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Research Article

Local knowledge and perceptions of animal population abundances by communities adjacent to the northern Gonarezhou National Park, Zimbabwe

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Abstract

Understanding animal abundances and population trends is a fundamental goal of ecology. The aim of this study was to examine local ecological knowledge (LEK) held by local people bordering the northern Gonarezhou National Park (GNP), Zimbabwe, concerning domestic and wild animal species abundances and perceived population trends, in order to evaluate the possible contribution of LEK to wildlife conservation and management. Data were collected through interviews using a semi-structured questionnaire from 236 local people in communities adjacent to the northern GNP from December 2010 to May 2011. The results show that perceptions of domestic animal population trends were mixed, with 44% of the respondents perceiving an increase, 36% perceiving a decline, and 20% perceiving that domestic animal populations had remained the same between 2000 and 2010. Furthermore, about 76% of the respondents perceived that wild animal abundances had increased, 15% perceived a decline, and 9% perceived that wild animal abundances had remained the same in GNP between 2000 and 2010. Responses on perceptions of animal population trends were to a great extent in line with recorded population trends from conventional scientific studies. The study results suggest that LEK may serve as a valuable source of ecological information and could compliment scientific information for wildlife conservation and management, particularly in community-based natural resources management programmes.

Keywords: conservation, local people, knowledge, perception, savanna

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Introduction

Human communities, especially those living in and around protected areas, often have important and long-standing relationships with these areas, giving local people particular knowledge about the environments in which they live [1, 2]. Indigenous knowledge is a body of knowledge built by a group of people through generations of living in close contact with nature [3]. Indigenous groups offer alternative knowledge and perspectives based on their own locally developed practices of resource use [4]. Local knowledge is increasingly being sought by academics, scientists, and policymakers as a potential source of ideas for emerging models of ecosystem management, conservation biology, and ecological restoration [4-8]. To this end, the United Nations Convention on Biodiversity calls for recognition, protection, and utilization of Traditional Ecological Knowledge (TEK) [5].

TEK consists of biophysical observations, skills, and technologies, as well as social relationships such as norms and institutions, that structure human–environmental interactions [4, 9]. TEK is transferred from one generation to the next, representing cumulative local knowledge, and is modified and amended as a result of new experiences and observations [9]. Because new knowledge is created all the time, recent Local Ecological Knowledge (LEK) is defined as knowledge, practices, and beliefs regarding ecological relationships that are gained through extensive personal observation of and interaction with local ecosystems, and shared among local resource users [6]. LEK may eventually become TEK [6]. LEK has been used to obtain information on the presence and qualitative abundance of species, qualitative population trends, and other far-reaching insights into ecological processes [10, 11]. Local perception refers to local people's understandings that reflect their habitual way of life, as well as their shared expectations [2].

Although TEK is increasingly being recognized as a suitable alternative approach to promoting environmental sustainability in both academic circles and policy formulation, there are still doubts and heated debates about its viability [12]. Most of these doubts and debates arise from the important differences between TEK and scientific ecological knowledge. TEK observations tend to be qualitative, recording observations from a single location over a long time period [5, 9]. In TEK, the observers tend to be the resource users themselves, such as hunters, fishers, and gatherers whose harvesting success is inextricably linked to the quality and reliability of their ecological observations [5]. In contrast, scientific observations made by a small group of professionals tend to be quantitative and often represent simultaneous observations from a wide range of sites, which frequently lack the long-term perspective of TEK [5]. Furthermore, scientific ecological knowledge tends to be driven by theoretical models and hypothesis testing, and generated using the scientific method; it is not necessarily utilitarian, is often general and not always local, is generated by research institutions, and is documented and widely disseminated in written form [6].

On the other hand, TEK and LEK tend to be driven by a need for utilitarian information that will help people survive and maintain a natural resource-based livelihood; such information is generated through practical experience with the natural world in the course of everyday life, is locally based and specific, and is transmitted orally or through demonstration [6]. Additionally, the production of TEK is relatively inexpensive compared to scientific ecological knowledge, because relevant information is accumulated incidentally while also pursuing several other goals and can provide observational replication over extended temporal periods [13].

An increasing number of recent studies have highlighted major declines in large mammal populations in many of Africa’s protected areas as a result of diverse factors including habitat loss and degradation, bushmeat hunting, diseases and droughts [14-18]. The knowledge that local people gain through daily interaction with ecosystems and constituent animal species may hold clues for

sustainable animal species conservation and management in tropical ecosystems [19]. Most of the emphasis in understanding local people's knowledge and perceptions has focused on the conflicts between people and protected areas, such as loss of traditional extraction access or damage by wildlife to crops and livestock [20-24]. It is therefore essential, from both a scientific and conservationist perspective, to understand local people's knowledge and perceptions in order to allow for comprehensive wildlife conservation and management [25]. However, studies presenting cases using local knowledge in understanding animal species abundances and trends are few [e.g. 10, 13, 19, 25, 26]. Therefore, this study examined the LEK held by local people bordering the northern Gonarezhou National Park (GNP), Zimbabwe, concerning domestic and wild animal species abundances and perceived population trends, in order to evaluate the possible contribution of LEK to wildlife conservation and management. The objectives of this study were to: (i) document the local knowledge and perceptions related to domestic and wild animal abundances, and (ii) determine the reasons and/or explanations for the perceived animal abundances and qualitative population trends. In addition, a comparison of the collected LEK on qualitative animal population trends for the GNP ecosystem was made using scientific information from previous studies.

Methods

Study area

This study focused on local communities adjacent to the northern GNP, Zimbabwe. This study site was selected because it is representative of the socio-ecological complex of communal areas and protected areas, mostly national parks, in Zimbabwe, and also because the local communities are involved in community-based natural resources conservation. Therefore, it was expected that the local people had some knowledge of animal abundances and qualitative population trends. Established in the early 1930s as a Game Reserve, GNP was upgraded into a national park in 1975 under the Parks and Wildlife Act of 1975. GNP is the second largest national park in Zimbabwe after Hwange National Park; it covers an area of about 5000 km^2 in southeastern Zimbabwe, between 21° 00'–22° 15' S and 30° 15'–32° 30' E. The study area lies in a semi-arid savanna ecosystem with an average annual rainfall of between 400 and 600 mm [27]. The Gonarezhou ecosystem is endowed with a wide variety of both large carnivores and herbivore species [28, 29]. As GNP is largely unfenced, animals move inside and outside of the park to the adjacent communal areas.

Four wards or communities adjacent to the northern GNP were selected for this study: Chibwedziva and Chizvirizvi in Chiredzi district, and Mtandahwe and Mahenye in Chipinge district (Fig. 1). A ward is a sub-district administration unit which is comprised of at least 6 villages [30]. The selection of these wards or communities was largely informed by an earlier study on perceptions of illegal wildlife hunting by local communities in the same area [29]. Within the four selected communities, eight villages were randomly selected for data collection.

All the four study communities practice wildlife conservation under the Communal Area Programme for Indigenous Resources (CAMPFIRE), a conservation programme that was initiated in 1989 [31]. Sustainable wildlife utilisation is a legitimate form of land use in communal areas in Zimbabwe, which allows rural communities adjacent to protected areas to derive benefits from natural resources [32]. Shangaan is the major ethnic group in the study area. Local residents in communities adjacent to the northern GNP practice a combination of subsistence, cash crop farming and livestock production [29].

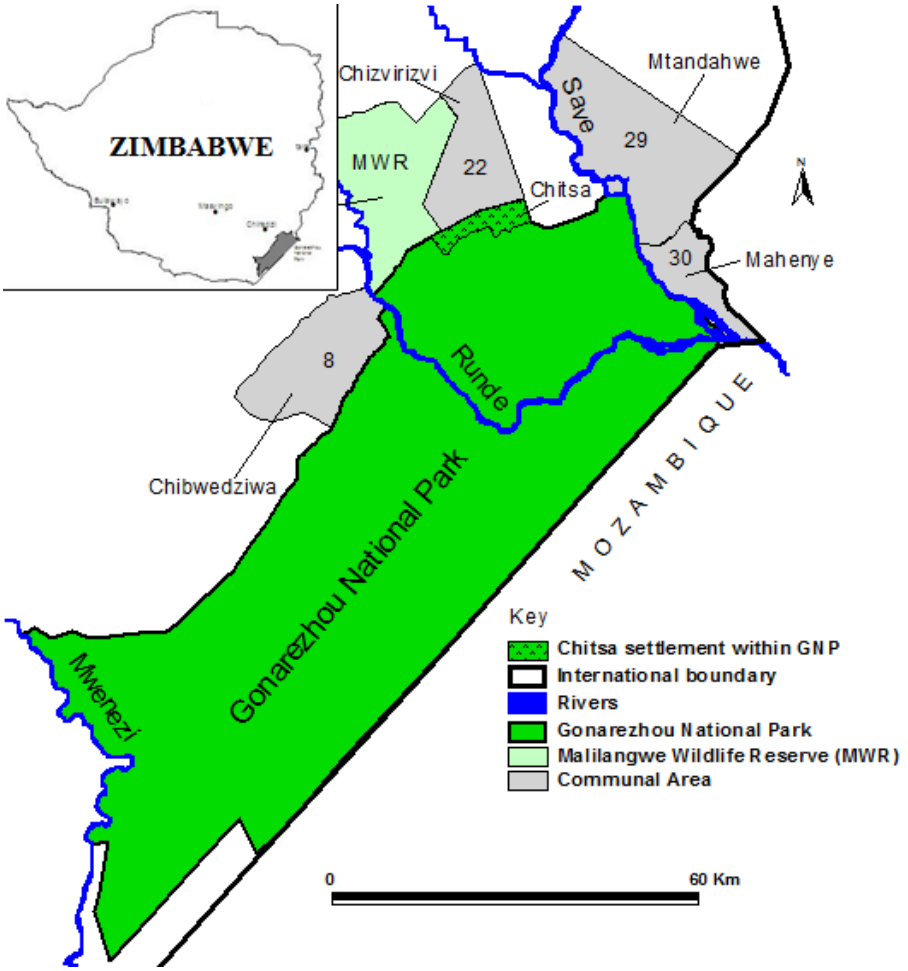

Fig. 1. Location of the four study wards adjacent to the northern Gonarezhou National Park, Zimbabwe. Notes: Numbers represents ward numbers

Data collection

Data were collected from December 2010 to May 2011. The questionnaire survey, which formed part of a broad study on human effects on tropical savanna ecosystems, involved a sample of 236 local people drawn from eight villages in four communities adjacent to the northern GNP. Questionnaires are particularly suitable tools for approaching studies of local knowledge and perceptions of ecological processes [33]. Current village registers of the eight study villages formed the sampling pool, and households were randomly selected by picking numbers from a hat. Household heads or other permanently resident adults (≥18 years) were targeted as the respondents and took part in the interviews in each respondent's residence.

The date for interview was communicated to each selected household one or two days in advance. With the help of one field assistant conversant with the local language acting as a translator, a total of 236 local people, each representing a different household, were interviewed. The sample included 146 (62%) males and 90 (38%) females. Interviews were carried out in Shangaan and English. Respondents were interviewed using a semi-structured questionnaire. Pre-testing was conducted in a village in the Chitsa ward, outside the study communities, to ensure that all questions were clear, and a final version was prepared for sampling. Questions were constructed to gather information on local knowledge and perceptions of domestic animal qualitative population trends, frequency of wild animal sightings in the villages and/or communities, and wild animal qualitative population trends. Both close- and open-ended questions were included in the interview questionnaire (Appendix 1). Each interview took between 45 and 75 minutes to complete. In order to compare the collected LEK on qualitative animal population trends for the GNP ecosystem, data on observed populations of

animal species were retrieved from past aerial surveys of large herbivores and spoor surveys of large carnivores [34-38].

Data analysis

Descriptive statistics were used to summarize the questionnaire response data set. Where multiple responses were possible on an open-response question, data are presented as the percentage of respondents giving each response, and may sum to over 100%. Chi-square (χ^2) tests of goodness-of-fit were used to analyse responses on frequency of sighting wild animals and qualitative population trends. Differences were considered to be significant at $P \leq 0.05$. Statistical analyses were conducted using Statistical Package for Social Sciences (SPSS version 19, Chicago, USA). The information derived from LEK was evaluated by comparing it with data derived from more standard scientific methods of aerial surveys and field sampling.

Results

Perceptions of domestic animal qualitative population trends

Respondents showed mixed perceptions on qualitative population trends of domestic animals between 2000 and 2010, with 44% (n = 104) of the respondents perceiving an increase, 36% (n = 85) perceiving a decline, and 20% (n = 47) perceiving that domestic animal populations had remained the same (χ^2 = 21.42, df = 2, $P < 0.0001$). Goats, poultry and domestic cats were mostly perceived to have increased, whereas cattle, sheep and donkeys were largely perceived to have decreased in abundance between 2000 and 2010 (Table 1). Domestic animal species perceived to have increased were reported to be less negatively affected by diseases and predators, whereas those perceived to have declined were reported to be more negatively affected by diseases and more often attacked by large carnivores (Table 2).

Table 1. Domestic animal species perceived to have increased and/or decreased in communities adjacent to the northern Gonarezhou National Park, Zimbabwe, between 2000 and 2010

Common name	Scientific name	Number of responses	%
Perceived increase			
Goat	*Capra hircus*	117	49
Chicken (poultry)	*Gallus gallus*	107	45
Domestic cat	*Felis catus*	37	16
Perceived decline			
Cattle	*Bos taurus*	158	67
Sheep	*Ovis aries*	137	58
Donkey	*Equus asinus*	123	52
Domestic pig	*Sus scrofa*	71	30
Domestic dog	*Canis familiaris*	58	25

Perceptions of wild animal abundances and qualitative population trends

About 12% (n = 29) of the respondents reported that they sighted wild animals daily, 31% (n = 73) reported sighting wild animals once in every two weeks, 19% (n = 44) reported sighting wild animals at least once within a month, 12% (n = 29) reported sighting wild animals once between one and three months, and 26% (n = 61) reported sighting wild animals once between three and six months in their villages and/or communities (χ^2 = 32.39, df = 4, $P < 0.0001$). About 76% (n = 179) of the respondents perceived that wild animal abundances had increased, 15% (n = 36) perceived that wild

animal abundances had declined, and 9% (n = 21) perceived that wild animal abundances had remained the same between 2000 and 2010 in GNP (χ^2 = 193.38, df = 2, P < 0.0001).

The following wild animal species were largely perceived to have increased: elephant, spotted hyena, buffalo and lion (Appendix 2). The main explanations given by the respondents for the perceived increases included perceived availability of adequate grazing resources, low disease occurrence and no culling in the recent past in GNP (Appendix 3). In contrast, cheetah, African wild dog and leopard were largely perceived to have declined in abundance, attributed to illegal hunting, diseases, past droughts and habitat degradation.

Table 2. Explanations for the perceived increases and decreases in domestic animal species in communities adjacent to the northern Gonarezhou National Park, Zimbabwe, between 2000 and 2010

Explanation	Number of responses	%
Perceived increase		
Less affected by diseases	104	44
Safe from predators	61	26
Enough pasture	61	26
High breeding rate	40	17
Less prone to theft	26	11
Perceived decline		
Disease	167	71
Predation	92	39
Drought	83	35
Inadequate grazing area	54	23
Livestock theft	53	22
Local trade	23	10

Recorded wild animal population trends from scientific studies

Data from aerial surveys conducted between 1998 and 2009, show that populations of elephant, impala, buffalo, kudu and zebra increased, whereas populations of eland, giraffe and sable either remained stable or slightly declined (Fig. 2a). Spoor survey counts of large carnivores in the GNP show that the five major large carnivore species, spotted hyena, leopard, African wild dog, cheetah and lion, all increased in abundances between 2009 and 2011 (Fig. 2b). Compared to the qualitative population trends given by local people in this present study, all respondents' responses on the large herbivore species were similar to the recorded trends in large herbivores. In contrast, leopard, African wild dog and cheetah were perceived to have declined in abundance, whereas scientific data showed that these species were increasing.

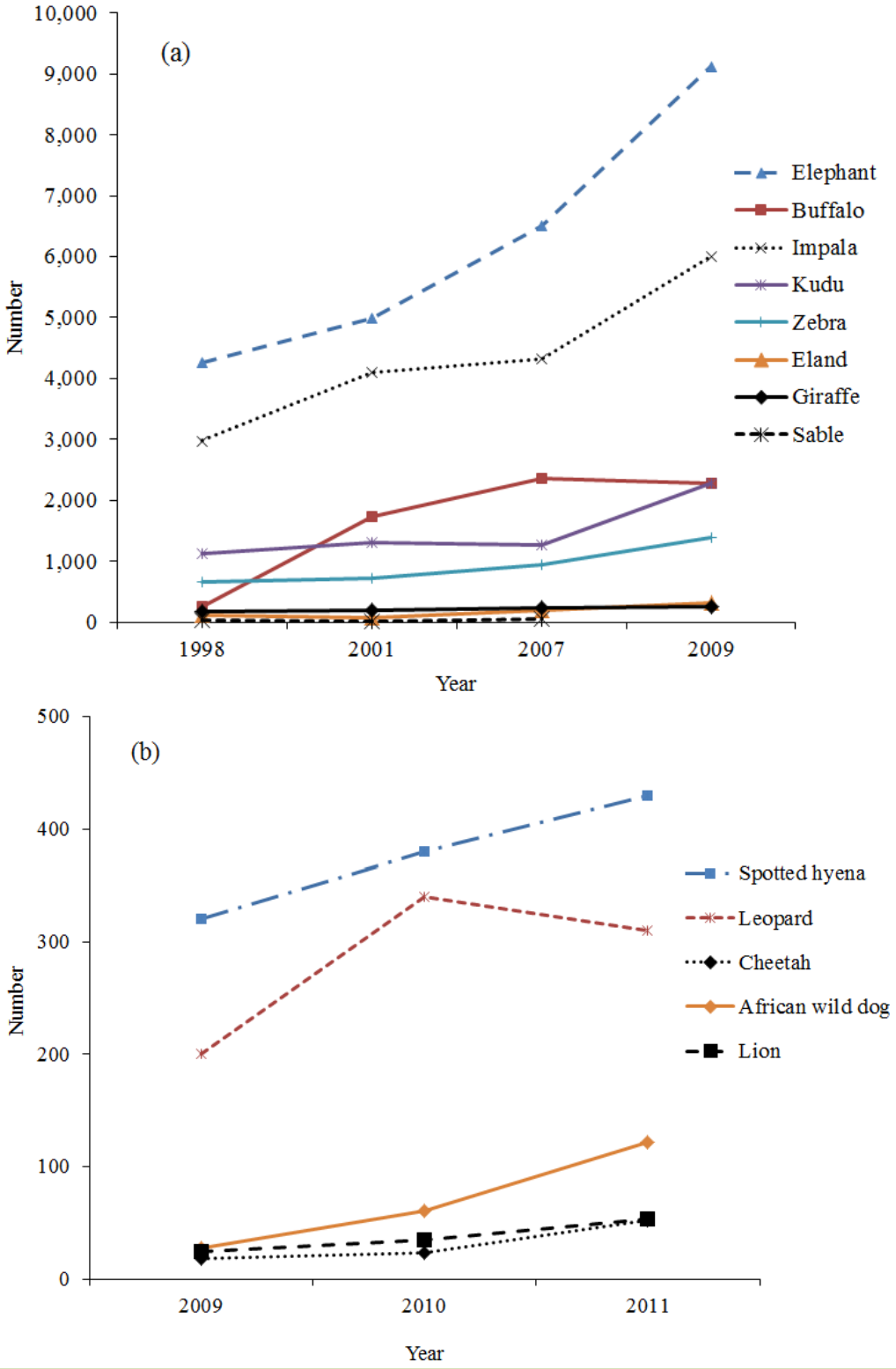

Fig. 2. Observed population trends for (a) eight large herbivores (1998–2009) and (b) five large carnivores (2009–2011) in Gonarezhou National Park, southeastern Zimbabwe. Source: [34-38].

Discussion

The study findings show that local people can recognize and distinguish different animal species, as well as notice and explain qualitative population trends. Goats and poultry were largely perceived to have increased in abundance, whereas cattle, sheep, donkeys and pigs were largely perceived to have declined in abundance between 2000 and 2010. Goats and poultry were reported to be less negatively affected by diseases and also were regarded as being easier to keep and protect from predators, hence the perceived increase in these species' populations. In contrast, the majority of the respondents reported that cattle, sheep, donkeys and pigs were more negatively affected by diseases such as anthrax and foot-and-mouth, hence the perceived decline in their populations over the study period. Cattle have been reported to play a central role in livelihoods of people living in marginal areas in semi-arid regions [39]. Accordingly, in the southeast lowveld of Zimbabwe cattle-based households generally cope with hazards such as crop failures and economic decline by selling cattle [40]. For instance, in the present study respondents reported that during the socio-economic challenges in Zimbabwe between 2000 and 2008, they raised money through selling cattle despite the unreliable livestock marketing system. Additionally, livestock were reportedly sold during crop failure periods to buffer the households against hunger, probably contributing to the perceived decline in cattle populations.

Most respondents perceived that some of the wild animal population species had increased in the GNP between 2000 and 2010. Frequent sighting of wild animals in the study area was the main indicator for local perceptions that wildlife populations had increased. These study results show that local perceptions are to some extent in agreement with the increasing wild animal population trends reported by scientific studies conducted in the GNP [28, 34, 35]. However, rare and endangered animals such as cheetah, African wild dog and leopard were mostly perceived as having decreased in abundance, whereas recent carnivore research suggests that these species populations are slightly increasing [34]. Surprisingly, the majority of respondents perceived an increase in livestock depredation by large carnivores, although except for spotted hyenas, actual numbers of most large carnivores in the Gonarezhou ecosystem are low [34]. The perceived increases in large carnivore-livestock conflicts could be a result of the temporary stoppage of legal (safari) hunting of lions by the Zimbabwe Parks and Wildlife Management Authority in communal areas adjacent to the GNP since 2009 [41].

Knowledge of specific species abundances and qualitative population trends was quite variable among local people in this present study. Factors that may influence the variability in the LEK include levels of environmental awareness in the study communities, extent of human-wildlife conflicts, and success of CAMPFIRE programmes [29]. The resulting variations in LEK among respondents suggest that there is a need to expand conservation awareness and wildlife-related educational programmes. Although the distribution and quality of LEK vary among individuals and groups within any community, a common denominator of ecological knowledge often underlies community resource management institutions [9]. For instance, shared ecological knowledge and perceptions are strongly reflected in quota setting for wild animal species off-takes under CAMPFIRE programmes in the study communities, contributing to wildlife conservation management regimes. Interestingly, the identification of species qualitative population trends suggests that local people have to some extent similar views on the population trends of animal species in the study area. The ecological knowledge held by local people suggests a strong understanding of ecological relationships and processes. For example, increases in large native herbivores were attributed to less disease occurrences, no culling and availability of sufficient grazing resources. Similarly, declines in animal abundances were attributed to factors such as increased illegal hunting, droughts, diseases and habitat degradation.

Since LEK is based on experiences over lengthy time periods, LEK also provides information on past situations [10]. In the present study, the focus was on information related to the period 2000–2010.

Nevertheless, interviews provided information about the causes of animal abundance changes, especially the culling programmes implemented in the 1970s until 1993 and the 1991-92 severe drought [41]. Such information could provide insights on factors that have influenced the present day population abundances of animal species in the GNP. This information could also be used in developing new research questions and/or hypotheses for future studies. In cases where precise scientific data are scanty, it is necessary to establish precautionary management actions based on the available scientific information and local people's LEK, which have proven to be extremely useful for management purposes under an ecosystem-based approach [42]. LEK can also be particularly useful when population densities are low and traditional sampling methods are expensive or difficult to implement [10], for instance, in the case of large carnivores. It has been suggested that LEK can serve as a useful, complementary data source, and may be particularly valuable when managing wildlife populations that occur in remote locations inhabited by indigenous peoples [43].

Implications for conservation

Interviews with local people showed that they have a wide knowledge of some animal species' abundances and qualitative population trends in the study area. However, generalisations of the study results over a large geographical area could be difficult given that LEK is location specific, is dynamic and changes over time, and is dependent on a specific cultural context that gives it meaning [44]. It should be highlighted that LEK for some species' population trends may be incorrect, for instance in the case of large carnivores as recorded in this present study. For example, local people may have less knowledge on cryptic animal species, such as carnivores, which are very difficult to see and encounter, or those being interviewed may not understand the full life cycle or biology of some species [43]. Most LEK is inherently qualitative and difficult to validate, but it could help to identify coarse changes in population size [43]. Therefore, LEK could be used as (i) a supplementary source of scientific studies, (ii) a basis for new scientific investigation, and (iii) a proxy in cases of limited resources [27, 45, 46].

It should be emphasised that other local communities in southeastern Zimbabwe or other similar areas elsewhere may not have the same LEK about animal species abundances and qualitative population trends as recorded in this present study. Therefore, scale may play an important role when gathering LEK [44] related to animal abundances and qualitative population trends. Furthermore, reliability of LEK also depends strongly on characteristics of the target taxa and the interviewee population [10]. For instance, the taxa should be easily recognizable. In the present study context, most domestic and wild animal species are easily known by local people in areas with community-based natural resources conservation programmes, such as CAMPFIRE. As for the interviewee population, the local people or residents in areas having community-based natural resources conservation programmes constitute an ideal group of informants about animal species abundances and population trends. However, such target groups of interviewees may be absent in other settings. Nevertheless, it is believed that the present study provides some insights to encourage the use of LEK in wildlife conservation in savanna ecosystems.

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Appendix 1: Questionnaire on animal population abundances and trends

1. Village of respondent?
2. Ward of respondent?
3. In your opinion has population or abundances of livestock increased or decreased or remained the same in your village and ward between 2000 and 2010?
4. List the livestock species that you perceive to have increased
5. What are the explanations for the increase in livestock species populations?
6. List the livestock species that you perceive to have decreased
7. What are the explanations for the decrease in livestock species populations?
8. How often do you see wild animals in your village or ward? (Everyday / Once in 14 days / Once in 30 days / Once in 1-3 months / Once in 3-6 months)
9. In your opinion has populations of wild animal species increased or decreased or remained the same in the Gonarezhou ecosystem between 2000 and 2010?
10. List the wild animal species that you perceive to have increased
11. What are the explanations for the increase wild animal species populations?
12. List the wild animal species that you perceive to have decreased
13. What are the explanations for the decrease in wild animal species populations?

Appendix 2. Wild animal species perceived to have increased and/or decreased in the Gonarezhou ecosystem, Zimbabwe, between 2000 and 2010

Common name	Scientific name	Number of responses	Percentage (%)
Perceived increase			
Elephant	*Loxodonta africana*	206	87
Spotted hyena	*Crocuta crocuta*	105	44
Buffalo	*Syncerus caffer*	82	35
Lion	*Panthera leo*	77	33
Kudu	*Tragelaphus strepsiceros*	48	20
Impala	*Aepyceros melampus*	42	18
Hippopotamus	*Hippopotamus amphibius*	27	11
Zebra	*Equus quagga*	23	10
Perceived decline			
Cheetah	*Acinonyx jubatus*	65	28
African wild dog	*Lycaon pictus*	56	24
Leopard	*Panthera pardus*	54	23
Eland	*Taurotragus oryx*	43	18
Sable antelope	*Hippotragus niger*	40	17
Giraffe	*Giraffa camelopardalis*	30	13

Appendix 3. Explanations for the perceived increase and decrease in wild animal species in the Gonarezhou ecosystem, southern Zimbabwe, between 2000 and 2010

Explanation	Number of responses	Percentage (%)
Perceived increase		
Adequate grazing resources	69	29
Less disease occurrence	52	22
No culling	47	20
Improved law enforcement	34	14
Perceived decline		
Illegal hunting	160	68
Diseases	68	29
Drought	49	21
Habitat degradation	49	21