalida and Donazar 2020; Lambertucci et al. 2021; Oliva-Vidal et al. 2022).

### Benefits derived by local people from having vultures in their localities

Generally, birds provide numerous economic, cultural and ecological benefits that broadly support human well-being and livelihoods (Clamsen and Røskaft 2013; Mwadzingeni et al. 2018; Garcia-Jimenez et al. 2021). Benefits derived from coexisting with wildlife can play a key role in shaping local people's perceptions and attitudes towards biodiversity and its conservation (Partasmita et al. 2016; Ehlers-Smith et al. 2021). Different population groups, such as farmers and tourists, appreciate vultures for providing niche-based provisioning, regulatory and cultural ecosystem services (Cortés-Avizanda et al. 2018; Garcia-Jimenez et al. 2021). Many of our study participants derived benefits from the occurrence of vultures in their environments. Carrion removal was the most appreciated service provided by vultures as it reportedly helps keep the environment habitable, whilst possibly preventing the spread of diseases from animals to humans (Morales-Reyes et al. 2018). Study participants from northern KwaZulu-Natal (HiP and Mkhuze) gave a narrative about a severe drought that hit the region between 2015 and 2016, decimating large herds of livestock (Vetter et al. 2020; Lottering et al. 2021). More than 40 000 cattle were lost by the end of 2015 in KwaZulu-Natal (Vetter et al. 2020). Respondents indicated that vultures removed most carcasses that the community would have otherwise battled to dispose of timely.

Carrion removal is the most recognised and valued material benefit of human-vulture coexistence worldwide (Moleón et al. 2014; Cortes-Avizanda et al. 2018; Craig et al. 2018; Mdhlanu et al. 2018). In a study conducted in two

municipalities of the Eastern Cape Province, Pfeiffer et al. (2015) indicated that 82% of the participants noted that Cape vultures consumed livestock that had died from natural causes or predation. It has been established that vultures have a natural competitive advantage over scavenging mammals and can control their populations, especially in communal lands (Whelan et al. 2008). Vultures are also the only scavenger guild that can alternate between protected areas and communal lands without initiating cogent human-wildlife conflict. Moreover, evidence suggests that by optimising on the freely available carrion removal service provided by vultures, regions can reduce their carbon footprint and save on monetary resources (Morales-Reyes et al. 2015).

Vultures were also valuable to local people for assisting in locating missing cattle. Herders often found the location of their lost and often dead cattle by following vulture cues. This relationship has been observed in other parts of southern Africa (Craig et al. 2018; Mdhlanu et al. 2018). Carcass location is an essential contribution because many rural communities in southern Africa customarily rely on livestock farming for economic and cultural purposes. During the dry season, when pasture and drinking water are reduced, cattle are compelled to travel long distances searching for food and water, often unattended. By being naturally drawn to carcasses, vultures provide cues for owners to locate their cattle in the event of death. This information can help farmers quantify costs and adopt better management and monitoring practices to reduce cattle mortalities. The aforementioned scenario provides evidence of local people using local ecological knowledge (LEK) and experience to take advantage of ecosystem services (Morales-Reyes et al. 2018; Ehlers Smith et al. 2021).

### Locally shared beliefs about vultures

A few participants (25%) presented beliefs about vultures, mainly concerning their alleged traditional medicine usefulness. Vultures are believed to have a keen sense of smell, enabling them to locate carcasses from vast distances. Locally, they are otherwise called *izwangomoya* (main name: *Inqe*) because they find food by deciphering the contents of the air whilst flying, often in circular motions. Therefore, by using certain vulture parts, especially the head, ordinary people can gain the ability to see into the future or obtain information that would otherwise be inaccessible to them. However, this belief contradicts scientific evidence, demonstrating that Old-world vultures locate carcasses by sight, relying on collective foraging strategies and following cues provided by other scavengers (Kane et al. 2014; Buechley and Şekercioğlu 2016). Nonetheless, the belief-based use of vultures is seemingly prevalent in southern Africa (Cunningham and Zondi 1991; McKean et al. 2013; Williams et al. 2014; Mdhlanu et al. 2018; Mashele et al. 2021b). In

the current study, traditional medicine was the most reported driver for the killing of vultures, especially in northern KwaZulu-Natal. Ogada et al. (2016) state that traditional medicine is responsible for approximately 29% of African vulture mortalities. Existing evidence further indicates that the use of vulture parts in traditional medicine is projected to increase. Hence, McKean et al. (2013) suggest the formulation of strategies aimed at supporting cultural traditions whilst ensuring the long-term persistence of natural resources that form part of these beliefs. Such initiatives may require meaningful deliberations between resource users and conservation practitioners.

Culturally, human-raptor relations are complex, ranging from raptors being considered sacred to being perceived as bad omens (Wyndham and Park 2018; Horgan et al. 2021). Despite being known as bringers of luck and rain, owing to their close association with carcasses, vultures were believed by many (20%) participants to indicate an impending misfortune if they were spotted flying in a circular motion above someone's property. We link this belief to an isiZulu idiom, *uzulelwa amanqe*, meaning vultures are hovering over you. This phrase is often used when threatening or warning someone whose behaviour is about to land them in danger. Such impressions suggest that historically, vultures were once widespread across KwaZulu-Natal, and interactions with local people were established, gaining their prominence in the isiZulu culture and folklore. These findings reveal nuances of non-material culture and identity-related values of vultures worth exploring (Garcia-Jimenez et al. 2022).

### Threats to vultures and conservation perspectives

Socio-ecological landscapes are synonymous with human-wildlife conflicts. Most commonly, cases of human-wildlife conflict involve predators preying on livestock and farmers resorting to using poison to eradicate the perceived culprits. Farmers have long considered poisoning the most effective predator control method (Ogada 2014). Although vultures are seldom targeted in retaliatory wildlife killings, they do, however, fall victim to unintentional poisoning (Ogada 2014), representing one of the major threats to vulture populations globally (Margalida et al. 2011; Ogada et al. 2012; Botha et al. 2017; Safford et al. 2019). In the present study, participants responded to human-wildlife conflict by reporting cases to the neighbouring protected area, and the use of poison was rarely reported. Similarly, Pfeiffer et al. (2015) found that using poison in predator management was not common in communities neighbouring the Msikaba Cape Vulture Colony. The use of toxic substances to kill wildlife is illegal, whilst most apex predators are threatened and therefore protected by the law against the illegal killing (Ogada et al. 2003; Lindsey et al. 2013). It is then likely that respondents underreported their use of poison against

problem-causing animals in fear of potential prosecution (Shanee 2012). Therefore, these results should be interpreted with caution.

Only two per cent of our participants reported cases of conflict with vultures, and these were mainly in the form of chicken depredation. Reports of vultures preying on domestic animals such as sheep and cattle have become common in recent years, especially in Europe, but conservation practitioners are challenging these reports as anecdotal and biased (Margalida et al. 2011; 2014; Duriez et al. 2019; Margalida and Donazar 2020; Oliva-Vidal et al. 2022). It has been shown that 70% of complaints by farmers against vultures are shown to be post-mortem cases and thus rejected (Margalida et al. 2014; Duriez et al. 2019). Both Old and New world vultures are not tailored for predatory behaviour. In the rare cases where vultures inflicted harm on livestock, it was mainly through secondary interference, such as causing minor injuries on frail animals, which may have resulted in a fatality (Duriez et al. 2019). Unfortunately, the essentially rare cases of human-vultures conflict are amplified on social media platforms with risks of mass misinformation that could further culminate in unwarranted enmity towards vultures (Margalida et al. 2014; Margalida and Donazar 2020).

### Population dynamics and conservation perspectives

Vulture populations were perceived to have declined in the last 10 years by respondents and in other studies (Safford et al. 2019). This observation agrees with empirical reports largely indicating that vulture populations across southern Africa have declined dramatically over the last three decades (Ogada et al. 2012, 2016; Kruger et al. 2015; Rushworth et al. 2018). The protection of vultures was supported by a great number of respondents. This outcome could be attributed to their natural heritage importance (non-material) as well as the tangible benefits that local people enjoy by having vultures in their localities. We tested support for the protection of vultures against demographic and socioeconomic indices. Age and gender were found to be the best predictors of support for vulture conservation. Participants over 50 years were most likely to advocate for the protection of vultures. Surprisingly, male participants were less likely to favour protecting vultures than female participants. This finding was in contradiction with the perceptions expressed by men throughout the study. Male participants exhibited stronger awareness of vultures. These participants also perceived vultures as useful, more than their female counterparts. Regarding beliefs, men were less likely to associate vultures with misfortunes. We found that most participants, males, in particular, were positive about vultures and wished to see them thrive in their localities.

## Conclusions

Our results suggest that vultures are salient in the landscapes they occupy as providers of regulatory and provisioning ecosystem services (i.e. carrion removal and signalling livestock carcass location). Vulture awareness and familiarity amongst local people were adequate and may have played a role in facilitating the recognition of ecosystem services provided by vultures. The study participants exhibited predominantly positive perceptions towards vultures, which is interesting because, in contrast with South Africa, studies conducted in Europe report negative perceptions exhibited by local people (Morales-Reyes et al. 2018; Oliva-Vidal et al. 2022). Our findings can be considered in designing vulture conservation initiatives. Further, we propose incorporating vulture conservation initiatives into the already existing local community-based programmes. One particular example is the horse racing initiative that is gaining momentum in rural KwaZulu-Natal. It mainly involves young people as horse riders, and it is competition based. Vultures can be incorporated, for instance, in the naming of horses and event themes. This can be a channel for awareness raising, especially amongst young people and can challenge the existing and emerging negative perceptions, especially those relating to vultures as being useful in traditional medicine.

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## Declarations

**Conflict of interest statement** The authors declare no conflict of interest.

**Ethical approval** Approval of the ethical appropriacy of the research instrument was granted by the University of KwaZulu-Natal, Ethics committee (Reference: HSS/1089/108D).

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