Research Article

Preliminary assessment of illegal hunting by communities adjacent to the northern Gonarezhou National Park, Zimbabwe

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Abstract

Illegal hunting of wildlife is a major issue in today's society, particularly in tropical ecosystems. In this study, a total of 114 local residents from eight villages located in four wards adjacent to the northern Gonarezhou National Park, south-eastern Zimbabwe were interviewed in 2009, using semi-structured questionnaires. The study aimed to answer the following questions: (i) what is the prevalence of illegal hunting and what are commonly used hunting methods? (ii) Which wild animal species are commonly hunted illegally? (iii) What are the main reasons for illegal hunting? (iv) What strategies or mechanisms are currently in place to minimize illegal hunting? Overall, 59% of the respondents reported that they saw bushmeat, meat derived from wild animals, and/or wild animal products being sold at least once every six months, whereas 41% of the respondents reported that they had never seen bushmeat and/or wild animal products being sold in their villages and/or wards. About 18% of the respondents perceived that illegal hunting had increased between 2000 and 2008, whereas 62% of the respondents perceived that illegal hunting had declined, and 20% perceived that it remained the same. Snaring (79%) and hunting with dogs (53%) were reportedly the most common hunting methods. A total of 24 wild animal species were reportedly hunted, with African buffalo (*Syncerus caffer*) (18%), Burchell's zebra (*Equus quagga*) (21%), kudu (*Tragelaphus strepsiceros*) (25%) and impala (*Aepyceros melampus*) (27%) amongst the most targeted and preferred animal species. In addition, large carnivores, including spotted hyena (*Crocuta crocuta*) (11%), leopard (*Panthera pardus*) (10%) and African lion (*Panthera leo*) (8%), were reportedly hunted illegally. The need for bushmeat, for household consumption (68%), and raising money through selling of wild animal products (55%) were reported as being the main reasons for illegal hunting. Strengthening law enforcement, increasing awareness and environmental education, and developing mechanisms to reduce human-wildlife conflicts will assist in further minimizing illegal hunting activities in the Gonarezhou ecosystem.

Key words: Bushmeat, conservation, enforcement, poverty, snaring

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Introduction

Hunting of wildlife by humans is an ancient practice [1]. Research over the last two decades has shown that humans may have a significant influence in structuring terrestrial ecosystems. Studies in tropical forest ecosystems provide evidence that increased human hunting activities have led to reductions and local extinctions of some wildlife populations [2,3], and that many populations of tropical species such as gorillas (*Gorilla gorilla*) have been or will be lost in equatorial Africa [4,5], if the current exploitations prevail. Consequently, the exploitation of animal populations has been highlighted as one of the central reasons why species are currently threatened [6,7].

Humans have the potential to hunt any animal species in any ecosystem. Humans use numerous methods to catch their prey, including snares, iron-jaw or gin-traps, pit traps, net drives, firearms, crossbows, bow and arrow, blowpipes, spears, catapults, dogs, machetes, poisoning, fire, dazzling by torchlight or gathering by hand [8]. Although law enforcement patrols attempt to control illegal hunting, the expected economic benefits from the sale of bushmeat, derived from wild animals, are far greater than the costs associated with a low probability of arrest and punitive fines; thus illegal hunting is a persistent, widespread problem for animal species conservation [9,10]. Most bushmeat studies in Africa have concentrated on Central and Western tropical forests on the mainland [11-15]. In contrast, the prevalence and impacts of bushmeat hunting and illegal trade in bushmeat have been under-appreciated in Southern Africa, despite indications that illegal hunting constitutes a serious conservation threat in parts of the region [16]. Recently, however, there has been an increase in research on bushmeat hunting and illegal trade in Southern Africa [17-19]. In addition, several authors have also documented an established hunting culture that points to regular consumption of wild animals for food in Zimbabwe [20-24].

There has been widespread concern about increasing illegal hunting of wildlife in most conservation areas in Zimbabwe following the socio-economic and political challenges the country faced between 2000 and 2008. Therefore, a survey to assess the extent and nature of illegal hunting of wild animals in the northern Gonarezhou National Park (GNP) ecosystem, south-eastern Zimbabwe by adjacent local communities was conducted. Specifically, the study sought to answer the following questions: (i) what is the prevalence of illegal hunting and what are the commonly used hunting methods? (ii) Which wild animal species are commonly hunted illegally? (iii) What are the main reasons for illegal hunting? (iv) What strategies or mechanisms are currently in place to minimise illegal hunting?

Methods

Study area

This study was conducted in four wards: Chibwedziva (ward 8) and Chizvirizvi (ward 22) falling under Chiredzi district, and Mahenye (ward 30) and Mtandahwe (ward 29) falling under Chipinge district, adjacent to the northern GNP, south-eastern Zimbabwe (Fig. 1), as part of a broad study of human effects on tropical savanna multispecies wildlife communities. Established in the early 1930s as a Game Reserve, GNP was upgraded into a National Park under the Parks and Wildlife Act of 1975. GNP and the surrounding areas have been part of the Great Limpopo Transfrontier Conservation Area (GLTFCA) since 2000. Covering an area of 5053 km^2, GNP is located in south-eastern Zimbabwe, between 21° 00'–22° 15' S and 30° 15'–32° 30' E.
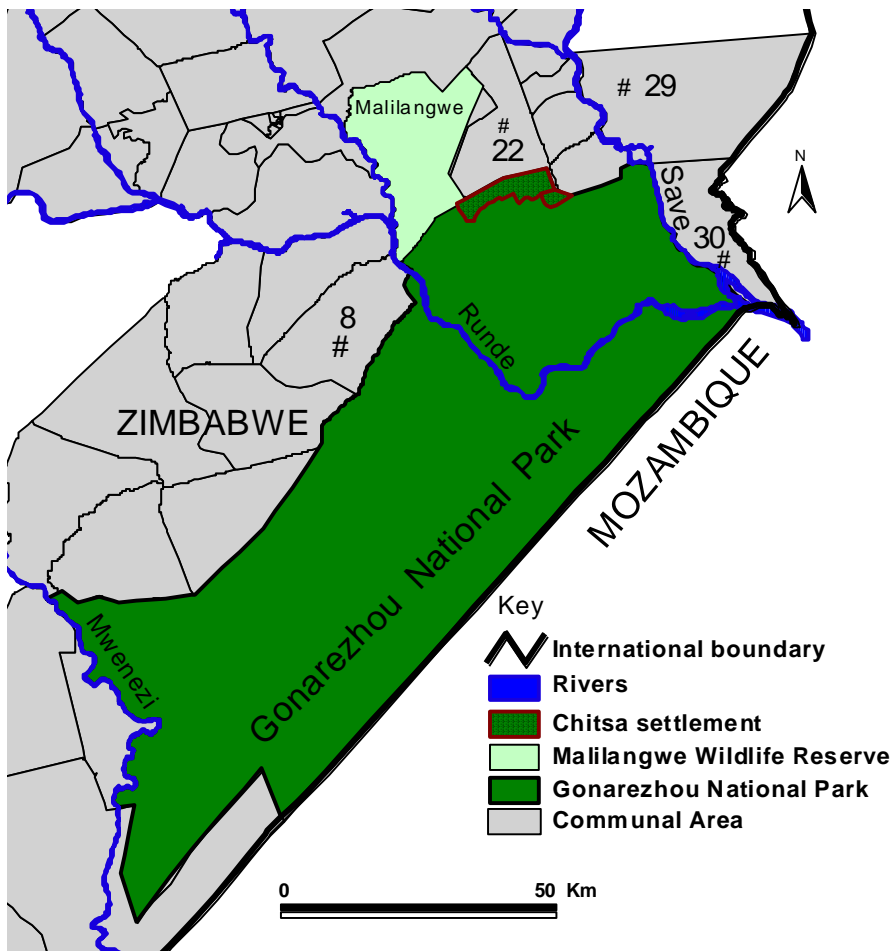
Fig. 1. Location of the study wards adjacent to the northern Gonarezhou National Park, south-eastern Zimbabwe. Notes: #8 represents Chibwedziva ward (ward 8), #22 represents Chizvirizvi ward (ward 22), #29 represents Mtandahwe ward (ward 29) and #30 represents Mahenye ward (ward 30)

The study area experiences three seasons: hot dry, hot wet and cool dry. Annual average rainfall for GNP is about 466 mm, with November to March being the wettest months. The dry season normally lasts from April to October. Average monthly maximum temperatures are 25.9 °C in July and 36 °C in January. Average monthly minimum temperatures range between 9 °C in June and 24 °C in January [25]. The vegetation of the Gonarezhou ecosystem in the south-eastern Zimbabwe is typical of semi-arid savanna and dominated by *Colophospermum mopane* woodlands [26].

There is a wide variety of large herbivore species in the Gonarezhou ecosystem. These include the African elephant (*Loxodonta africana*), hippopotamus (*Hippopotamus amphibius*), African buffalo (*Syncerus caffer*), giraffe (*Giraffa camelopardalis*), Burchell's zebra (*Equus quagga*), waterbuck (*Kobus ellipsiprymnus*), roan antelope (*Hippotragus equinus*), sable antelope (*Hippotragus niger*) and Blue wildebeest (*Connochaetes taurinus*). The park is also endowed with a variety of large carnivores, including the African lion (*Panthera leo*), leopard (*Panthera pardus*) and spotted hyena (*Crocuta crocuta*) [27]. Table 1 provides the population estimates for the major wildlife species in the GNP. In the GNP, anti-poaching patrols are routinely conducted by the park's staff as a way of protecting the natural resources. The anti-poaching patrols are divided into three categories: (i) local or daily patrols which cover a maximum radius of 10–15 kilometers, (ii) extended patrols consisting of between 10 and 21 days and covering a larger area, and (iii) strategic patrols which cover areas of specific interest. Overall, at least 20 extended patrols are conducted monthly in the entire GNP.

Table 1. Population estimates of major wildlife species in the Gonarezhou National Park, south-eastern Zimbabwe. Note: Confidence interval defines upper and lower 95 % confidence limits. Source: Dunham et al. [28], Groom and Brand [29].

Species	Scientific name	Population estimate	Confidence interval (%)
Elephant	*Loxodonta africana*	9123	21
Buffalo	*Syncerus caffer*	2274	85
Eland	*Taurotragus oryx*	317	120
Giraffe	*Giraffa camelopardalis*	251	62
Impala	*Aepyceros melampus*	6005	37
Kudu	*Tragelaphus strepsiceros*	2285	30
Waterbuck	*Kobus ellipsiprymnus*	360	86
Zebra	*Equus quagga*	1385	30
Nyala	*Tragelaphus angasii*	370	51
Wildebeest	*Connochaetes taurinus*	364	82
Warthog	*Phacochoerus aethiopicus*	267	79
Common duiker	*Sylvicapra grimmia*	159	36
Steenbok	*Raphicerus campestris*	97	54
Lion	*Panthera leo*	54	—
Spotted hyena	*Crocuta crocuta*	421	—
Leopard	*Panthera pardus*	315	—
Cheetah	*Acinonyx jubatus*	50	—
Small-spotted genet	*Genetta genetta*	456	—

Local residents in communities adjacent to the northern GNP practice a combination of subsistence, cash crop farming and livestock production. The main crops include sorghum (*Sorghum bicolor*) and maize (*Zea mays*) grown for both subsistence utilisation and commercial sale, and cotton (*Gossypium* spp.) specifically grown for commercial sale. Livestock include cattle (*Bos taurus*), goats (*Capra hircus*), sheep (*Ovis aries*), donkeys (*Equus asinus*) and poultry. Wildlife conservation in communal areas adjacent to the GNP is practiced under the Communal Areas Management Programme For Indigenous Resources (CAMPFIRE), a community-based conservation approach. Before 1982, anti-poaching patrols in the communal areas were conducted by the then Department of National Parks and Wildlife Management (now Zimbabwe Parks and Wildlife Management Authority [ZPWMA]). Since 1982, following the amendment of the Parks and Wildlife Act to allow for local communities to utilise wildlife resources in their areas, anti-poaching patrols in the communal areas with CAMPFIRE status have been conducted by resource monitors employed under the CAMPFIRE committees. The dominant ethnic group in the study area is Shangaan.

Data collection

In this study a cross-sectional case-study design was used. A cross-sectional research design allows data to be collected at one particular point in time from a sample selected to represent a larger population [30]. This type of research design was used because it is the most common design used in survey research to compare the extent to which at least two groups of people differ on one common subject. Data were collected from eight villages occurring in four wards, *i.e.* two villages per ward, within 10 km of the northern GNP boundary. The villages covered were Chihosi (n = 14) and Chipachani (n = 14) in Chibwedziva ward, Chizvirizvi village 5 (n = 15) and Chizvirizvi village 6 (n = 14) in Chizvirizvi ward, Maparadze (n = 14) and Matunga (n = 14) in Mtandahwe ward and lastly, Mudavanhu (n = 15) and Tongogara A (n = 14) in Mahenye ward.

Within each village, study households were selected from village registers using random number tables. The total sample comprised 114 respondents. Respondents were local villagers, and no distinction was made between hunters and non-hunters. This was done to encourage local residents to openly provide illegal hunting information, which can be regarded as sensitive. All interviews were conducted with the willingness of the respondents, who were assured of anonymity to increase the chances that they would provide reliable answers. The interviews were conducted at each respondent's homestead and took approximately 20–30 minutes to complete.

Data were collected from May to December 2009 through face-to-face interviews conducted in English and Shangaan. The interview questions were constructed to gather information on the general hunting practices by the community. Respondents provided information based on their general knowledge of illegal hunting practises inside the GNP and adjacent areas, regardless of whether or not they practised illegal hunting themselves. Data collected included information on gender, age, education, occupation, period of stay in the area, frequency of sighting bushmeat and/or wild animal products being sold, trends of illegal hunting, methods of hunting, most hunted species, reasons for hunting, and methods currently being used to control or minimise illegal hunting (see Appendix 1). Most of the questions were open-ended, in order to tap into the actual views of villagers in a form that was not *a priori*. Before final adjustments were made, the questionnaire was pre-tested in February, 2009, on a pilot sample of 18 local people in two villages from the Chitsa ward in Chiredzi district adjacent to the northern GNP. However, the general shortcomings of illegal hunting data obtained through interview surveys are acknowledged. For example, biases could arise from non-truthful disclosures by survey respondents on commonly hunted species; errors associated with recall data such as frequency of sighting bushmeat or wild animal products being sold and insufficient replication of surveys [31].

Data analysis

Collected survey data were tabulated in Microsoft Office Excel 2007, and all analyses were conducted using Statistical Package for Social Sciences (SPSS Version 19.0). Descriptive statistics were used in the form of bar charts and percentages. Chi-square (χ^2) tests for goodness-of-fit were used to establish whether or not the sampled respondents' socio-demographic composition data were significantly different. In addition, cross tabulations involving chi-square (χ^2) tests were used to: first, establish whether responses on prevalence and trends in illegal hunting activities were dependent and/or independent of location within the four study wards, and second, establish the relationships between socio-demographic variables and local people's responses on prevalence and perceived trends of illegal hunting. Differences were considered to be significant at $P \leq 0.05$.

Results

Demography

Of the 114 respondents in this study, 86% (n = 98) were men, **more men would be respondents, if present, at most households** (χ^2 = 58.98, df = 1, P < 0.0001). Twelve percent (n = 13) of the respondents were between 18 and 20 years, 19% (n = 22) were between 21 and 40 years, 64% (n = 73) were between 41 and 60 years and 5% (n = 6) were older than 60 years (χ^2 = 97.16, df = 3, P < 0.0001). Only Chibwedziva and Chizvirizvi wards had no respondents between 18 and 20 years old. Eighty-seven percent (n = 99) of the respondents had stayed in the study area for at least five years, and 13% (n = 15) for less than five years (χ^2 = 61.89, df = 1, P < 0.0001). About 96% of respondents from Chizvirizvi ward had stayed in the ward for at least five years, whereas 73%, 65% and 61% of respondents from Chibwedziva, Mahenye and Mtandahwe wards, respectively, had stayed in the study area for at least five years. Respondents significantly differed in education: 16% (n = 18) had never attended school, 53% (n = 61) had attended primary school and 31% (n = 35) had completed at least secondary education (χ^2 = 24.68, df = 2, P < 0.0001). Chibwedziva (24%) and Mahenye (29%) had the most respondents who had not attended formal education. Seventy-eight percent (n = 89) of the respondents were employed and/or involved in agricultural activities, whereas only 22% (n = 25) were unemployed (χ^2 = 35.93, df = 1, P < 0.0001). Chibwedziva (70%) and Chizvirizvi (93%) wards had the most employed respondents or respondents involved in agricultural activities compared to Mahenye (47%) and Mtandahwe (44%) wards.

Prevalence of illegal hunting and perceived trends in illegal hunting

Four percent (n = 5) of the respondents reported that they saw bushmeat and/or wild animal products being sold every day, 14% (n = 16) of the respondents reported that they saw bushmeat and/or wild animal products being sold once in two weeks, 16% (n = 18) of the respondents reported that they saw bushmeat and/or wild animal products being sold once a month, whilst 25% (n = 29) of the respondents reported that they saw bushmeat and/or wild animal products being sold at least once between three and six months. Forty-one percent (n = 47) of the respondents reported that they had never seen bushmeat and/or wild animal products being sold in their villages and/or wards. The frequency of sighting bushmeat and/or wild animal products being sold significantly differed across the four study wards (χ^2 = 29.39, df = 12, P = 0.004). Respondents from Mtandahwe ward had the highest frequency of sighting bushmeat and/or wild animal products being sold in one month compared to the other three study wards (Fig. 2). Overall, responses on prevalence of illegal hunting in the study area were similar between males and females (χ^2 = 1.97, df = 4, P = 0.741), education levels (χ^2 = 1.53, df = 8, P = 0.992), length of stay in the ward (χ^2 = 5.07, df = 4, P = 0.280), occupation (χ^2 = 4.18, df = 4, P = 0.382) and age (χ^2 = 9.21, df = 12, P = 0.685).

The perception of illegal hunting trends in the Gonarezhou ecosystem between 2000 and 2008 differed significantly across the four study wards (χ^2 = 33.23, df = 6, P < 0.0001). Respondents from Chibwedziva (83%) and Mahenye (83%) wards largely perceived that illegal hunting had decreased. However, there were mixed responses from respondents in Chizvirizvi and Mtandahwe wards (Fig. 3). Overall, about 18% (n = 21) of the respondents perceived that illegal hunting activities had increased, whereas 62% (n = 71) of the respondents perceived that illegal hunting activities had decreased, and only 20% (n = 22) of the respondents perceived that illegal hunting activities had remained the same. Responses on perceived illegal hunting trends were similar between males

and females (χ^2 = 3.28, df = 2, P = 0.194), education levels (χ^2 = 4.97, df = 4, P = 0.290) and length of stay in the ward (χ^2 = 2.58, df = 2, P = 0.275). In contrast, responses were significantly different with age (χ^2 = 18.11, df = 6, P = 0.006). Approximately, 49% of respondents >40 years reported that illegal hunting had declined, whereas 17% of respondents <40 years reported that illegal hunting activities had increased. In addition, responses significantly differed with occupation (χ^2 = 12.88, df = 2, P = 0.002). About 15% of unemployed respondents reported that illegal hunting activities had increased, compared to only 4% of employed respondents who reported the same. Main reasons given for the perceived decline in illegal hunting in the Gonarezhou ecosystem were: (i) that illegal hunters (or poachers) were afraid of being arrested or imprisoned (77%) due to strengthened law enforcement, and (ii) the positive impact of conservation awareness, education under CAMPFIRE programme and associated benefits such as cash dividends and bushmeat (19%) (Table 2).

Table 2. Reasons for the perceived decline in illegal hunting levels in the Gonarezhou ecosystem, Zimbabwe. Note: Total percentage exceeds 100 for each ward because the respondents were allowed to give multiple answers

Reason	Ward (%)				Overall (%)
	Chibwedziva	Chizvirizvi	Mahenye	Mtandahwe	
Illegal hunters afraid of being arrested or imprisoned	86	91	57	74	77
Awareness, education and benefits from CAMPFIRE programme	0	9	55	10	19
Illegal hunters afraid of being injured or killed by rangers	19	5	5	21	13
Few firearms to use in illegal hunting	2	0	0	0	1

Illegal hunting methods
Most respondents across the four study wards reported that snaring (79%, n = 90), hunting with dogs (53%, n = 60), and using bow and arrows (35%, n = 40) were the common hunting methods used both inside the GNP and adjacent areas (Table 3). Wire snares were reportedly made from stolen telephone copper cables and steel wire from the old veterinary fence along the GNP boundary. Respondents highlighted that most of the illegal hunting occurred inside the GNP since wild animals were more abundant inside the park compared to the communal areas. A higher proportion of residents in Mtandahwe (38%) and Chibwedziva (24%) wards reported that poisoning was used to kill wild animals both inside the GNP and the communal area. Poisoning, mostly using herbicides and pesticides, was reportedly used in revenge killings of large carnivores such as spotted hyenas and lions as a way to reduce livestock-carnivore conflicts.
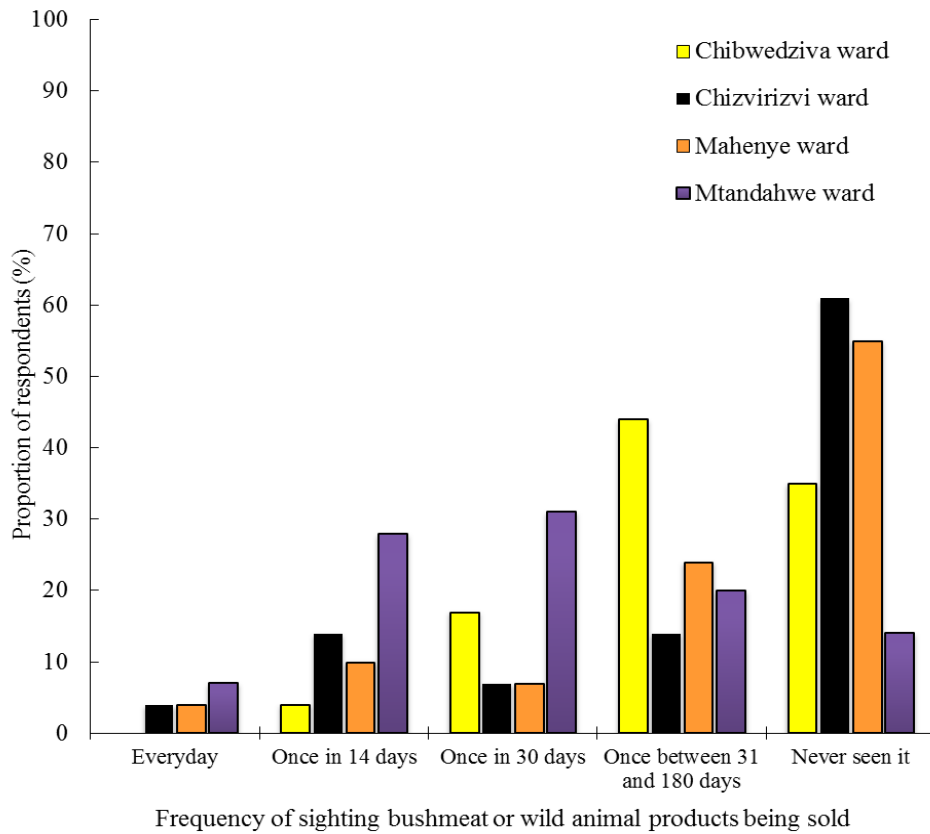
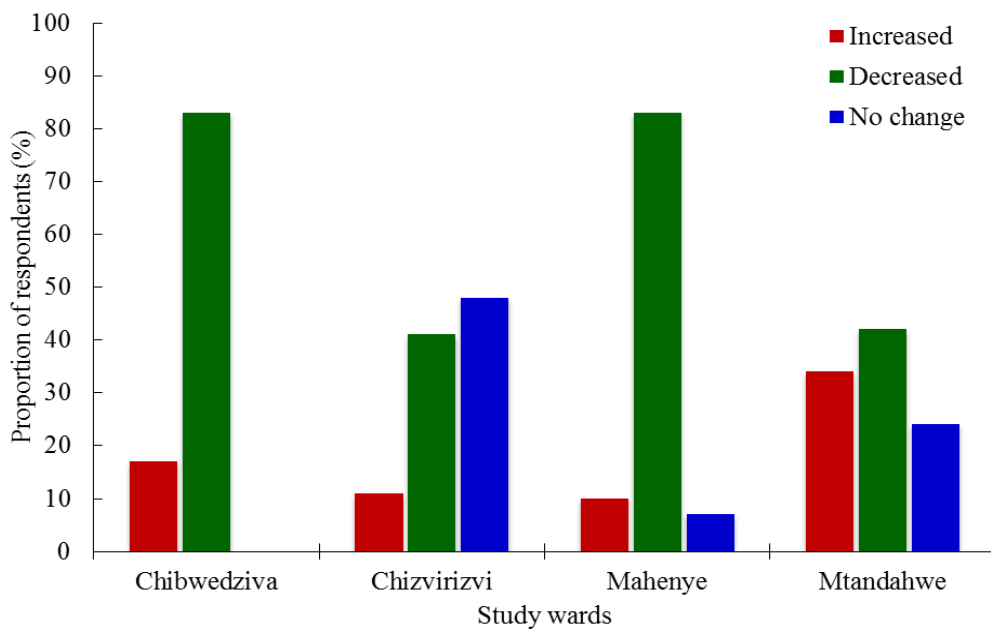**Fig. 2. Prevalence of illegal hunting in the Gonarezhou ecosystem, south-eastern Zimbabwe.**

Fig. 3. Perceived trends in illegal hunting of wildlife in the Gonarezhou ecosystem, south-eastern Zimbabwe, between 2000 and 2008.

The least reported illegal hunting methods were firearms (10%), nets to capture wild animals (10%), and wildfires (7%) (Table 3). Respondents indicated that firearms were both difficult to obtain and made detection easier by law enforcement staff due to noise. Most respondents reported that few local illegal hunters used firearms. Wildfires were reportedly used to drive animals towards wire snares and also to make hunting by dogs easier.

Table 3. Common illegal hunting methods used in the Gonarezhou ecosystem, south-eastern Zimbabwe. Note: Total percentage exceeds 100 for each ward because the respondents were allowed to give multiple answers

	Ward (%)				Overall (%)
Hunting method	Chibwedziva	Chizvirizvi	Mahenye	Mtandahwe	
Snaring	79	76	79	83	79
Hunting with dogs	55	45	48	62	53
Use of bow and arrow	31	38	28	41	35
Poisoning	24	17	17	38	24
Netting wild animals	10	10	7	14	10
Firearms	10	3	14	14	10
Wildfires	7	7	3	10	7

Animal species targeted by illegal hunters
A total of 24 wild animal species, including large herbivores and carnivores, were reported to be illegally hunted in the Gonarezhou ecosystem (Appendix 2). Most of the respondents in the four study wards reported that impala (27%), kudu (25%) and zebra (21%) were the most abundant, preferred and commonly illegally hunted animals. In addition, large carnivores, including spotted hyena (11%), leopard (10%), lion (8%) and cheetah (2%), were reported as also being illegally killed in the Gonarezhou ecosystem. Respondents from Chibwedziva ward indicated that zebra (59%), wildebeest (39%), spotted hyena (27%), leopard (24%) and giraffe (12%) were the most commonly illegally hunted compared to the other three study wards. Respondents from Chizvirizvi ward reported that more lions (19%) were hunted illegally in the Gonarezhou ecosystem compared to the other wards.

Reasons for illegal hunting
Overall, respondents highlighted eight reasons why local people illegally hunted wild animals in the Gonarezhou ecosystem including the need for bushmeat for domestic consumption (68%, *n* = 78), commercial trade in animal products in order to raise money (55%, *n* = 63), and as a way to reduce crop damage (11%, *n* = 13). Respondents from Chibwedziva (71%), Mahenye (81%) and Mtandahwe (78%) wards reported that the need for bushmeat as a source of protein to alleviate poverty was the main reason that local residents illegally hunted wild animals. Generating money from the commercial sale of animal products was indicated as the second major reason for illegal hunting, with most responses recorded from Mahenye (97%), Mtandahwe (60%) and Chizvirizvi (36%) wards. Thirty-three percent of the respondents from Chibwedziva ward indicated that illegal

hunting was conducted for traditional reasons and/or to get animal products for use in cultural ceremonies. For example, baboons were reportedly hunted for their bones, which were used by traditional healers. In Chizvirizvi ward, revenge killings as a way to reduce crop destruction (40%) and livestock depredation (14%) were reported. The other reasons fueling illegal hunting were reported to be unemployment, revenge killings after arrests by resource monitors or rangers, and hunting as a hobby (Appendix 3).

Strategies for minimizing illegal hunting in the Gonarezhou ecosystem
A high proportion of respondents in the four wards reported that conservation-oriented meetings (52%, *n* = 59) and awareness by CAMPFIRE committees (38%, *n* = 43) were playing important roles in the reduction of illegal hunting activities in the Gonarezhou ecosystem (Appendix 4). About 54% of respondents from Mahenye ward reported that tangible benefits such as cash dividends and bushmeat under the CAMPFIRE programme had a positive influence in reducing illegal hunting. Other mechanisms of reducing illegal hunting highlighted by respondents in the study wards included existence of penalties (33%), role of traditional leaders (29%), direct benefits to the community from CAMPFIRE programme through creating of employment, e.g. resource monitors (26%), and anti-poaching patrols by resource monitors and rangers (23%).

Discussion

The present study suggests that illegal hunting constitutes part of the livelihoods of some local residents in communities adjacent to the northern GNP. The demographic variables influencing local people's knowledge and perceptions of illegal hunting were age and occupation. Education, gender and length of stay in the study area had no significant influence. Young people who were mostly involved in cattle herding and also unemployed appeared to have more information on illegal hunting activities in the northern Gonarezhou ecosystem. Despite the general perception that illegal hunting trend had declined in the northern Gonarezhou ecosystem between 2000 and 2008 as a result of strengthened law enforcement, awareness and education and benefits from the CAMPFIRE programmes, a higher proportion of respondents reported that they sighted bushmeat and/or wild animal products being sold in their communities. It appeared that much of the bushmeat and/or wild animal products were frequently sighted in Mtandahwe and Chibwedziva wards. In contrary, Mahenye and Chizvirizvi wards had the fewest reports of bushmeat and/or wild animal products being sold or sightings.

The study recorded a variety of illegal hunting methods reportedly being used in the northern Gonarezhou ecosystem. In all four study wards, illegal hunting was perceived to be mostly conducted using wire snares, hunting dogs, and bows and arrows. Circumstantial evidence also indicates that snaring is the most common hunting method used in the Gonarezhou ecosystem, since wire snares are continuously collected within the GNP by rangers on patrols (Fig. 4). However, poisoning of animals, mostly large carnivores as a way of reducing livestock depredation, appeared to be common in Mtandahwe and Chibwedziva wards. The hunting methods least reported in this study were using nets to capture wildlife, use of firearms and wildfires. The study findings corroborate those of Mavhunga [24] and Muboko [32] who reported that illegal hunting has remained prevalent in the Gonarezhou ecosystem. Similarly, the study results are consistent with the findings of Lindsey et al. [19] who also reported that illegal hunters used snares, dogs and spears in Save Valley Conservancy in south-eastern Zimbabwe. Snares are regarded as the simplest and most effective hunting devices [13]. Snares are however, selective on

a broad scale [33]. Elephants, for example, cannot be caught by snares set for cane rats (*Thryonomys* spp.) due to their body size [34]. However, snaring as a form of illegal hunting is difficult to detect by wildlife enforcement staff [35,36]. Wild animals are usually caught by wire snares set in thickets and on animal trails [10]. Elsewhere, in the Serengeti National Park (SNP), Tanzania, illegal hunters were reported to use a variety of hunting methods with wire snaring being the common hunting method [37]. However, in areas outside the SNP, where law enforcement was regarded as low, hunters were reported to actively stalk their prey [38]. It has been suggested that with increased law enforcement efforts in an area, illegal hunters were likely to switch to less detectable methods such as snaring, and to target smaller sized mammals [39].

Fig. 4. Images of the most illegally hunted wild animal species and wire snares collected by law enforcement rangers in the Gonarezhou ecosystem, south-eastern Zimbabwe. (Top Left) Impala (*Aepyceros melampus*), (Top Right) Kudu (*Tragelaphus strepsiceros*), (Bottom Left) Burchell's zebra (*Equus quagga*) and (Bottom Right) wire snares. Photo credits: Kim Wolhuter (wild animals) and Patience Gandiwa (wire snares).

This study recorded that illegal hunting was fueled by various factors, including the need for bushmeat for household consumption; commercial trade in wild animal products in order to raise income; revenge killing after livestock loses to large carnivores; and as a way to minimize human-wildlife conflicts. In addition, the importance of hunting for medicinal purposes and revenge killings after arrests by rangers was recorded. A recent study by Lindsey et al. [19] in the south-eastern Zimbabwe reported that key drivers of the bushmeat trade include: (i) poverty, (ii) unemployment and food shortages, (iii) failure to provide benefits to communities in wildlife-based land uses, (iv) absence of affordable protein sources other than illegally sourced bushmeat,

(v) inadequate investment in anti-poaching in some areas under wildlife management and (vi) weak penalty systems that do not provide sufficient deterrents to illegal bushmeat hunters.

In the present study it was recorded that illegal hunters preferred a range of animal species with different body sizes, from large to small-bodied animals. Impala, kudu, zebra and buffalo were among the most targeted and preferred species, whereas giraffe and sable were amongst the least targeted and illegally hunted species. Differences in illegal hunting animal preferences and targeted species in the northern Gonarezhou ecosystem may be explained by variations in animal species abundances. Abundant large herbivore species were more frequently mentioned as being preferred than less abundant species. Elsewhere, other authors have also reported that large herbivore species are the prime target for illegal hunting [11,17,40,41]. Overall, population trends of large herbivores in the GNP after the 1991–92 severe drought and the stoppage of elephant culling in 1993, i.e. between 1993 and 2009, show that giraffe and impala populations were stable, whereas elephant, buffalo, eland, kudu, waterbuck and zebra populations were increasing [28,42]. These recorded trends in large herbivore populations in the GNP seem to suggest that the overall negative impact of illegal hunting is low.

In addition, the population trends of large herbivores in the GNP contradict the generally perceived decline in wildlife abundances across Zimbabwe following the socio-economic and political challenges faced by the country between 2000 and 2008. However, it is likely that illegal hunting may have negatively affected animal species with low populations and non-significant population trends. It has been reported that most wildlife population declines following the political instability and economic decline in Zimbabwe were recorded in private game ranches or farms [43]. For instance, following settlement of game ranches by subsistence farming communities since the year 2000, illegal hunting led to the eradication or major declines of wildlife populations over large areas, thereby threatening the viability of wildlife-based land uses [43].

Respondents from Mahenye ward reported that hunting was mostly conducted as a way to acquire bushmeat for subsistence consumption and also for commercial trade. Animal products reported to be commercially traded included bushmeat, ivory, skins from species such as leopard, cheetah, lion and zebra. On the other hand, respondents from Chizvirizvi ward reported that most illegal hunting was fueled by human-wildlife conflicts such as crop-raiding and livestock depredation. Most of the problem-causing large carnivores were commonly poisoned or hunted with dogs. It is likely that the poisoning of large carnivores in the Gonarezhou ecosystem could be an important factor contributing to the current low abundance of large carnivores such as lions. However, the extent to which indiscriminate killing of large herbivores occurs in northern GNP remains unknown and needs further examination.

Humans may affect large carnivore populations through a wide range of lethal methods such as shooting, poisoning, trapping or snaring, or through habitat modification and encroachment [44,45]. Illegal predator control has been attributed to the overall population declines of large carnivores in many ecosystems [46]. Furthermore, it is likely that problem elephants were also being poisoned, given that elephants are difficult to hunt or kill illegally, especially within communal areas. In a few cases, elephant carcasses, together with ivory, have been found within the northern GNP, and indications have pointed to possible poisoning as the cause of death. Poisoning has detrimental effects on other, unintended species, particularly scavengers such as

spotted hyenas and vultures. In Chibwedziva ward, there were noticeable reports that illegal hunting was fueled by traditional and cultural reasons. For example, some animal parts such as bones from baboons were reportedly used by traditional healers.

The link between illegal hunting and human-wildlife conflicts recorded in this study is in line with earlier studies conducted elsewhere in Africa. For example, in Eastern and Southern Africa, it has been shown that demand for more land for agricultural and livestock production has increased antagonism between humans and wildlife to the level of illegal hunting of problem animals [16,47,48]. It is possible that such antagonism may be present in areas adjacent to the northern GNP where land-use conversion, habitat modification and fragmentation appear to be on the increase [32,49]. One way to reduce such antagonism, shown to be effective, is to supply bushmeat from legal sources to affected communities [16]. Bushmeat derived from problem animal control in many cases represents the only form of direct and tangible compensation that communities receive for wildlife damage caused to property, crops and human lives [16]. In addition, it has been suggested that simple improvements in livestock husbandry practices that take into consideration the cultural values and differences among local communities would help mitigate human-carnivore conflicts [50,51].

The heterogeneity recorded amongst study wards regarding illegal hunting practises in this study can partly be attributed to variations in human-wildlife conflicts, benefits received from wildlife projects mainly under CAMPFIRE programmes, employment, and the existence of other income-generating projects in the study wards. Personal observations, discussions with respondents, and literature review suggest that conservation efforts, benefits and achievements are different amongst the study wards [52-55]. Mahenye ward and to some extent Chibwedziva ward seem to have more viable CAMPFIRE programmes, which allow local residents to get tangible benefits and thereby positively influence the conservation of wildlife. In contrast, Mtandahwe and Chizvirizvi wards seem to have challenges in the viability of their CAMPFIRE programmes, mainly due to micro-politics at local level, resulting in few tangible benefits to the community.

The GNP, like so many of Africa's protected areas, has also been under increasing pressure from human activities. Human population increase, encroachment, and illegal activities such as hunting in protected areas, result in habitat loss and degradation, thus influencing wildlife abundances and their distribution [56-58]. In 2000, some of the Chitsa families from local communities adjacent to the northern GNP took advantage of the febrile atmosphere surrounding the land redistribution programme and established huts for permanent grazing inside the northern GNP [59]. Central to the invasion into northern GNP was the contested chieftaincy between Headman Chitsa and Chief Tshovani [49]. The invasion into GNP came to be 'formalized' when agricultural extension land-use planners pegged the area during 2001 as part of the 'fast-track' land reform programme [60,61]. In May, 2000, the settled area had 740 households with an overall population of 5365 people [62].

This encroachment into the northern GNP created a major problem for wildlife management. Illegal hunting activities within the northern GNP increased as hunters took advantage of the prevailing atmosphere to indiscriminately kill wild animals, since fewer law enforcement patrols were conducted in the illegally settled area. The human encroachment also resulted in increased fire frequencies in the northern GNP [26], as fires were most likely used in the hunting of wild animals. Recent evidence shows that areas close to human settlements in the northern GNP have

low populations of large herbivores such as buffalo, giraffe, kudu, impala and zebra compared to areas further inside the park [28,63], possibly due to illegal hunting and competition for forage with livestock.

Illegal hunting of wildlife is a form of resistance to certain types of wildlife policy and demonstrates problems with use rights and access to wildlife [64]. Most local communities had their rights of access to wildlife removed by the colonial states in order to manage wildlife resources [65]. In some cases, post-colonial governments continued with this policy of excluding local communities from any benefits of wildlife resources [64]. This led to local communities not recognizing wildlife laws that they considered unjust, leading to more conflict and illegal hunting activities [64]. In Zimbabwe, the CAMPFIRE programme has been implemented in an effort to generate benefits for local communities that otherwise had been deprived by protection policies [66,67]. CAMPFIRE empowers local communities to manage wildlife resources in defined places and realize benefits from them [68-70]. It is a long-term programme of rural development that uses wildlife and other natural resources to promote devolved rural institutions and improved governance and livelihoods. The amendment of the Parks and Wildlife Act in 1982 provided the legal structure for the devolution of authority over wildlife resources to democratically elected rural district councils [66]. Balint and Mashinya [54] reported that illegal hunting remained low in most rural areas in Zimbabwe despite the drop in CAMPFIRE benefits associated with the socio-economic challenges faced by the country between 2000 and 2008, because of effective enforcement of wildlife laws by the wildlife authorities.

Implications for conservation

Development measures that diversify sources of income and reduce poverty among local communities are likely to result in a reduction in illegal hunting and bushmeat trade [10,71]. Most studies of illegal hunting in developing countries commonly take the view that illegal hunting is poverty-driven [72,73]. The assumption is that alternative economic income opportunities and increasing opportunities for employment will have a positive effect on reducing illegal hunting activities. Poverty is a major problem in rural areas of sub-Saharan Africa. In 1995, 48% of the rural population in Zimbabwe lived below the poverty threshold [74]. It is likely that in south-eastern Zimbabwe, an area with frequent poor rainfall, resulting in poor yields or crop failures, bushmeat hunting acts as a buffer in difficult times for the local communities.

This study suggests that there is need for: (i) collaborative efforts in law enforcement among key stakeholders, (ii) increased awareness and environmental education, and (iii) developing mechanisms to reduce human-wildlife conflicts to ensure that illegal hunting is further minimized in the Gonarezhou ecosystem. Anti-poaching is effective for the protection of wildlife if there are sufficient resources and when rules are followed [75]. Without compliance, however, rules are meaningless, so effective enforcement is essential [76,77]. Local unfounded beliefs about medicinal and traditional uses of wildlife products should be discouraged where these lead to illegal hunting [78]. Local people should be educated on the dangers of indiscriminate use of herbicides or pesticides for killing wild animals. In addition, there is need to monitor levels of illegal hunting on less abundant species in the Gonarezhou ecosystem, as continued hunting might lead to population collapse. Lastly, further studies should aim to quantify the scale of bushmeat hunting, trade and dynamics in south-eastern Zimbabwe.

Acknowledgements

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Appendix 1. Sample questionnaire

1. Village of respondent?
2. Ward of respondent?
3. Sex of respondent?
4. Age of respondent? (18–20 years; 21–40 years; 41–60 years; >60 years)
5. Level of education? (None; Primary level; At least Secondary level)
6. Occupation? (Employed or involved in agricultural activities; Unemployed)
7. Length of time of stay in the village? (<5 years; ≥5 years)
8. How often do you see bushmeat or wild animal products being sold in your village or ward? (Everyday; Once in 14 days; Once in 30 days; Once between 31 and 180 days; Never seen it)
9. In your opinion has illegal hunting of wild animals increased, decreased or remained the same in your ward and adjacent Gonarezhou National Park in last nine years, i.e. between 2000 and 2008?
10. What are the reasons for the given trend in illegal hunting?
11. Which are the most commonly used illegal hunting methods in the ward and adjacent Gonarezhou National Park?
12. Where do illegal hunters get the material to make snares?
13. May you list the wild animal species that are mostly hunted illegally in your ward and nearby Gonarezhou National Park?
14. Why are these wild animals hunted or targeted?
15. In your opinion what are the main reasons why people engage in illegal hunting activities in the area?
16. What ways or strategies are in place to minimise illegal hunting in the area?
17. Are there any other information/comments you would like to share with us regarding illegal hunting in the area?

Appendix 2. Commonly hunted wild animal species in the Gonarezhou ecosystem, south-eastern Zimbabwe. Note: Total percentage exceeds 100 for each ward because the respondents were allowed to give multiple answers

Species	Scientific name	Ward (%)				Overall (%)
		Chibwedziva	Chizvirizvi	Mahenye	Mtandahwe	
Impala	*Aepyceros melampus*	3	29	41	33	27
Kudu	*Tragelaphus strepsiceros*	10	19	47	24	25
Zebra	*Equus quagga*	59	9	5	9	21
Buffalo	*Syncerus caffer*	5	21	10	36	18
Spotted hyena	*Crocuta crocuta*	27	10	2	5	11
Warthog	*Phacochoerus africanus*	11	9	12	11	11
Wildebeest	*Connochaetes taurinus*	39	2	0	0	10
Leopard	*Panthera pardus*	24	4	3	9	10
Lion	*Panthera leo*	3	19	0	11	8
Waterbuck	*Kobus ellipsiprymnus*	0	0	29	3	8
Eland	*Taurotragus oryx*	0	5	19	3	7
Elephant	*Loxodonta africana*	8	3	4	9	6
Nyala	*Tragelaphus angasii*	0	0	24	0	6
Bushbuck	*Tragelaphus scriptus*	6	4	3	5	5
Giraffe	*Giraffa camelopardalis*	12	0	0	2	4
Common duiker	*Sylvicapra grimmia*	4	2	3	6	4
Steenbok	*Raphicerus campestris*	3	5	3	4	4
Reedbuck	*Redunca redunca*	3	2	4	4	3
Sable	*Hippotragus niger*	2	0	2	2	2
Klipspringer	*Oreotragus oreotragus*	2	2	2	3	2
Cheetah	*Acinonyx jubatus*	8	0	0	0	2
Baboon	*Papio ursinus*	0	0	2	6	2
Small-spotted genet	*Genetta genetta*	2	3	2	2	2
Porcupine	*Hystrix cristata*	0	0	0	2	1

Appendix 3. Reasons given for the illegal hunting of wild animals in the Gonarezhou ecosystem, south-eastern Zimbabwe. Note: Total percentage exceeds 100 for each ward because the respondents were allowed to give multiple answers

Reason for illegal hunting	Ward (%)				Overall (%)
	Chibwedziva	Chizvirizvi	Mahenye	Mtandahwe	
Bushmeat consumption	71	42	81	78	68
Commercial trade - raise money	28	36	97	60	55
Crop damage control	0	40	0	2	11
Traditional rituals or cultural ceremonies	33	0	0	2	9
Revenge for livestock depredation	0	14	5	5	6
Hunting as a hobby	0	0	0	2	1
Unemployment	0	0	0	2	1
Revenge killings following arrests by resource monitors or rangers	0	2	0	2	1

Appendix 4. Strategies for minimizing illegal hunting in the Gonarezhou ecosystem, south-eastern Zimbabwe. Note: Total percentage exceeds 100 for each ward because the respondents were allowed to give multiple answers

Strategy	Ward (%)				Overall (%)
	Chibwedziva	Chizvirizvi	Mahenye	Mtandahwe	
Conservation oriented meetings under the CAMPFIRE programme	54	32	74	48	52
Awareness and education by CAMPFIRE resource monitors	23	32	48	48	38
Penalties for illegal hunting, e.g., fines, legal prosecution	37	32	32	32	33
Traditional leaders rules and regulations	23	27	48	19	29
Participatory quota setting workshops at the ward level – sustainable wildlife utilisation	32	14	37	24	27
Returns from CAMPFIRE programme, e.g. bushmeat, cash dividends and ward projects	17	9	54	23	26
Anti-poaching patrols by CAMFIRE resource monitors and rangers	23	5	41	24	23
Safari hunter's presence deter illegal hunting activities in the wards	14	5	32	5	14