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People and wildlife: prevention strategies and farmers' perspectives on human-wildlife conflict management around Yankari Game Reserve, Bauchi State, Nigeria

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ABSTRACT Protected areas are universally acknowledged as being crucial to the conservation of biodiversity. However, through cross-border contacts, protected areas can also be the source of conflict between people and wildlife. As wild animals migrate or move in and out of protected areas for feeding, they may encroach upon adjacent human settlements or agricultural lands, resulting in social-ecological interactions such as crop raiding, wildlife depredation, and retaliatory killings which can significantly affect both humans and the survival of wildlife. This study investigates the type, extent, mitigation strategies by locals and the perceptions of the villagers on what should be done by the management of Yankari game reserve toward addressing human-wildlife conflict around the protected area. A total of 255 households from 17 villages around Yankari game reserve, were interviewed. Results showed that maize (60%), and millet (31%) were the most affected crops. Fox (78.4%) was the common species related to livestock depredation. Guarding mitigation strategy was the most frequently used method (60.6%) by villagers. Results showed that patas monkey (42%), baboon (34%) elephant (27%), were the most frequently reported animals involved in conflict. Monitor lizard (29.4), African hedgehog (19.2), and feral cat (15.3%) were the most frequently killed animals.

KEY WORDS Protected Area; Wildlife species; Biodiversity Conservation; Livestock depredation; Rural communities.

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INTRODUCTION

A protected area (PA) is a geographically defined region that is set aside, controlled, and maintained in order to accomplish particular conservation goals (CBD, 1992). As a result, in 2017, PAs collectively accounted for 15% of the planet's land area and 7% of its maritime environment (Protected Planet, 2017).

However, the much-lauded "socially oriented model" of PA management stands in contrast to the widespread belief that it takes a defensive stance. This concept combines conservation goals with local people's wellness (Andrade et al., 2012; Parker et al., 2017).

Protected areas are increasingly recognized as intricate components of social-ecological systems (Ostrom, 2009). These systems involve social-ecological interactions across borders between areas primarily managed for human activities and those dedicated to biodiversity conservation (Blanco et al., 2020). Cross-border interactions, also known as boundary effects, are the numerous ways that protected areas affect their surroundings and vice versa (Ament & Cumming, 2016; Balme et al., 2010).

PAs, however, can also be the cause of conflict between people and wildlife (Shilongo & Sam, 2018; Bhattarai et al., 2019; Bastille-Rousseau et al., 2020) through cross-border interactions. According to Loveridge, et al. (2017), wildlife mobility across PA boundaries for migration or feeding purposes, for instance, may have an impact on nearby farm or settlement areas through social-ecological interactions like attacking farmland and revenge killings that may impact both human and faunal existence (Guerbois et al., 2012). Around PAs, human-wildlife conflicts typically involve attack on crops, domestic animals and people (Acha, 2015; Biru et al., 2017). In these areas, there is very high and typically direct conflict between native populations and wild animals for available space and natural resources (Boer & Baquete, 1998; Eniang et al., 2011). Wildlife needs and behaviour that negatively affect humans or human conduct that negatively affects wildlife requirements are known as human-wildlife conflict. Such conflicts might arise when wildlife destroys crops or poses a threat to human safety or domestic animals (Sillero-Zubiri & Switzer, 2001). Conflict can also arise when human objectives are adversely affected by the requirements and actions of wildlife (Nelson et al., 2003).

Human-wildlife conflict is an escalating global challenge that negatively impacts both wildlife conservation and indigenous communities (Dickman, 2010; Nyhus et al., 2016). This conflict poses significant threats to biodiversity and human populations, making human-wildlife coexistence a critical global issue (Gandiwa et al., 2014; Larson et al., 2016). The problem is notably prevalent in Africa, where limited resources force human and wildlife populations to share the same spaces, exacerbating risks to personal safety and resulting in economic losses (Lebel et al., 2010).

The impact of conflicts between humans and wildlife on livelihoods differs based on the household's level of security regarding their means of subsistence during the conflict (Mulonga et al., 2003). As a result, farmers view these animals as pests since they pose a serious threat to farmers who are close to protected areas (Tweheyo et al., 2012). Wildlife suffers negative consequences from the conflict, along with property damage including destroyed crops, fatalities, and injuries to both people and wildlife (Ladan, 2014). Species mainly involved in a conflict are also shown to be more prone to extinction (Ogada et al., 2003), due to accidental injuries and deaths caused by human activities, for instance, traffic collisions, traps aimed at other wildlife, or plunging into wells on farms. Additionally, deliberate actions like revenge killings, poisoning, or catching further threaten these species (Bagchi & Mishra, 2006; Sifuna, 2005; Distefano, 2010).

Giving that both within and close to PAs, the impact of conflict between humans and wildlife on people have been investigated (Karanth et al., 2013; Mass´e 2016; Manjari & Krishnamurthy 2017; LeFlore et al., 2019; Bhattarai et al., 2019) in this study, we assessed the human-wildlife conflict around Yankari Game Reserve, to encourage management strategies that consider social and ecological impacts of wildlife species in biodiversity conservation. This focus is particularly critical given that attacks on crops and domestic animals - common causes of human-wildlife conflict in Africa - significantly affect rural populations living in and around PAs (Matseketsa, 2019; Tamrat et al., 2020). Additionally, the potential for impacted individuals to engage in retaliatory killings poses a substantial threat to the successful conservation of wildlife species (Störmer et al., 2019; Gandiwa et al., 2013; Moreto, 2019). Understanding the dynamics of human-wildlife conflict through social-ecological frameworks has been emphasized in existing literature (Störmer et al 2019; Gandiwa et al., 2013, Moreto, 2019). Conflict between people and wildlife has been studied and understood using social-ecological ideas (Madden, 2004; Virapongse et al., 2016; Pooley et al., 2017; Lischka et al., 2018; Maurer et al., 2021; Yeshey et al., 2023).

Human activities around the Yankari Game Reserve encompass various livelihood practices, including livestock grazing, logging, poaching, fuelwood collection, and agriculture (Ezealor, 2001; Wildlife Conservation Society, 2021). These interactions have a significant impact on both wildlife and local communities, often leading to human-wildlife conflicts (Wildlife Conservation Society, 2021; Magama et al., 2018). To comply with the Bauchi State Wild Animal Protection Law (Odan, 2006) and promote the conservation and sustainable use of biodiversity in line with Nigeria's national environmental strategy (Federal Government of Nigeria, 2015), it is crucial to evaluate the dynamics of human-wildlife conflict surrounding the PA.

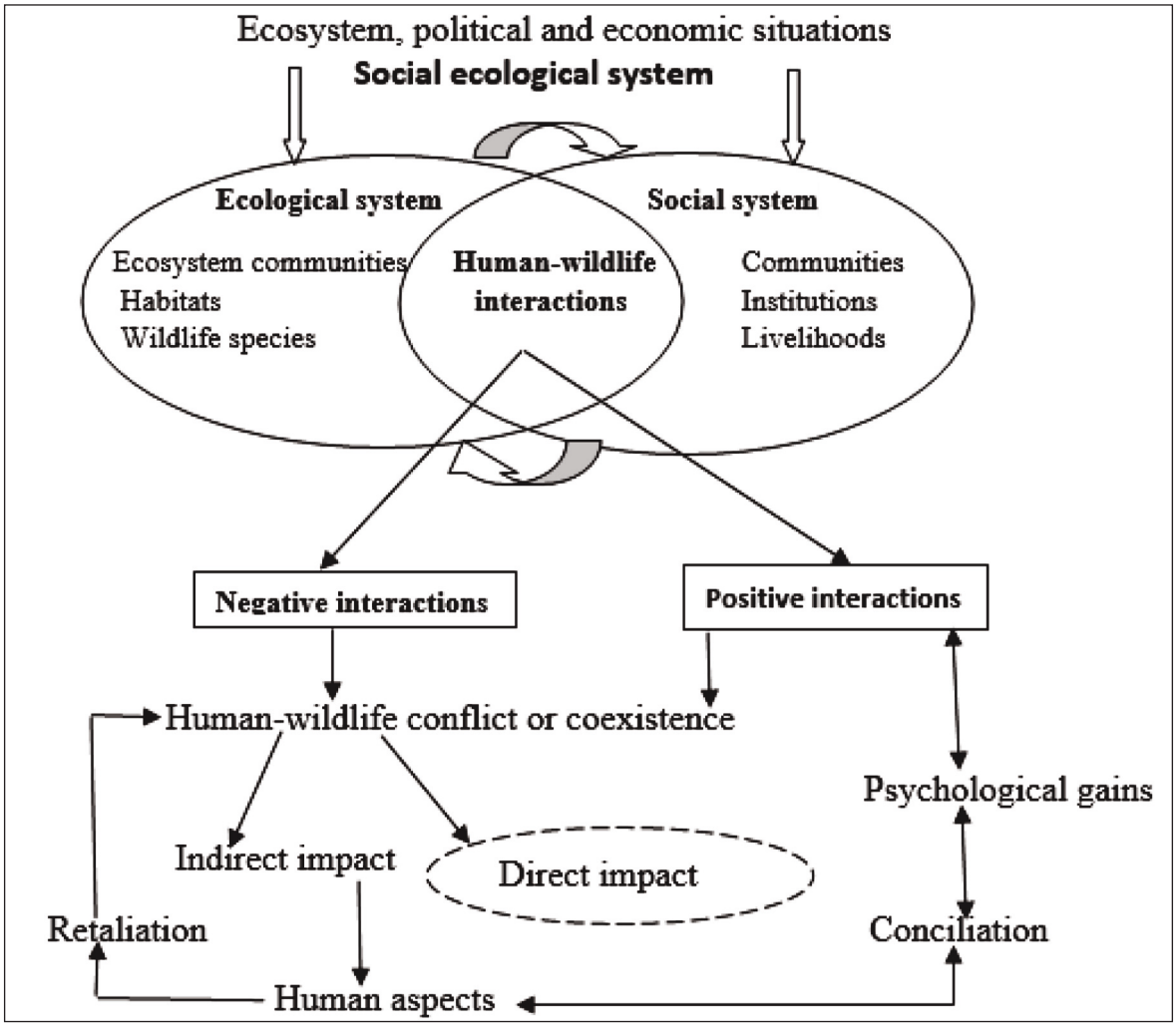

Figure 1. A simplistic model of the Social Ecological System framework used in this study to comprehend human-wildlife conflict. The main focus of this work is the direct impacts. Modified from Lischka et al. (2018) and Yeshey et al. (2023)

This study seeks to build upon existing research by examining the specific types of crops affected by wildlife, the animals responsible for livestock losses, and the responses of protected area management to human-wildlife conflict. Additionally, it will assess the measures taken by farmers to mitigate conflict, their perspectives on how protected area management can address these issues, as well as the species involved in crop-raiding and those that are killed possibly in retaliation or due to hunting.

Conceptual Framework

We employed the framework of social-ecological systems (Fig. 1), which states that ecosystems and humans coexist in tightly coupled systems that are marked by interactions, connectivity, and integration between ecological and social systems (Jochum et al., 2014; Kansky et al., 2016). Lischka et al. (2018) and Nyirenda et al. (2018) indicate that human-wildlife interactions occur within social-ecological systems, which consist of interconnected social, economic, cultural, political, and ecological components that interact throughout time to influence impacts and outcomes. A combination of social and ecological elements influences the nature and result of the interaction between social and ecological components (Lischka et al., 2018; Konig et al., 2020). For instance, one major cause of human–wildlife conflict is the expansion of human-wildlife

interactions due to the increasing number of rural dwellers in and around wildlife areas, leading to an overlap between human needs and established wildlife boundaries (Parasnis et al., 2014). These conflicts occur more frequently and with greater intensity as the human population and resource demand rise (Berihun et al., 2016) such as, for instance, expansion of farmlands due to high demand for food. These occurrences can occasionally result in negative perceptions among neighbouring communities of PAs (Castilho et al., 2018).

The ecological system is home to a variety of wildlife species, habitats, and ecological communities. Due to the presence of different habitats and sources of sustenance, conflicts may occur between subsistence farmers and these species (Yeshey et al., 2023). According to Girmay (2015), certain animal species can significantly affect crops, while others may impact domestic animals (Nibret & Yihune, 2017). The type of impact is influenced by the extent to which humans and wildlife coexist and share a common habitat (Lebel et al., 2010). For instance, human activities around Yankari game reserve includes livelihood activities such as livestock grazing, logging, poaching, fuelwood collection and subsistence farming where in some instances crops are being cultivated right at the edge of the protected area (Ezealor, 2001; Wildlife Conservation Society, 2021). Additionally, the livelihoods of farmers are impacted by human-wildlife conflict in diverse ways depending on the situation and the animal taxonomic group involved (Merkebu & Yazezew, 2021; Nyhus et al., 2003).

Both official and unofficial institutions play a role in managing communities within the social system (Yeshey et al., 2023). Following the creation of PAs, many communities that previously relied on forest assets and ecological services for their means of living often face restricted access imposed by PA management, a common issue in developing countries (Wells & Brandon, 1992; Das Kanti, 2005). In developing countries, a greater percentage of these population is characterised mainly by livelihoods based on livestock holdings and farming (Hoare & Johan, 1999; Anand & Radhakrisana, 2017). People are impacted and respond to human-wildlife conflict differently depending on a variety of factors, including the environmental context, cultural background socioeconomic features, lifestyle and the sources of subsistence (Yeshey et al., 2023) (Fig. 1).

MATERIAL AND METHODS

Study area

The study was carried out around Yankari Game Reserve within Duguri, Pali and Gwana districts of Alkaleri Local Government area, Bauchi State. Yankari Game Reserve (09°45'N - 10°30'E) spanning 2,244 km² is in Bauchi State in northeastern Nigeria. Yankari was gazetted as a Game Reserve in 1956, the first in Nigeria, and became a National Park in 1991 and managed by the National Parks Service (Ezealor, 2001). However, Yankari National Park was reverted to game reserve in 2006 and the state government of Bauchi state was given control over the reserve's administration (Wildlife Conservation Society, 2021). The protected area is situated in the Sudan Savannah vegetation zone, and it is bisected by the Gaji river. There are two major types of habitats, dry savanna woodlands and riparian vegetation, which includes areas liable to flood. Tree species typical of the woodlands include African mahogany (*Afzelia Africana*), wild seringa (*Burkea africana*), African rosewood (*Pterocarpus erinaceus*), doka (*Isoberlinia doka*), and *Monotes kerstingii*, while in the riparian forest black plum (*Vitex doniana*), paperbark acacia (*Acacia sieberiana*), tamarind (*Tamarindus indica*), and West African copal tree (*Daniella oliveri*) are common (Ezealor, 2001). The reserve has between 900 and 1,000 millimeters of rainfall annually and May to September is considered the rainy season. It has a temperature range between 18 °C and 35 °C. Wildlife species includes mammals such as African elephant (*Loxodonta africana*), African buffalo (*Syncerus caffer*), roan antelope (*Hippotragus equinus*), olive baboon (*Papio Anubis*), patas monkey (*Erythrocebus patas*), tantalus monkey (*Chlorocebus tantalus*) and hippopotamus (*Hippopotamus amphibius*). There are some 337 known bird species as the PA is also an important bird area (IBA) (Ezealor, 2001; Wildlife Conservation Society, 2021).

Data collection

Primary data for the study was collected through a household survey in the study communities using close and open-ended questionnaires, primarily designed to capture household characteristics, major

livelihood activities, and use of forest resources. A mixed-method approach using quantitative and qualitative technique was used in data collection (Creswell, 2009). Field data collection started with community-entry meetings with the village heads and other elders. Such meetings were used to explain the research objectives and what is expected of the villagers. Informed and oral consent was sought from village heads to make it possible to carry out the main data collection. Seventeen (17) communities neighbouring the protected area were randomly selected. Within each sample village, 15 households were randomly selected for an interview survey. Interviews were purposively conducted with heads of households 18 years and above, who normally make decisions for the household. A total of 225 households were interviewed from these villages. All the interviews were conducted in-person at the respondents' homesteads (Neuman, 2014). The sample communities were Gale, Dagudi, Mainamaji, Gaji, Gaji Gamu, Kafi, Bakin Dutse, Mai Ari, Jada, Kuka, Pali, Kwala, Kashera, Yalo, Garin Kweri, Walakerol, and Sarki Malla (Fig. 1). The questionnaire included questions to assess the types of wildlife killed in last 12 months, animals' crop-raiding, types of animals involved in crop-raiding, wild animals attack on livestock, steps taken by villagers to reduce crop-raiding by wildlife, and the perceptions of steps that can be taken to reduce animal crop-raiding. Age, education, occupation, types of crops cultivated, land ownership, and household size were among the demographic and socioeconomic characteristics of the respondents recorded. In accordance with ethical principles, the participants gave their consent, were guaranteed anonymity and that the information they provided would be utilized solely for study objectives. Ethical approval was also obtained from the management of Yankari Game Reserve Bauchi Sate, Nigeria, with reference number YETWCD/YGR/CON/10. The survey was conducted from January to July 2023.

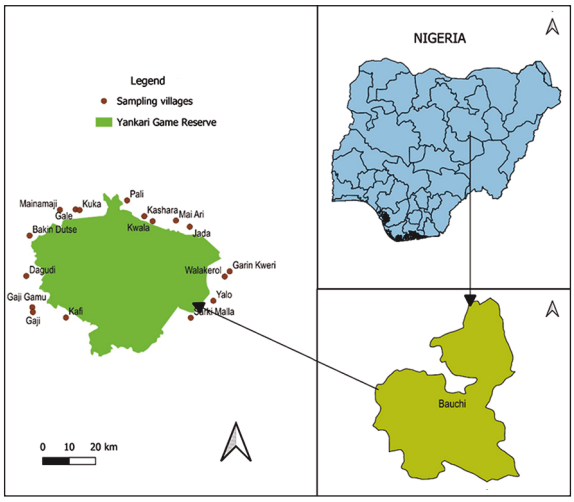

Figure 2. Map of the study area showing sampling villages. Source: Authors' survey (2023).

Data analysis

Based on the survey questionnaire, descriptive statistics were used to ascertain the frequencies of the relevant variables. The data was then analysed using both quantitative and qualitative methodologies. Furthermore, the information was graphically depicted using basic descriptive statistics, percentage tables, and graphs. SPSS Version 22 was used for all statistical analyses (IBM, Armonk, USA).

RESULTS

The social dimension: descriptive attributes of the respondents

The majority (26.3%) of the 255 respondents were in the 40–45 age range. The Dugurawa ethnic group made up 18.4% of the villagers, all of whom were native-born. Farming accounted for the majority of respondents' livelihood activities (76.5%), with over 25% having informal education (36.9%). (Table 1). Families with six to ten individuals made up more than half (55.7%) of the households. A remarkable 96.9% of the households possessed land. The majority of households (47.5%) had land sizes ranging from 5 to 9 acres. In addition to raising animals, the respondents farmed a range of crops for sustenance. Maize, beans, and millet were the most often grown crops (19.2%). Cows and sheep were the most common farm animals owned by the majority of households (38.4%), with between 11 and 15 animals in total.

The type and extent of human wildlife around Yankari Game Reserve have profoundly impacted humans and wild animal in many ways such as for instance through crop-raiding, livestock depreda-

Variable (N=255)	Respondents (%)
Distance from protected area (Km)	
≤ 2km	37.5
2.1-4km	58.4
4.1-6km	5.9
Age (years)	
18-25	2.7
26-33	17.6
34-41	20.8
42-50	26.3
51-60	18.8
60+	13.7
Ethnicity	
Bajari	9.8
Fulani	16.1
Baboli	15.3
Dugurawa	18.4
Others (1)	40.4
Education	
Informal	36.9
Primary	23.1
Secondary	32.2
Tertiary	7.8
Occupation	
Farming	76.5
Others (2)	23.5
Household size (number individuals)	
1-5	8.2
6-10	55.7
11-15	36.1
Land size (acre)	
1-4	20.8
5-9	47.5
10-14	16.1
15+	15.7
Cultivated Crops	
Maize, millet, and benniseed	9.0
Maize and millet	11.4
Benniseed, millet, and beans	3.1
Maize, rice, and beans	3.5
Maize, millet, and guinea corn	2.4
Maize and rice	2.1
Maize, millet, and cassava	1.7
Rice, millet, and maize	6.7
Millet, maize, and beans	19.2
Rice, maize, millet, beans	1.7
Others (3)	46.5
Number of livestock owned by household	
1-5	9.8
6-10	25.5
11-15	38.4
16-20	17.6
Types of livestock owned by household	
Sheep	5.1
Cows and sheep	18.0
Cows and chickens	12.9
Cows, sheep, goats, and chickens	11.4
Sheep, goats, and chickens	20.8
Goats, chickens, and cows	5.1
Sheep and goats	11.4
Cows, sheep, and goats	5.1
Others (4)	12.9

Table 1. Descriptive attributes of the respondents: (1) Other ethnicities included Guruntawa, Bolawa and Wukurnanwa. (2) Other occupations included civil service and farming, mechanic and farming, and farming and driving. (3) Other crops included maize, rice and beans, millet, maize, and soybeans, and maize, groundnut, and beans. (4) Other livestock included cows and goats, and horse, cows, chickens, and cows.

tion and killing of wildlife. This may have an adverse influence on animal conservation by making the local communities hate the wildlife that inhabits the area around them.

Crop types affected by wildlife species. Since cultivation of crops typically provides a good food source for both people and wildlife, there has been conflict between humans and wildlife due to crop-raiding (Mekone, 2020). See summary in Table 2. The respondents stated that the crops most susceptible to raiding were maize, rice, millet and beans.

Livestock depredation. A total of three wildlife species were mentioned by the respondents as troublesome with regards to livestock depredation. See summary in Fig. 3. It was stated that foxes were attacking goats and hens. Sheep and goats were targeted by hyena, while goats were reportedly attacked by jackals.

Responses of the protected area management with regards to human-wildlife conflict. According to our results all the respondents who reported animal crop raiding to the protected area management

said that the management mostly send protection staffs to patrol the affected area, investigate the incidence, seek the patience of the affected farmers and dialogue with them. See summary in Table 3.

Methods of reducing crop raiding by villagers. Based on our findings, communities in the study area were using different methods to lessen the effects of the conflict between humans and wildlife. The respondents stated that farmers employ a variety of strategies to keep crop raiders away from their crops. See summary in Fig. 4. Guiding mitigation strategy was the most frequently used method.

Farmers' opinions on mitigating measures to be taken by protected area management. Based on our findings, communities in the study area suggested several strategies to be employed by the management of the protected area to solve human-wildlife conflict. See summary in Figure 4. More than half of the respondents suggested the employment of more protection staff in order to manage human-wildlife conflict.

The ecological dimension: human-wildlife conflict in relation to species of wildlife involved in crop raiding and those killed

Species of wildlife involved in crop raiding. The findings indicated that crop raiding in the study area did not harm all crops in the same way. It was reported that patas monkey, baboon, elephant, guineafowl, warthog, and tantalus monkey were the main crop raiding animals. See summary in Table 4.

Wildlife species killed. The findings indicated that killing of animals in the study area affected animals differently. According to respondents, monitor lizard, African hedgehog, feral cat, guineafowl and baboon, were the most frequently killed animals. See summary in Table 5.

DISCUSSION

These results illustrate the ongoing conflict between wildlife and local communities near the PA, manifested through attack on crops, livestock, and the killing of wild animals. This result is consistent

Crop types affected by wildlife	Frequency	Percent (%)	Rank
Maize	153	60	1
Millet	80	31	2
Beans	60	23.5	3
Rice	43	16.9	4
Benniseed	33	12.9	5
Cassava	14	5.5	6
Watermelon	4	1.6	7

Table 2. Crop types affected by wildlife.

Action taken by Yankari Game Reserve	Frequency	Percent (%)
Patrol the affected areas	33	12.9
Investigation of the incidence	24	9.4
Placate the affected farmers	16	6.27
Dialogue with affected individuals	57	22.4

Table 3. Responses to human-wildlife conflict by Yankari game reserve.

Animal species involved in crop-raiding	Frequency	Percent (%)	Rank
Patas monkey	108	42	1
Baboon	87	34	2
Elephant	71	27	3
Guineafowl	68	26.7	4
Warthog	51	20	5
Tantalus monkey	46	18	6
Squirrel	22	8.6	7
Hippopotamus	19	7.5	8
Bushbuck	7	2.7	9
Roan antelope	6	2.4	10
Buffalo	5	1.96	11
Rodent	5	1.96	11
Grass cutter	3	1.2	13
Francolin	2	0.8	14
Duiker	1	0.4	14

Table 4. Animals species involved in crop-raiding.

with the results from previous research conducted by Biru et al. (2017), Acha (2015), and (Siljander et al., 2020) who reported that conflicts between local residents and animals often occur near PAs, primarily as a result of attack on crops and domestic animals.

The results of this study align with findings from Warren (2008), which indicated that in West Africa, crop raiding predominantly affects cereal crops such as wheat. Research conducted in the Rwandan Forest Fragment revealed that wild animals have raided various crops, including maize, potatoes, beans, cabbage, sweet potatoes, and tomatoes (Guinness & Taylor, 2014).

A survey in the study area identified African buffalo, Tantalus monkeys, Patas monkeys, bushbucks, and waterbucks as significant threats to crops like maize, groundnuts, millet, and beans (Magama et al., 2018). Similar findings were reported in Nigeria's Gashaka Gumti National Park's Filinga Range, where monkeys, baboons, birds, and rodents were noted for preying on crops such as maize, cassava, rice, and bananas (Eniang et al., 2011). Additionally, a report from the vicinity of Bale Mountains National Park in Southeast Ethiopia identified species like the Olive baboon (*Papio anubis*), warthog (*Phacochoerus aethiopicus*), common mole rat (*Tachyoryctus splendens*), porcupine (*Hystrix cristata*), grey duiker (*Sylvicapra grimmia*), mountain nyala (*Tragelaphus buxtoni*), and bohor reedbuck (*Redunca redunca*) as significant crop raiders causing damage to crops such as wheat, potatoes, maize, tef, and legumes (Mekonen, 2020).

Carnivores such as foxes, spotted hyenas, and common jackals are known to prey on livestock, leading to conflict, with foxes identified as the most problematic species in terms of livestock depredation. This finding aligns with Messmer (2009), who noted that the primary domestic animal predators in and around Ethiopia's Semen Mountains National Park included spotted hyenas and common jackals, which targeted sheep, goats, oxen, cows, donkeys, and mules. Similarly, a study conducted at Chebera Churchura National Park in southwestern Ethiopia (Datiko & Bekele, 2013) identified eight wild animals responsible for domestic animal losses, with jackals and hyenas among the most problematic. Furthermore, the results of this study are consistent with Temesgen et al. (2022), who reported that hye-

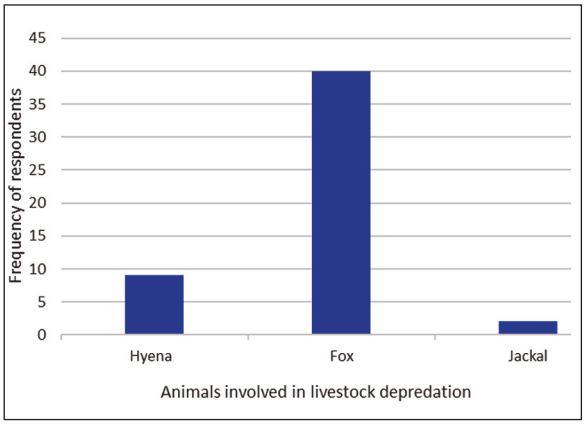

Figure 3. Animals involved in livestock depredation. Source: Authors' survey (2023).

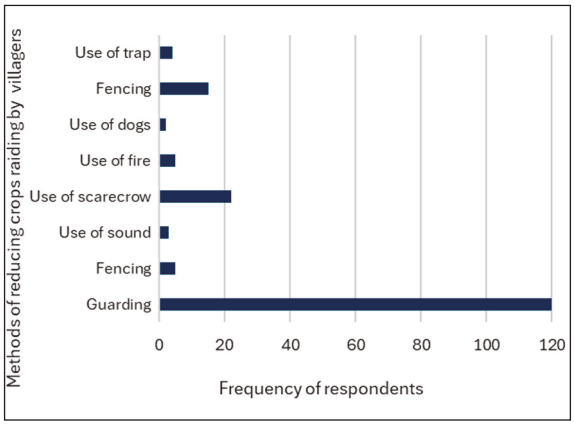

Figure 4. Methods of reducing crop raiding by villagers. Source: Authors' survey (2023).

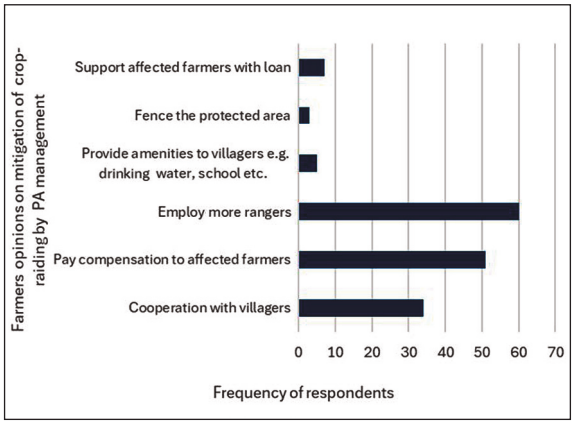

Figure 5. Farmers' opinions on mitigating measures to be taken by the protected area management. Source: Authors' survey (2023).

nas and common jackals were the main livestock predators in the districts surrounding Alage College in the Central Rift Valley of Ethiopia.

PA staff employed various strategies, including dialogue (Bruyere, 2009), communication (Baral and Heinen, 2007), benefit-sharing (Tessema et al., 2010), and collaborative management (Furze et al., 1996), to enhance biodiversity conservation in surrounding communities. Supporting the findings of this study, Eniang et al. (2011) reported that protected area management engaged in dialogue with affected villagers in the Filinga Range of Gashaka Gumti National Park, Nigeria, encouraging them to exercise patience and learn to tolerate wildlife as a response to human-wildlife conflict.

Wild animal species killed	Frequency	Percent (%)	Rank
Monitor lizard	75	29.4	1
African hedgehog	49	19.2	2
Feral cat	39	15.3	3
Guineafowl	38	14.9	4
Baboon	35	13.7	5
Africa civet	29	11.4	6
Patas monkey	28	10.9	7
Squirrel	19	7.5	8
Bushbuck	19	7.5	8
Abyssinian ground hornbill	18	7.1	9
Porcupine	17	6.7	10
Warthog	17	6.7	11
Water buck	15	5.9	12
Bateleur	15	5.9	13
Tantalus monkey	15	5.9	14
Crocodile	13	5.1	15
Hare	12	4.7	14
Hyena	12	4.7	14
Roan antelope	9	3.5	16
Buffalo	8	3.1	17
Python	7	2.7	18
Duiker	6	2.4	19
Francolin	6	2.4	20
Western hartebeest	4	1.6	21
Hippopotamus	4	1.6	21
Reindeer	4	1.6	21
Fish	3	1.2	22
Rodent	3	1.2	22

Table 5. Species of wild animals killed.

Farmers mitigate human-wildlife conflict by using both lethal and nonlethal management techniques. Nonlethal methods include trapping and shooting while nonlethal approach include chemical repellent, physical barriers and chasing (Shanko et al., 2022). A survey conducted at the study site indicated that strategies such as scarecrows, pounding drums, chasing, guarding, shooting, and trapping were utilized to reduce animal-crop raiding (Magama et al., 2018). Similar findings were reported in Nigeria's Gashaka Gumti National Park's Filinga Range, where guarding emerged as the most effective strategy employed by local communities to prevent crop damage (Eniang et al., 2011). Supporting these results, Guinness and Taylor (2014) noted that the best method for protecting livestock and crops from wildlife near a Rwandan forest fragment was through the use of permanent adult guards. Additionally, a survey from the Bale Mountains National Park region in Southeast Ethiopia found that guarding was the primary means of preventing crop damage (Mekonen, 2020). Consistent with these observations, Matusal et al. (2023) identified guarding as the most effective method for protecting crops and livestock from wildlife in the Konasa Pulasa community protected forest in Ethiopia's Omo Valley.

Villagers perceived the reserve management's strategies for mitigating human-wildlife conflict as involving cooperation between communities and management, compensation payments, increased ranger hiring, fencing of the PA, and providing loans to affected farmers. In addition to protective measures like guarding and fencing implemented by villagers, PA management employs strategies such as insurance policies and compensation payments as mechanisms for resolving human-wildlife conflict (Karanth et al., 2013; Ravenelle & Nyhus, 2017). These results are in line with Dertien et al. (2023), who noted that fostering communication between conservation managers and local communities is a key strategy for reducing poaching and human-wildlife conflict in India and Nepal.

Furthermore, the results align with Johnson et al. (2018), who highlighted compensation payments as part of conservation initiatives intended to lessen human-wildlife conflict and protecting large,

charismatic species like elephants and tigers in four PAs in Rajasthan, India.

Likewise, in evaluating the spatial and social dynamics of attitudes toward wildlife and the conservation value of tourism in human-carnivore conflict in Botswana, Hemson et al. (2009a) and Marchand (2002) reported that compensation payments effectively mitigate conflicts arising from livestock depredation, which supports the findings of this study. Similar to the results of these findings, Mutanga et al. (2017) found that villagers in Zimbabwe's Umfurudzi Park, Gonarezhou National Park, Matusadona National Park, and Cawston Ranch believed that amenities such as clinics, schools, and boreholes would help reduce conflicts between local communities and PAs. A variety of interventions—including compensation plans, incentives to enhance tolerance, mitigation techniques, and lethal control for ''problem animals'' - have been proposed to balance the needs of wildlife with human activities (Marchand, 2002; Wanjau, 2002; Obunde et al., 2005).

Primates, along with rodents and bird species, are among the most commonly reported animals involved in crop-raiding (Hill, 2000; Girmay, 2015). Other notable species include the common warthog, African buffalo, and African savanna elephant (Shanko & Tona, 2022). Consequently, farmers perceive these animals as pests due to the significant threats they pose to agricultural activities near PAs (Tweheyo et al., 2012).

Human-wildlife dispute can manifest in various forms, including crop-raiding, livestock attacks, and the killing of wild animals. This conflict has resulted in wildlife poaching for bush meat (DeGeorges & Reilly, 2008) and retaliatory actions such as poisoning, snaring, spearing, and shooting of wild animals (Ogada et al., 2003). The findings of this study align with observations by Muruthi (2005) and Shanko & Tona (2022), who noted that villagers may kill wild animals in response to crop damage and livestock depredation, as well as through illegal hunting. Additionally, this study supports Kissui's (2008) report of retaliatory killings of wildlife, including lions, leopards, and hyenas, in the Maasai steppe of Tanzania. Furthermore, Muriuki et al. (2017) found that the Maasai people in Kenya's Amboseli ecosystem occasionally kill problematic carnivores that threaten their livelihoods, a claim supported by the results of this study.

This study contributes four new findings to the existing literature on human-wildlife conflict at the research site. Previous studies focused on wildlife species identified by host communities as involved in conflicts, respondents' perceptions of wildlife intrusion into their settlements, strategies employed by these communities to manage conflicts, the types of crops most frequently raided by wildlife near the protected area, and the nature of these conflicts (Magama et al., 2018). In contrast, this research evaluates livestock depredation (Datiko & Bekele, 2013; Temesgen et al., 2022) alongside crop-raiding incidents, identifies wildlife species that are killed (Ogada et al., 2003; Shanko & Tona, 2022), examines the responses of PA management to human-wildlife dispute (Tessema et al., 2010; Eniang et al., 2011), and gathers respondents' opinions on how protected area management can address crop-raiding issues (Karanth et al., 2013; Ravenelle and Nyhus, 2017). This study highlights the negative impacts of human-animal disputes on both human and wild animals, complicating efforts in wildlife conservation. It also emphasizes the potential significance of mitigation and management strategies in decreasing both the frequency and severity of human-wildlife conflict.

CONCLUSIONS

Conflicts between humans and wild animals are recognized as a significant threat to the conservation of wildlife species. Human-wildlife conflict remains a prevalent issue in regions neighbouring PAs in Nigeria (Magama et al., 2018; Eniang et al., 2011). This study examines the types of crops affected, instances of livestock depredation, the responses of protected area management to human-wildlife conflicts, mitigation strategies employed by respondents, farmers' perspectives on how management can address crop-raiding, the wildlife species involved in attacking crops and thoes species killed.

Hence, effective conservation policies and initiatives must extend beyond merely reducing biodiversity loss, particularly the decline of endangered species (Gaillard et al., 2019). They should also tackle the growing issue of human-wildlife conflict, which adversely affects local communities and wildlife conservation efforts

(Dickman, 2010; Nyhus et al., 2016), representing a substantial threat to the successful preservation of wildlife species (Störmer et al., 2019; Gandiwa et al., 2013; Moreto, 2019).

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