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The knowledge of local people on human-wildlife conflict and their attitudes towards problematic wildlife around Wof-Washa Forests, North Shewa Administrative Zone, Ethiopia

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ABSTRACT

Human-wildlife conflict (HWC) around wildlife areas is a common phenomenon, but rarely studied in Ethiopia. The purpose of this study was to examine the knowledge of local people on HWC and their attitudes towards problematic wildlife around Wof-Washa Forests (WoWF), Ethiopia. The study utilized a structured questionnaire comprising closed-ended questions which were administered to a total of 162 respondents. The respondents were randomly selected through a lottery system based on their house identification numbers. Descriptive statistics, Chi-square test, and multiple linear regression were used to analyze and interpret the data. The results revealed that HWC arising from crop damage and livestock predation was prevalent around WoWF. The common crop raiding wild animals were vervet monkey, warthog, anubis baboon, and gelada while common jackal and spotted hyena were major predators responsible for livestock predation. The respondents reported that guarding, chasing, and planting scarecrows were the main traditional measures used to manage HWC. More than three-fourth of the respondents (about 79%) held negative attitudes towards crop raiders and livestock predators. The multiple linear regression model predicted that several socioeconomic variables had significant effects on the attitudes of the respondents towards problematic wildlife (49% variance explained). Introducing community-based ecotourism initiative is recommended to mitigate the existing HWC around WoWF. Moreover, promoting the direct participation of local residents in decision-making and implementation is crucial towards the conservation and management of wildlife resources in the study site.

ABBREVIATIONS

AGP: Agricultural Growth Program
ETB: Ethiopian Birr
FAO: Food and Agriculture Organization for the United Nations
HWC: Human-wildlife conflict
LMD: Livestock Market Development
SPSS: Statistical Package for Social Scientist
USAID: United States Agency for International Development
VIF: Variance inflation factor
WoWF: Wof-Washa Forests
χ^2: Chi-square test

INTRODUCTION

Human-wildlife conflict (HWC) refers to the interaction between wild animals and people and the resultant negative impact on people or their resources, or wild animals or their habitats (Messmer, 2000; Sillero-Zubiri and Laurenson, 2001; Conover, 2002; Gadd, 2005; Madden, 2008; Seoraj-Pillai and Pillay, 2017). For example, HWC occurs when growing human populations overlap with established wildlife territory. Although both developed and developing countries are affected by HWC, developing countries are more prone than developed countries due to a heavily dependent economy on subsistent use of natural resources (Hill, 1998, 2000; Gadd, 2005; Lamarque et al., 2009; Fairet, 2012; Bibi et al., 2013; Seoraj-Pillai and Pillay, 2017; Biset et al., 2019). Some of the major reasons for such HWC are competition for limited resources (e.g. habitat overlap), fear as a threat to the local community, crop raiding, diseases and parasites transmission, livestock predation, and trading the body parts of wild animals (Newmark et al., 1994; Hill, 1998, 2000; Sillero-Zubiri and Laurenson, 2001; Conover, 2002; Gadd, 2005; Lamarque et al., 2009; Hoffman and O'Riain, 2011; Datiko and Bekele, 2013; Seoraj-Pillai and Pillay, 2017). For example, due to competition for shared natural resources between people and wildlife, HWC influences food security of people and the well-being of people and animals (Seoraj-Pillai and Pillay, 2017; Mbise et al., 2018; Agyeman and Baidoo, 2019).

The common resultant effects of HWC include crop damage, livestock predation, damages on properties and human themselves (Newmark et al., 1994; Hill, 1998, 2000; Gadd, 2005; Woodroffe et al., 2005; Lamarque et al., 2009; Bibi et al., 2013; Datiko and Bekele, 2013). HWC are most prevalent along the boundaries of wildlife protected areas (Hill, 1998, 2000; Datiko and Bekele, 2013; Karanth et al., 2013; Mbise et al., 2018; Biset et al., 2019). Indeed, wildlife species involved in conflict are more vulnerable to extinction (Woodroffe and Ginsberg, 1998; Gadd, 2005; Seoraj-Pillai and Pillay, 2017) and also create a basis for resentment due to the undermined welfare of the local people through crop damage and livestock predation (Bower and Baquete, 1998; Hill, 1998, 2000; Gadd, 2005; Lamarque et al., 2009; Datiko and Bekele, 2013; Mbise et al., 2018; Biset et al., 2019). Resulting from HWC, local people's reactions (e.g. poaching, harassment, and habitat destruction) towards wild animals created important threats to the survival of several wildlife species and is increasingly significant obstacle to the conservation of wildlife in both developing and developed countries around the world (Newmark et al., 1994; Bower and Baquete, 1998; Hill, 1998, 2000; Messmer, 2000; Conover, 2002; Madhusudan, 2003; Gadd, 2005; Graham et al., 2005; Osborn and Hill, 2005; Woodroffe et al., 2005; Kideghesho et al., 2007; Madden 2008; Lamarque et al., 2009; Karlsson and Johansson, 2010; Hoffman and O'Riain, 2011; Fairet, 2012; Bibi et al., 2013; Datiko and Bekele, 2013; Seoraj-Pillai and Pillay, 2017; Mbise et al., 2018; Biset et al., 2019).

Farming practice and rearing of livestock are the integral parts of the local economy especially in most developing countries around the rural landscape. However, the economic loss incurred due to crop raiding and livestock predation is rarely compensated through the loss because such incidences can be relatively paramount in developing countries (Newmark et al., 1994; Bower and Baquete, 1998; Hill, 1998, 2000; Gadd, 2005; Linkie et al., 2007; Lamarque et al., 2009; Fairet, 2012; Bibi et al., 2013; Datiko and Bekele, 2013; Seoraj-Pillai and Pillay, 2017; Mbise et al., 2018; Biset et al., 2019). For example, encounter of crop damages was reported in a wide range of wildlife species, including elephant (*Loxodonta africana*) (Bower and Baquete, 1998; Hill, 1998; Gadd, 2005; Nyirenda et al., 2011; Datiko and Bekele, 2013; Seoraj-Pillai and Pillay, 2017), wild boar (*Sus scrofa*) (Linkie et al., 2007), primates (Hill, 2000; Yihune et al., 2009a; Engeman et al., 2010; Oduntan et al., 2012; Agyeman and Baidoo, 2019; Biset et al., 2019), and rodents (Sillero-Zubiri and Laurenson, 2001; Singleton et al., 2005). Livestock predation by various carnivores is another conflict observed in several parts of the world which is exhibited by different carnivores in many countries (e.g. Newmark et al., 1994; Bower and Baquete, 1998; Hill, 1998, 2000; Gadd, 2005; Kolowski and Holekamp, 2006; Holmern et al., 2007; Kideghesho et al., 2007; Roskaft et al., 2007; Kissui, 2008, Dar et al., 2009; Karlsson and Johansson, 2010; Kabir et al., 2013; Mwakatobe et al., 2013; Bhattarai and Fischera, 2014; Linkowski et al., 2017; Megaze et al., 2017; Mbise et al., 2018; Biset et al., 2019). Similar to other countries, HWC also exist in Ethiopia. In fact, field studies are very few though such HWC are severe in the country (e.g. Yihune et al., 2008, Yihune et al., 2009a,b; Gebeyehu and Bekele, 2009; Atickem et al., 2010; Yirga et al., 2011; Mekonnen et al., 2012; Datiko and Bekele, 2013; Kumssa and Bekele, 2013; Megaze et al., 2017; Biset et al., 2019).

Resulting from diverse ecological conditions, Ethiopia is popular for its endemic wildlife species.

However, the damages (i.e. crop raiding and livestock predation) caused by different wildlife species in the country vary from place to place. This is because the nature of HWC, type and extent of crop damage and livestock predation depend on the wildlife species involved. For instance, conflict manifested in terms of livestock predation was noted where spotted hyena (*Crocuta crocuta*), leopard (*Panthera pardus*), and common jackal (*Canis aureus*) are common (Yirga et al., 2011; Biset et al., 2019). Sheep predation by Ethiopian wolf (*Canis simensis*) (Yihune et al., 2008) and crop raiding by gelada (*Theropithecus gelada*) were also reported around the Simien Mountains National Park (Yihune et al., 2009a) and Borena Sayint National Park (Biset et al., 2019). However, Yihune et al. (2009b) have noted prevalent problems (e.g. domestic goat and sheep predation) caused by common jackal. In addition, minimal problems resulting from Ethiopian wolf, leopard (*Panthera pardus)*, vervet monkey (*Chlorocebus aethiops*), hamadryas baboon (*Papio hamadryas*), and crested porcupine (*Hystrix cristata*) were reported around the Simien Mountains National Park of Ethiopia (Yihune et al., 2009a, b). Gebeyehu and Bekele (2009) noted that vervet monkey is one of the major problematic wildlife species around the Zegie Peninsula (i.e. a small island), Lake Tana, Ethiopia. In another study, Atickem et al. (2010) reported that spotted hyena followed by leopard were responsible for livestock predation to the pastoral society in the Bale Mountains. Mekonnen et al. (2012) also noted that crop raiding by the Bale monkey (*Chlorocebus djamdjamensis*) is becoming a chronic problem in Oromia National Regional State, Ethiopia. However, Datiko and Bekele (2013) claimed that the common problematic wildlife species damaging food crops in Ethiopia include buffalo *(Syncerus caffer*), anubis baboon (*Papio anubis*), vervet monkey, and warthog (*Phacochoerus aethiopicus*). Moreover, Kumssa and Bekele (2013) noted that warthog was considered notorious pest in Senkelle Swayne's Hartebeest Sanctuary. Spotted hyena and leopard were responsible for livestock predation around Chebera Churchura National Park of Ethiopia (Datiko and Bekele, 2013; Megaze et al., 2017). In a very recent study, Biset et al. (2019) reported that leopard and spotted hyena were the top livestock predators while grivet monkey, gelada, and crested porcupine were notorious crop raiders around Borena Sayint National Park, Ethiopia.

Given the prevalence of HWC around various wildlife areas in Ethiopia, it is essential to reduce or control HWC where local people and wildlife coexist (Newmark et al., 1994; Bower and Baquete, 1998; Hill, 1998, 2000; Gadd, 2005; Holmern et al., 2007; Kideghesho et al., 2007; Roskaft et al., 2007; Madden, 2008; Yihune et al., 2009a, b; Karlsson and Johansson, 2010; Karanth et al., 2012; Mwakatobe et al., 2013; Megaze et al., 2017; Seoraj-Pillai and Pillay, 2017; Mbise et al., 2018; Biset et al., 2019). In fact, knowledge on the underlying human and habitat driving factors is mandatory for effective mitigation of HWC. So far, no study was conducted to examine the magnitude of HWC around WoWF, North Shewa Administrative Zone, Ethiopia. However, crop raiding and livestock predation are perceived to be the major problems challenging the local communities living adjacent to WoWF. Hence, the following two questions were addressed in this study. These were: (1) how is the knowledge of local people on HWC around WoWF? (2) How are the attitudes of the local people towards problematic wildlife (i.e. crop raiders and livestock predators)? To answer the aforementioned two questions, the study aimed at examining the knowledge of the local people on HWC and their attitudes towards problematic wildlife around WoWF.

Mitigating crop and livestock loss from the impacts of problematic wildlife and improving compensation distribution are important for conservation efforts in a landscape where people and wildlife coexist (Hillman, 1993; Hill, 1998, 2000; Madden, 2008; Yihune et al., 2009a, b; Hoffman and O'Riain, 2011; Tadesse and Kotler, 2016; Mbise et al., 2018; Biset et al., 2019). Unlike most previous studies conducted in Ethiopia (e.g. Tessema et al., 2010; Yihune et al., 2009a, b; Datiko and Bekele, 2013; Kumssa and Bekele, 2013; Megaze et al., 2017; Biset et al., 2019) and other countries (e.g. Fiallo and Jacobson, 1995; Bower and Baquete, 1998; Hill, 1998; Bowman et al., 2001; Walpole and Goodwin, 2001; Gadd, 2005; Kideghesho et al., 2007; Morzillo et al., 2007; Roskaft et al., 2007; Ogra, 2008; Bhattarai and Fischera, 2014; Mbise et al., 2018; Agyeman and Baidoo, 2019), the present study utilized a combination of knowledge and attitudes of local people to address HWC around WoWF, Ethiopia. Hence, this study is believed to uniquely provide comprehensive evidence that helps increase our insights and understanding about the resultant impacts of HWC. Moreover, the study is important to develop remedial wildlife conservation strategies and measures that integrate the local people in the conservation and management of wildlife species. Thus, the resulting information is crucial for policy analysts, decision-makers, land use planners, and forest and natural resources conservation managers working in and around WoWF, Ethiopia.

MATERIALS AND METHODS

Study Area

Wof-Washa Forests (WoWF) are located in North Shewa Administrative Zone (about 9°45' N and 39°45' E), central highlands of Ethiopia, some 160 km northeast of Addis Ababa (Fig. 1). There are different opinions about the size of WoWF. For example, previous researchers estimated that WoWF were thought to cover an area of 3,500 ha (Von Breitenbach, 1962; Chaffey, 1979). However, FAO (1988) estimated that WoWF cover an area of 10,000 ha. The total area of WoWF is 6604.35 ha (Personal communication with Tarmaber District Administration Office, March 10, 2017). These differences suggested the need for further investigations

about the exact boundary of WoWF. However, WoWF are under steady human and livestock pressures, which are believed to reduce the area of the forests as time goes on (Teketay and Bekele, 1995; Woldie and Tadesse, 2018). The WoWF are known for their very steep slopes and rugged topography. For example, there are several peaks covered by WoWF and ericaceous shrubs among which the highest is at about 3,500 m at the north-western part of the forests (Teketay and Bekele, 1995).

The common woody plant species in WoWF include *Juniperus procera*, *Afrocarpus falcatus*, *Cynoglossum amplifolium*, *Polyscias fulva*, *Hypericum revolutum*, *Vernonia amygdalina*, *Vernonia rueppellii*, *Ekebergia capensis*, *Bersama abyssinica*, *Ficus sur*, *Maesa lanceolata*, *Myrsine africana*, *Dovyalis abyssinica*, *Olea africana*, *Olea hochstetteri*, *Celtis africana*, *Hagenia abyssinica*, *Prunus africana*, *Allophylus abyssinicus*, *Rosa abyssinica*, and *Galium simense* (Bekele, 1994; Teketay and Bekele, 1995; Woldie and Tadesse, 2018).

The WoWF provide shelter, food, and breeding sites for a number of wild mammal species, including anubis baboon (*Papio anubis*), gelada (*Theropithecus gelada*), bushbuck (*Tragelaphus scriptus*), common duiker (*Sylvicapra grimmia*), Menelik's bushbuck (*Tragelaphus scriptus meneliki*), guereza (*Colobus guereza*), vervet monkey (*Chlorocebus aethiops*), klipspringer (*Oreotragus oreotragus*), spotted hyena (*Crocuta crocuta*), leopard (*Panthera pardus*), rock hyrax (*Procavia capensis*), common jackal (*Canis mesomelas*), common warthog (*Phacochoerus africanus*), African civet (*Civettictis civetta*), and bush pig (*Potamochoerus larvatus*) (Teketay and Bekele, 1995; Woldie and Tadesse, 2018). The WoWF are also known for bird species, and some of the endemic bird species in the forests include Ankober serin (*Serinus ankoberensis*), abyssinian catbird (*Parophasma galinieri*), abyssinian long-claw (*Macronyx flavicollis*), Ethiopian siskin (*Serinus nigriceps*), spot-breasted lapwing (*Vanellus melanocephalus*), and wattled ibis (*Bostrychia carunculata*) (Ashenafi et al., 2005; Woldie and Tadesse, 2018).

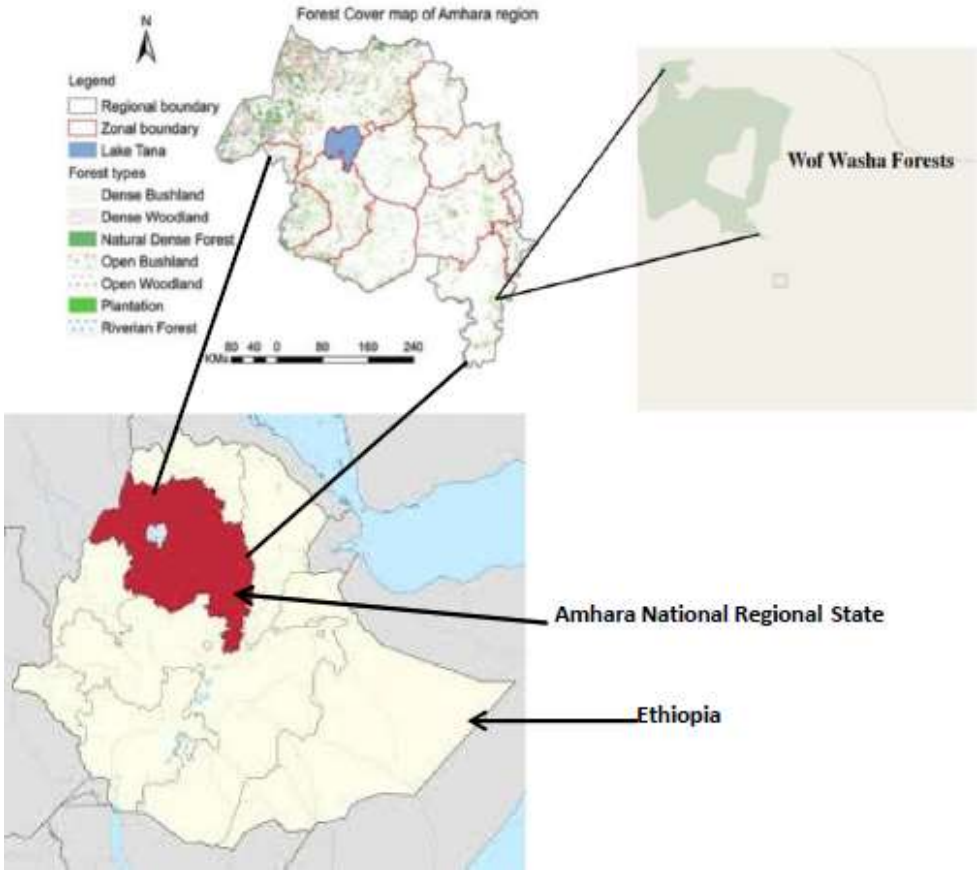

Figure 1: The location of Wof-Washa Forests in Amhara National Regional State, Ethiopia

Survey Instruments

Attitudes are positive or negative responses of people towards problematic wildlife (Hill, 1998; Bowman et al., 2001; Morzillo et al., 2007; Romanach et al., 2007; Karlsson and Johansson, 2010; Dickman et al., 2014; Tadesse and Kotler, 2016; Pirie et al., 2017; Mbise et al., 2018). Thus, negative or positive attitudes of local people will likely affect their contribution and participation in conservation and management of wildlife (Hill, 1998; Gadd, 2005; Hazzah, 2006; Kideghesho et al., 2007; Romanach et al., 2007; Roskaft et al., 2007; Tadesse

and Kotler, 2016; Pirie et al., 2017; Mbise et al., 2018). Behaviour of people can be influenced by their knowledge and experience about wildlife resources (Jotte, 1997; Hill, 1998; Walpole and Goodwin 2001; Tadesse and Kotler, 2016; Mbise et al., 2018). Attitudes of local people can be affected by their behaviors (Jotte, 1997; Hill, 1998; Roskaft et al., 2007; Tadesse and Kotler, 2016; Pirie et al., 2017; Mbise et al., 2018). So, understanding how behavior affects the attitudes of local people is of paramount importance for the conservation, management, and sustainable utilization of wildlife resources, especially in the developing countries, like Ethiopia, where local people are directly dependent on the natural resources to satisfy their livelihoods (Jotte, 1997; Hill, 1998; Gadd, 2005; Karlsson and Johansson, 2010; Tadesse and Kotler, 2016; Megaze et al., 2017; Pirie et al., 2017; Mbise et al., 2018; Biset et al., 2019). Previous studies suggested that attitudes of local people towards problematic wildlife were affected by social factors, such as sex, age, level of education, family size, annual income, occupation type, land and livestock ownerships, and distance between the residence area of the respondents and the edge of wildlife area (Hill, 1998; Bowman et al., 2001; Gadd, 2005; Kideghesho et al., 2007; Romanach et al., 2007; Roskaft et al., 2007; Dickman et al., 2014; Tadesse and Kotler, 2016; Megaze et al., 2017; Pirie et al., 2017; Biset et al., 2019).

The local people in the study site are historically linked to WoWF. More importantly, they can affect the forests and the wildlife resources because of their direct dependence on them for fuelwood, construction materials, wood products sold by households, foods, medicinal values, source of water, and free-range livestock grazing (Teketay and Bekele, 1995). Hence, the successful conservation of wildlife resources depends on knowledge about HWC and attitudes of the local people who are inherently connected with the local landscape (Hillman, 1993; Hoffman and O'Riain, 2011; Tadesse and Kotler, 2016), and through their active participation in its management.

To examine the relative importance of social factors (e.g. sex, age, level of education, family size, annual income, occupation type, distance between the residence area of the respondents and the edge of WoWF, land and livestock ownership) affecting the knowledge of local people on HWC and their attitudes towards problematic wildlife around WoWF (Dickman et al., 2014; Megaze et al., 2017), we chose local communities living adjacent to the forests, who had reported crop damages and livestock predation by problematic wildlife. This is because crop damage and livestock predation are the major causes for the incidences of HWC all over the world (Hill, 1998, 2000; Gadd, 2005; Holmern et al., 2007; Romanach et al., 2007; Lamarque et al., 2009; Karlsson and Johansson, 2010; Bibi et al., 2013; Mwakatobe et al., 2013; Dickman et al., 2014; Megaze et al., 2017; Pirie et al., 2017; Seoraj-Pillai and Pillay, 2017; Mbise et al., 2018; Agyeman and Baidoo, 2019; Biset et al., 2019). And hence, the data are more reliable to deal with the knowledge of local people on HWC and their attitudes towards problematic wildlife around WoWF, Ethiopia. Thus, the study site was more or less representative of the local communities' interactions with wildlife, and also it allowed us to evaluate the relative importance of the social factors in shaping attitudes towards problematic wildlife around WoWF.

Structured questionnaire comprising closed-ended questions were prepared (Tadesse and Kotler, 2016; Megaze et al., 2017) that likely help examine the knowledge of local people on HWC and their attitudes towards problematic wildlife (i.e. crop raiders and livestock predators) around WoWF. Most socio-economic, knowledge and experience measuring questions were measured in nominal scale and rated using 2 = yes, and 1 = no. Distance between the residential area of the respondents and the edge of WoWF, age, family size, annual income, and level of education were measured in numerical quantitative values. To quantify the attitudes of the respondents towards crop raiders and livestock predators, Likert scale was employed and rated using 5 = strongly agree, 4 = agree, 3 = unsure, 2 = disagree and 1 = strongly disagree through a structured questionnaire survey (Cohen et al., 2000; Hren et al., 2004; Tadesse and Kotler, 2016). Larger values reflected positive attitudes towards crop raiders and livestock predators.

Data Collection

After briefly orienting about the purpose of the study and the questionnaire survey, a total sample size of 162 respondents who live around WoWF were contacted. Respondents for the questionnaire survey were randomly selected through a lottery system based on their house identification numbers. Pre-testing of the structured questionnaire was carried out to ensure that all questions were clear and a final version was prepared for sampling.

The incidences of crop raiding and livestock predation by wildlife were noticed around WoWF from the pre-testing survey. Hence, the study was conducted by focusing on: (i) sex; (ii) age; (iii) level of education; (iv) family size; (v) annual income; (vi) occupation type; (vii) distance between the residence area of the respondents and the edge of WoWF; (viii) land ownership; (ix) livestock ownership; (x) the opinion of the local people on the nature of crop damage; (xi) the type and extent of crop damage; (xii) the techniques used by the local people to protect crops from the damage caused by crop raiders; (xiii) remedial measures suggested by the respondents to prevent the loss of food crops; (xiv) identifying and quantifying the type and number of livestock loss due to predation; (xv) people's knowledge on the trend of livestock predation; and (xvi) the attitudes of the respondents towards problematic wildlife. The correct identification of the observed predators was assured by showing the photographs of different predators to the respondents. The data were

collected through a household survey via house-to-house visits in April 2017.

Data Analyses

Descriptive statistics (i.e. proportion, mean, and standard deviation values) were computed. A summary of the proportion values was presented in tabular format. The monetary loss for each respondent from livestock killed by wild predators was calculated based on the market price (Ethiopia Birr) with reference to the nearest town (i.e. Debre Berhan town), which was later converted to US dollars for the different livestock type.

Chi-square test (χ^2) and multiple linear regression were used to analyze and interpret the data (Zar, 1999). Prior to the Chi-square test (χ^2) and multiple linear regression analyses, we tested continuous independent variables for collinearity using Spearman rank analysis and Pearson *r* correlations, as appropriate, and categorical variables using Pearson Chi-square to test for association between categorical variables (see also Hazzah, 2006 for the correlation matrix). The cut-off value for significance of the Spearman Rank and Pearson was $r > 0.70$ and $P < 0.001$ for Pearson Chi-square tests. We also tested the variance inflation factor (VIF) and checked the variance decomposition proportions; both tests confirmed that there was no collinearity present among the predictors. Finally, we ran additional diagnostic tests to check for the presence of outliers, influential observations, and heteroscedasticity (Fox, 1997). All test results were at normal levels; allowing us to proceed with the multiple regression analysis. After choosing the independent variables, we ran the multiple regression. For all statistical analyses, the alpha value was set to be 0.05. All the analyses were done using Statistical Package for Social Scientist (SPSS) version 16 (SPSS Inc., Chicago, USA).

RESULTS

A total 162 persons responded to the questionnaire survey. Majority (79.75%) of the respondents were males. The average age of the respondents was 43.4 years with a standard deviation of 9.36. Regarding the level of education, more than half of the respondents (68.6%) went to elementary school. The average family size in a household was about five persons. The average annual income of the respondents was about 28,935.23 Ethiopian Birr (ETB) which was equivalent to $1,263.55. Among all the respondents contacted, more than two-third of them (76.4%) practiced subsistence mixed farming (i.e. crop farming and livestock rearing). The mean distance between the residence area of the respondents and the edge of WoWF was 2.34 km with a standard deviation of 1.43. Majority of the respondents (82.4%) had land to grow food crops. Regarding livestock ownership, most of the respondents (about 89%) had livestock (Table 1).

As farming was practiced by the local people in proximity to WoWF, most of the respondents (90.0%) reported that HWC around WoWF arose from both crop damage and livestock predation (Table 2). The presence of HWC was also significant ($\chi^2 = 154.23$; df = 1; $P < 0.001$) among the respondents.

Vervet monkey, warthog, anubis baboon, and gelada were perceived as the major wildlife species accused for crop raiding around WoWF. The proportion of the respondents experienced crop damage adjacent to the boundaries of WoWF was significant for vervet monkey ($\chi^2 = 104.63$, df = 1, $P < 0.001$), warthog ($\chi^2 = 89.34$; df = 1; $P < 0.001$), anubis baboon ($\chi^2 = 76.34$; df = 1; $P < 0.001$), and gelada ($\chi^2 = 56.43$; df = 1; $P < 0.001$). However, porcupine and rodents were identified as minor crop pests. The important crops affected by crop raiding wild animals around WoWF, included faba bean, pea, sorghum, potato, barley, and wheat. This suggests that they were the most frequently grown crops to be damaged by crop raiding wild animals around WoWF (Table 3). The number of respondents reported for the presence of crop damage around WoWF was significant for faba bean ($\chi^2 = 94.86$, df = 1; $P < 0.001$), pea ($\chi^2 = 67.54$, df = 1, $P < 0.001$), potato ($\chi^2 = 65.34$; df = 1; $P < 0.001$), sorghum ($\chi^2 = 59.76$; df = 1; $P < 0.001$), barley ($\chi^2 = 54.32$; df = 1; $P < 0.001$), and wheat ($\chi^2 = 47.45$; df = 1; $P < 0.005$).

More than half of the respondents (53.6%%) believed that the main reason for the tendency of crop damage was due to the increase in subsistence agriculture followed by an increase in the populations of crop raiders (34.8%). However, some of the respondents believed that lack of natural food and/or attraction of staple food as an alternative reason for the tendency of crop damage around WoWF (Table 4). The respondents' reason to the tendency of crop damage was significant ($\chi^2 = 189.32$, df = 4; $P < 0.001$). As to the different mitigation strategies used by the local people to protect food crops, most of the respondents (92.8%) reported that they used guarding, chasing, and planting scarecrow (Table 4). The choice of the different mitigation strategies among the respondents was significant ($\chi^2 = 342.23$, df = 4; $P < 0.001$). Indeed, more than two-fifth of the respondents (43.2%) suggested that minimizing crop raiders either through translocating them to other areas or complete removal as remedial measures are good to prevent crop loss. Surprisingly, few of the respondents adopted some of the remedial measures, such as shifting from agriculture to either perennial plantation or animal husbandry practice. However, some of the respondents still practice guarding during the day- and nighttimes as remedial measures to protect their food crops against crop damaging wild animals (Table 4). The opinion of the remedial measures suggested by the respondents to prevent the loss of food crops was significant ($\chi^2 = 89.43$; df = 4; $P < 0.001$) among the respondents.

Regarding livestock predation, more than half of the respondents experienced this conflict from common jackal (56%) and spotted hyena (52%). However, the

incidence of livestock predation by leopard was reported by some respondents (38.4%) (Table 5). The proportion of the respondents who experienced livestock predation was significant only for common jackal (χ^2 = 46.64; df = 1; P < 0.005). As to the respondents, a total of 365 domestic animals (i.e. 267 sheep and goats, 12 head of cattle and 86 pack animals) were lost due to predation by wild animals around WoWF whose potential economic loss was estimated to be $26,830.00 per year (Table 5). Majority of the respondents (86.4%) noted that the trend of livestock predation had increased around WoWF (Table 5). The proportion of the respondents' opinion on the trend of livestock predation was also significant (χ^2 = 432.26; df = 2; P < 0.001) among respondents. Among the common mitigating strategies, more than half of the respondents (62.0%) reported that they used active guarding because it helps them to save their livestock from predators. Moreover, some of the respondents used to restrict the domestic animals around their backyards as another alternative technique to reduce predation by wild carnivores (Table 5). The choice of different mitigating strategies among the respondents was significant (χ^2 = 173.26; df = 3; P < 0.001).

Generally, the study revealed that more than three-fourth (78.93%) of the respondents held negative attitudes towards problematic wildlife (i.e. crop raiders and livestock predators) around WoWF. As revealed from their coefficients, age ($ß$ = 0.63), level of education ($ß$ = 0.21), annual income ($ß$ = 0.31), and distance between the residence area of the respondents and the edge of WoWF ($ß$ = 0.37) had positively significant effect on the attitudes of the respondents towards problematic wildlife (i.e. crop raiders and livestock predators) around WoWF. However, land ($ß$ = -0.84) and livestock ownerships ($ß$ = -0.59) had negatively significant effect on the attitudes of the respondents towards problematic wildlife around WoWF. Overall, the multiple linear regression model revealed that the socioeconomic variables (i.e. sex, age, level of education, family size, annual income, occupation type, distance between the residence area of the respondents and the edge of WoWF, land and livestock ownership) which were introduced into the model had significant effect on the attitudes of the respondents towards problematic wildlife around WoWF (49% variance explained) (Table 6).

Table 1: Sample characteristics and descriptive results of the study area

Variable	Descriptive Results	Proportion (%)
Total sample size (*n*)	162 households	
Sex	Male	79.75
	Female	20.25
Age	Mean = 43.4 years; SD = 9.36	
Level of education	Illiterate	4.71
	Literate	11.63
	Elementary school	68.6
	Secondary school	12.21
	Diploma	2.85
Family size	Mean = 4.98 persons; SD = 1.92	
Annual income	Mean = 28,935.23 ETB; SD = 1,386.21	
Occupation type	Crop cultivation	12.01
	Livestock rearing	11.59
	Mixed farming	76.4
Distance between the residence area of the respondents and the edge of WWF (km)	Mean = 2.34 km; SD = 1.43	
Land ownership	Yes	82.4
	No	17.6
Livestock ownership	Yes	88.99
	No	11.01

$1 = 22.90 ETB (The equivalent price in April 2017)

Table 2: The nature of human-wildlife conflicts reported by the respondents around WoWF. The total number of respondents was 162.

Nature of human wildlife-conflict	Proportion (%)
Only crop damage	10.0
Only livestock predation	0.0
Both crop damage and livestock predation	90.0

Table 3: Human-wildlife conflicts arising from crop raiders around WoWF. The total number of respondents was 162.

Attribute		Response	Proportion (%)
Major crop raiders	Vervet monkey	Yes	89.34
		No	10.66
	Warthog	Yes	84.56
		No	15.44
	Anubis baboon	Yes	82.38
		No	17.62
	Gelada	Yes	76.89
		No	23.11
Minor crop raiders	Porcupine	Yes	12.8
		No	87.2
	Rodents	Yes	8.4
		No	91.6
Name of crop damaged by crop raiders	Faba bean	Yes	75.6
		No	24.4
	Pea	Yes	66.4
		No	33.6
	Sorghum	Yes	61.2
		No	38.8
	Potato	Yes	60.8
		No	39.2
	Barley	Yes	60
		No	40
	Wheat	Yes	56.9
		No	43.1

Table 4: Reasons for the tendency of crop damage, strategies used to protect crops and suggested remedial measures to prevent crop loss around WoWF. The total number of respondents was 162.

Attribute	Response	Proportion (%)
Reasons for the tendency of crop damage by crop raiders	Increase in populations of crop raiders	34.8
	Increase in subsistence agriculture	53.6
	Both increase in populations of crop raiders and subsistence agriculture	2.8
	Lack of natural food and /or attraction of staple food	5.2
	Unknown reason	3.6
Mitigating strategies used to protect food crops from crop raiding wild animals	Guarding	4.0
	Chasing	0.4
	Scarecrow	0.8
	Guarding, chasing and scarecrow	92.8
	Using dogs	2.0
Remedial measures to prevent crop loss	No response / Do not know	5.6
	Minimizing crop raiders or translocating them to other areas	43.2
	Guarding during day- and nighttimes	17.2
	Shifting from agriculture to perennial plantation	19.2
	Shifting animal husbandry	14.8

Table 5: Human-wildlife conflicts arising from livestock predation around WoWF. The total number of respondents was 162.

Attribute		Response	Proportion (%)
Name of livestock predators	Common jackal	Yes	56.0
		No	44.0
	Spotted hyena	Yes	52.0
		No	48.0
	Leopard	Yes	38.4
		No	61.6
Number of heads of livestock loss per year		Cattle	12
		Sheep / Goats	267
		Pack animals	86
Cost of livestock loss per year (USD)		Cattle	882
		Sheep/Goats	22,359
		Pack animals	3,589
Trend of livestock predation		Increased	86.4
		Decreased	2.0
		Unknown	11.6
Techniques used to manage livestock predation		No response	15.6
		Active guarding	62.0
		Using guarding dogs	6.4
		Restricting domestic animals around backyards	16.0

$1 = 22.90 ETB (The equivalent price in April 2017)

Table 6: Multiple linear regression model[a] to predict the effect of socioeconomic variables on the attitudes of the respondents towards problematic wildlife (i.e. crop raiders and livestock predators) around WoWF[b].

Variables	Attitudes towards problematic wildlife [b]		
	ß	***t-value***	***P-value***
Intercept	0.73	1.86	-
Sex (male = 2; female = 1)	-0.44	-0.46	0.79
Age	0.63	2.95**	0.003
Level of education	0.21	2.28**	0.03
Family size	-0.34	-0.70	0.64
Annual income	0.31	3.45**	0.001
Occupation type	-0.93	-1.08	0.49
Distance between the residence area of the respondents and the edge of WoWF (km)	0.37	4.24**	0.001
Land ownership (Yes = 2; No = 1)	-0.84	-4.83**	0.001
Livestock ownership (Yes = 2; No = 1)	-0.59	-3.58**	0.001

"("+"indicates a positive change in attitudes and "-" indicates a negative change in attitudes)." [a]Standardized coefficients were reported; **represents significance at the 95% confidence level; and [b]R^2 = 0.69 (Adj. R^2 = 0.49), df = 8; F = 9.19, overall $P < 0.001$. The total sample size (N) considered in this analysis was 162 households.

DISCUSSION

Incidences of wildlife damage, loss of crops, and livestock predation occasionally are quite obvious with human settlements around wildlife areas (Studsrød and Wegge, 1995; Hill, 1998; Holmern et al., 2007; Romanach et al., 2007; Sillero-Zubiri et al., 2007; Atickem et al., 2010; Karlsson and Johansson, 2010; Karanth et al., 2013; Mwakatobe et al., 2013; Megaze et al., 2017; Mbise et al., 2018; Biset et al., 2019). This study was the first attempt that investigated the knowledge of local people on HWC and their attitudes towards problematic wildlife species around WoWF. The local people noted that the impacts of HWC on food crops and livestock were significant because most of the respondents practiced crop production and livestock rearing to meet their livelihoods around WoWF. The prominent reason for HWC incidences is either strayed wild animals outside WoWF (Woodroffe and Ginsberg, 1998; Holmern et al., 2007; Ogra, 2008; Karlsson and Johansson, 2010; Agyeman and Baidoo, 2019) or people who approach WoWF to meet their household needs (Ogra, 2008; Biset et al., 2019).

Most often, herbivores particularly vervet monkey, warthog, anubis baboon, and gelada are blamed to be the major crop raiders around WoWF. In fact, previous studies reported that primates were the most frequent pests damaging food crops in different African countries, including Uganda (Hill, 1998, 2000; Naughton-Treves et al., 1998), Zambia (Nyirenda et al., 2011), Ghana (Agyeman and Baidoo, 2019), and Ethiopia (Yihune et al., 2009a; Gebeyehu and Bekele, 2009; Mekonnen et al., 2012; Datiko and Bekele, 2013; Kumssa and Bekele, 2013; Megaze et al., 2017; Biset et al., 2019). The most important describing factor for such crop loss is the growing of food crops near to the edge of the forests or probable surrogates or greater reporting by affected local people (Studsrød and Wegge, 1995; Hill, 1998; Linkie et al., 2007; Megaze et al., 2017; Biset et al., 2019). Shortage of forest-based food or instead opportunistic (Naughton-Treves et al., 1998) probability is the other factor. The attraction of primates due to the presence of palatable crops grown around wildlife areas can also be accounted for such HWC (Hill, 1998, 2000; Yihune et al., 2009a; Datiko and Bekele, 2013; Megaze et al., 2017; Biset et al., 2019). In fact, some of the respondents reported the same reason in this study. According to Datiko and Bekele (2013), particularly food crops, such as maize, teff, and sorghum attract crop raiders around Chebera Churchura National Park, Ethiopia. The respondents also reported similar situation adjacent to WoWF in which faba beans, pea, sorghum, potato, barley, and wheat were highly preferred by primates as these crops were grown more often around the forests. Majority of the respondents believed that the sole reason for the tendency of crop damage was due to the increase in subsistence agriculture followed by an increase in primate populations. Previous studies also noted that large wildlife populations (Jones and Elliott, 2006) or increase in population density and/or range expansion were the most probable reasons for crop raiding (Newmark et al., 1994; Studsrød and Wegge, 1995; Hill, 2000; Madden, 2008; Engeman et al., 2010; Megaze et al., 2017; Biset et al., 2019).

Livestock predation by predators is another kind of HWC in different parts of the world which is also common around wildlife areas in Ethiopia. For example, according to USAID (2013), leopard and spotted hyena were the main livestock predators in Ethiopia. In the present study, majority of the respondents reported that livestock predations are caused by common jackal and spotted hyena around WoWF. Moreover, in other parts of Ethiopia, livestock predation was witnessed (e.g. Atickem et al., 2010; Datiko and Bekele, 2013; Megaze et al., 2017; Biset et al., 2019) because livestock are inherently vulnerable to predation due to their reduced anti-predatory skills (Jackson, 2012; Megaze et al., 2017; Mbise et al., 2018). Considering the fact that variety of domestic prey available to predators, medium sized livestock, such as goats and sheep are more vulnerable than cattle and pack animals to predation as revealed in the current study, because medium sized prey can be killed and predators leave to a safer place easier (Dar et al., 2009, Atickem et al., 2010; Bibi et al., 2013; Biset et al., 2019).

Resulting from livestock predation by wild animal species mainly common jackal and spotted hyena, the present study revealed that a total of 365 domestic animals were killed around WoWF with a potential revenue loss of $26,830.00 per year. Previous studies noted that, around Chebera Churchura National Park, out of 997 domestic animals preyed, around 200 animals (i.e. sheep, goats, and cattle) were killed by leopard and spotted hyena in three years, of which 75.5% of the domestic animals were killed by leopard alone (Datiko and Bekele, 2013; Megaze et al., 2017). However, in the Bale Mountains, out of 704 domestic animals preyed by wild carnivores, 57% and 18% of the domestic animals were killed by spotted hyena and leopard, respectively (Atickem et al., 2010). These incidences accounted more economic loss than revealed by the present study. This regional variation in livestock predation by different wild predators could be attributed to the differences in densities of carnivores, animal husbandry practices, or relative abundance of different stock species (Kolowski and Holekamp, 2006; Mbise et al., 2018). Most of the respondents reported that there is an increase in the trend of livestock predation in the recent past around WoWF. This increase in the trend of livestock predation by wild carnivores may be influenced either by push factors, such as reduction of natural prey and/or foods (Lamarque et al., 2009; Dickman et al., 2014) or pull factors like reduced anti-predatory skills of the livestock themselves (Jackson, 2012; Dickman et al., 2014).

As revealed from their coefficients, age, level of education, annual income, and distance between the residence area of the respondents and the edge of WoWF had positively significant effect on the attitudes of

the respondents towards problematic wildlife around WoWF. One of the possible reasons for the increase in the positive attitudes of the local people towards problematic wildlife with the increase in age is that old people are highly knowledgeable about problematic wildlife, including the different values of wildlife (e.g. economic, ecological, and recreational). As a result, they may tolerate the negative impacts of HWC so that they may worry about the conservation of wildlife resources, including the problematic wildlife existing around WoWF. Previous studies also noted that local people tolerate HWC when they have deep indigenous knowledge and experience about the different values of wildlife, which may in turn allow the sustainable coexistence of people and wildlife in the same area (Agrawal, 1997; Hill, 1998; Woodroffe et al., 2005; Holmern et al., 2007; Romanach et al., 2007; Madden, 2008; Dickman et al., 2014; Megaze et al., 2017; Pirie et al., 2017; Mbise et al., 2018; Agyeman and Baidoo, 2019). As the educational level of the respondents' increases, people may know more about the different values of wildlife and hold positive attitudes towards wildlife conservation around WoWF. Previous studies also noted that education and awareness had been suggested as being important in motivating people to develop positive attitudes towards problematic wildlife (Hill, 1998; Bowman et al., 2001; Morzillo et al., 2007; Dickman et al., 2014; Tadesse and Kotler, 2016; Pirie et al., 2017; Mbise et al., 2018; Agyeman and Baidoo, 2019). Moreover, people who have high annual income may not depend on the direct use of wildlife products and/or they do not have frequent physical contact with wildlife and its habitats so that they could hold positive attitudes even if the wildlife species is problematic as revealed in the present study. Similarly, one of the possible reasons for the positive correlation between the attitudes of the respondents with the increase in distance between the residence area of the respondents and the edge of WoWF could be explained by the less likely physical contact between humans and wildlife. Biset et al. (2019) also found a positive correlation between the attitudes of local people and the increase in distance between the residence area of the respondents and the edge of Borena Sayint National Park, northern Ethiopia.

However, the present study revealed that land and livestock ownerships had negatively significant effect on the attitudes of the respondents towards problematic wildlife around WoWF. When people have land to grow food crops and/or practice livestock rearing, this will lead to resource use competition and ultimately HWC (Sillero-Zubiri and Laurenson, 2001; Conover, 2002; Gadd, 2005; Kideghesho et al., 2007; Lamarque et al., 2009; Hoffman and O'Riain, 2011; Megaze et al., 2017; Seoraj-Pillai and Pillay, 2017). This is because problematic wild animals are blamed to damage food crops and/or accused for preying livestock belonging to the local people (Hill, 1998, 2000; Holmern et al., 2007; Romanach et al., 2007; Madden, 2008; Atickem et al., 2010; Dickman et al., 2014; Pirie et al., 2017; Mbise et al., 2018; Biset et al., 2019). Moreover, the government does not legally restrict the local people while they freely drive their livestock inside WoWF so as to practice free range livestock grazing (Tadesse and Teketay, 2017; Woldie and Tadesse, 2018). Hence, the local people usually drive their herds of livestock into WoWF especially during the crop growing season when they face a scarcity of grass for their livestock. This in turn increases physical contact and resource use competition between livestock and wild animals which ultimately leads to an increase in HWC (e.g. livestock predation) around WoWF. For example, Linkowski et al. (2017) noted that during the twenty-first century, large carnivores have increased in human dominated landscapes and have resulted in increasing numbers of livestock killed by large carnivores. Previous studies also noted that wild carnivores commonly generate negative attitudes among rural residents in many regions of the world where they prey on domestic animals because they negatively impact the livelihoods of the local people (Oli et al., 1994; Romanach et al., 2007; Røskaft et al., 2007; Mwakatobe et al., 2013; Dickman et al., 2014; Megaze et al., 2017; Pirie et al., 2017). Similar findings have been reported in plenty of other countries, including India (Oli et al., 1994; Madhusudan, 2003; Osborn and Hill, 2005), Pakistan (Dar et al., 2009), Nepal **(**Bhattarai and Fischera, 2014), Kenya (Gadd, 2005; Romanach et al., 2007), Tanzania (Newmark et al., 1994; Holmern et al., 2007; Kideghesho et al., 2007; Mwakatobe et al., 2013; Dickman et al., 2014; Mbise et al., 2018), Uganda (Hill, 1998, 2000; Webber et al., 2007), Ghana (Agyeman and Baidoo, 2019), South Africa (Treves and Karanth, 2003; Graham et al., 2005; Seoraj-Pillai and Pillay, 2017), Namibia (Potgieter et al., 2015), Mozambique (Bower and Baquete, 1998), Ecuador (Fiallo and Jacobson, 1995), Bhutan (Wang and Macdonald, 2006), Indonesia (Tilson, 2004), Norway (Røskaft et al., 2007), Sweden (Linkowski et al., 2017), USA (Treves and Karanth, 2003; Morzillo et al., 2007), and Ethiopia (Yihune et al., 2008; Gebeyehu and Bekele, 2009; Atickem et al., 2010; Yirga et al., 2011; Kumssa and Bekele, 2013; Megaze et al., 2017; Biset et al., 2019). As a result, respondents may hold negative attitudes towards problematic wildlife as revealed in the present study.

Among different mitigating techniques, the respondents noted that guarding, chasing, and planting scarecrows were the most effective traditional methods to protect food crops grown around WoWF. Moreover, the respondents mentioned that they used active guarding to save their livestock from wild predators. Previous studies also reported that one of the common practices to protect food crops across agriculture-wildlife interface was guarding (Hill, 2000; Hockings et al., 2009; Karlsson and Johansson, 2010; Datiko and Bekele, 2013; Megaze et al., 2017; Mbise et al., 2018; Biset et al., 2019). Apart from using traditional techniques to protect their food crops, most of the respondents suggested to reduce the population of crop raiders either through translocating them to other areas or completely removing them. In contrast, removal of problematic

harem of primates potentially creates an empty wildlife range which invites another harem to occupy that empty range (Hill, 2000; Naughton-Treves et al., 1998; Lamarque et al., 2009; Yihune et al., 2009a; Megaze et al., 2017). This suggested that HWC around WoWF demands better management practices, including buffer zone plantation, fencing, guarding, chasing, and planting scarecrows (Karlsson and Johansson, 2010; Megaze et al., 2017).

CONCLUSION

The present study revealed that majority of the respondents (about 79%) held negative attitudes towards problematic wildlife around WoWF. This suggested that HWC resulting from crop raiding and livestock predation are prevalent around WoWF. For example, the respondents reported that herbivores particularly vervet monkey, common warthog, anubis baboon, and gelada were the major crop raiders in the study site. Moreover, resulting from livestock predation by wildlife species, such as common jackal, spotted hyena, and leopard, a total of 365 domestic animals were killed around WoWF with a potential revenue loss of $26,830.00 per year. Hence, the respondents reported that guarding, chasing, and planting scarecrows were the main traditional measures used to manage HWC in the study site.

As strong negative attitudes towards problematic wildlife are evident among local people around WoWF, paying due attention is mandatory to resolve HWC. For example, informing the local communities about the various values (e.g. recreational, economic, and ecological) of wildlife through conservation education and advocating the need for sustainable utilization may improve the positive attitudes and increase the support of local people in wildlife conservation activities around WoWF. More importantly, public awareness programs and conservation education can assist in improving the attitudes of young people towards the conservation and management of wildlife. Introducing community-based ecotourism initiative is essential to mitigate HWC in the study site. This is because developing WoWF for community-based ecotourism seems to be a promising business in the future. Hence, eco-tourism activities can improve and diversify the incomes of the local people through creating job opportunities, such as tourist guiding services, souvenir selling, and horse renting all of which can help make eco-tourism economically viable around WoWF. Moreover, developing hiking trails and interpretive materials, including field guides to bird, wild mammal, and woody plant species would be valuable assets for implementing community-based eco-tourism around WoWF. Therefore, such kind of activities helps improve the livelihood of the local people living around WoWF and thereby reduce HWC.

Introducing sustainable and culturally acceptable conservation strategies and measures, such as guarding, chasing, and planting scarecrows are necessary to maintain an optimal balance between wildlife conservation priorities and the needs of the local people. For example, chasing and scaring can be done in various ways: drumming, shooting, rattles (i.e. short sharp sounds emitted quickly one after the other), shots in the air, chasing wild animals away from crops may be efficient for short periods, for example, when crops are ripening.

As a technique for mitigating HWC, people perceive translocation as humane, compassionate, and effective. Hence, on top of the aforementioned measures, the following management options are forwarded. For example, fences erected between WoWF and the agricultural lands help keep the problematic wildlife inside the forests and domestic animals out. However, the fences must be solid construction, of sufficient height, and they should be visible. Buffer zone plantations are the best solution, but the size and the location are very important. Such zones are important to reduce the tendency of wild animals to come out of the forested area by encircling WoWF with unattractive buffer zone planted with species that are not very palatable plant species (e.g. Eucalyptus plantation) to problematic wildlife or domestic stock, but are useful to improve the livelihoods of the local communities living around WoWF. When measures noted above prove ineffective, introducing compensation scheme- paying of restitution for the lost products (i.e. crops damaged and/or livestock preyed by problematic wildlife) to the local farmers is essential. Moreover, promoting the direct participation of local residents in decision-making and implementation is crucial towards the conservation and management of wildlife species existing in and around WoWF. In return, the remedial solutions help make coexistence and sharing of resources possible in the study site.

Ethics approval and consent to participate

Not applicable in this section because there are no close contact or disturbances imposed on the prevailing wildlife species or their habitats in this study.

Consent for publication

Not applicable in this section.

Availability of data and material

Please contact authors for data requests.

Authors' contributions

SA Tadesse – designed and conducted the field research, analyzed the data, and drafted the manuscript. NT Zewde – interpreted the results and helped in the manuscript writing. Both authors read, revised and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

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