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# Human–wildlife conflict in and around Borena Sayint National Park, northern Ethiopia

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***Abstract:*** We identified causes, impact, and traditional management measures of human–wildlife conflict (HWC) in and around Borena Sayint National Park, Ethiopia. We employed questionnaires, focus group discussions, direct observations, and key informant interviews to collect data. The respondents perceived an increase in the number of wildlife population (56 respondents; 42.4%) followed by human proximity to park areas (44 respondents; 33.3%) as the main causes of HWC. The respondents perceived leopards (*Panthera pardus*) and spotted hyenas (*Crocuta crocuta)* among the top livestock depredators while grivet monkeys (*Cercopethicus aethiops*) and porcupines (*Hystrix cristata*) were perceived as notorious crop raiders. Gelada baboons (*Theropithecus gelada*) were identified as both crop raiding and livestock depredator wildlife species. A majority of the respondents (113; 85.6%) perceived both crop and livestock damage as impact of wildlife on humans. Guarding was reported as the main traditional measure of conflict management. The incidents have caused economic loss to the livelihood of the local community and have adverse impacts on wildlife conservation. We recommend community-based ecotourism to mitigate the conflict.

***Key words:*** crop raiders, Ethiopia, human–wildlife conflicts, livestock depredators, traditional measures

Human–wildlife conflicts (HWCs) occur when wildlife requirements overlap with those of human populations, at the costs of both humans and wildlife (Messmer 2000, International Union of the Conservation of Nature [IUCN] 2010). Human and wildlife competition for food and space in their shared ecosystem is becoming increasingly common throughout the world (Conover 2002, Hoffman and O'Riain 2011). Human–wildlife conflicts exist in different forms all over the world as humans continue to encroach wildlife habitat (Messmer 2000, Lamarque et al. 2009). Even though all continents and countries, whether developed or developing, are affected by HWC, developing countries are more vulnerable than developed countries due to a heavily dependent economy on subsistent use of natural resources (Fairet 2012).

Increasing HWCs are among the most important threats to the survival of many wildlife species and are a cause for increasing failure of wildlife conservation practice in the world (Madden 2008). These conflicts are becoming more prevalent as human populations increase and the resulting changes in land use related to development and expansion result in wildlife habitat loss or fragmentation (Waweru and Oleleboo 2013). By identifying the potential for HWCs, managers may implement actions or strategies that may mitigate their impacts on both humans and wildlife. When the solutions implemented to resolve HWCs are not effective, local community support for conservation will decline (Waweru and Oleleboo 2013).

Ethiopia has a large number of wildlife species with diverse ecology and unique environmental conditions (Yalden et al. 1984). However, wildlife habitats have been degraded, fragmented, and lost in most parts of the country, and the wildlife species are largely restricted over few protected areas (Kumsa and Bekele 2008). Almost all protected areas in Ethiopia are surrounded by agricultural landscape, whereby there is an immediate contact between the wildlife species and the people (Kumsa and Bekele 2008). This in turn escalates HWCs. These HWCs disproportionally, negatively affect marginal communities through loss of access to livelihood resources such as crops and

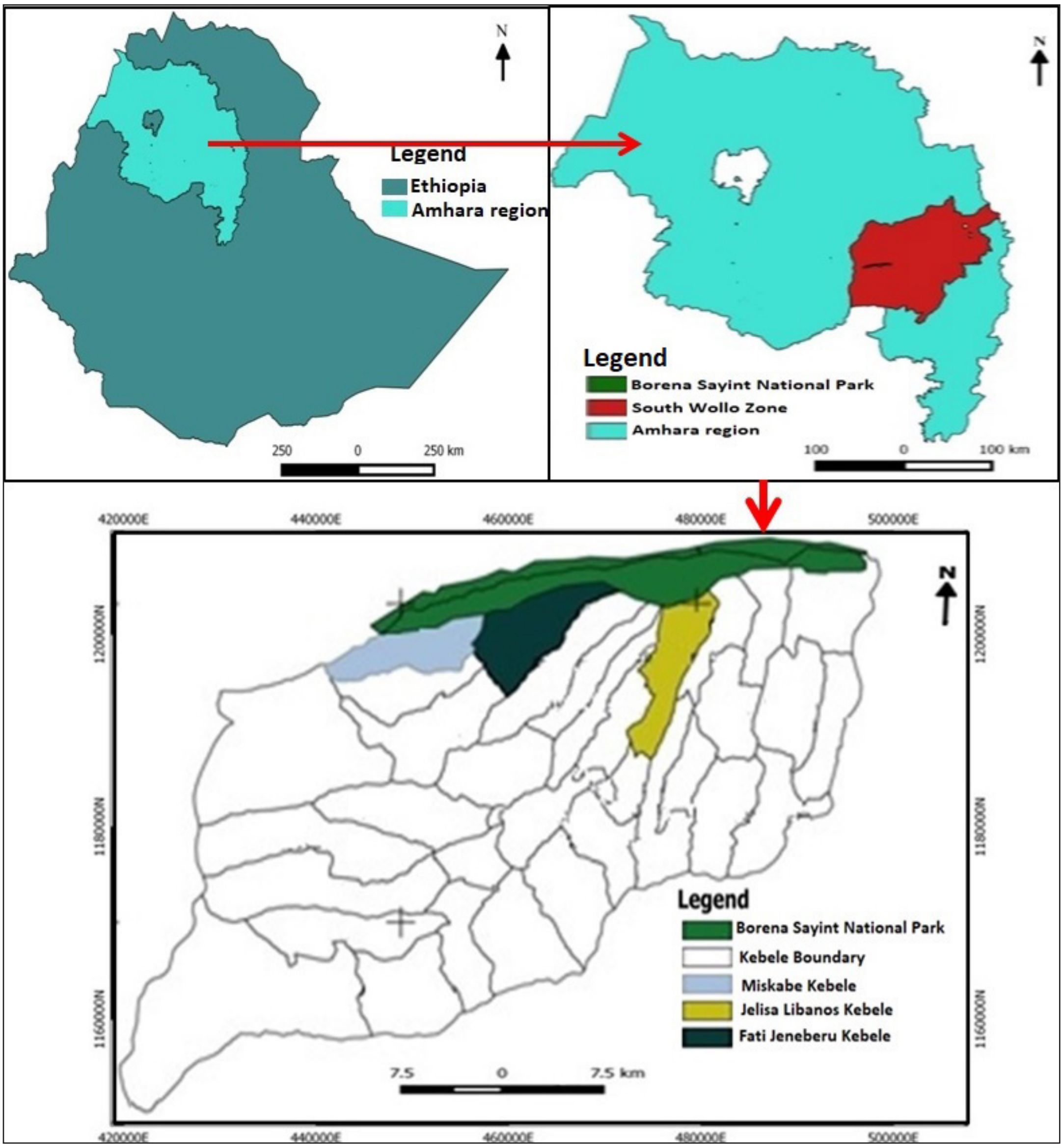


**Figure 1.** Location of the Borena Sayint National Park, Ethiopia.

domestic animals (Colchester 2004, Lockwood 2006, West et al. 2006) and may lead to an increased negative impact on wildlife due to retaliatory killing by the people.

For HWCs to be effectively mitigated, there is a need for better information regarding their magnitude and acceptable strategies that could promote coexistence through balancing both human and wildlife needs (Newmark et al. 1993, Messmer 2000, Gemechu et al. 2014). This information must include accurate documentation of data on causes, types, distribution, impacts, stakeholder perceptions of these impacts, and possible solutions.

In Ethiopia, published HWC case studies (Demeke 2010, Yirga and Bauer 2010, Datiko and Bekele 2013), are limited to some localities. Because wildlife diversity varies across habitat types (Yalden et al. 1984), those species that are considered crop raiders and livestock depredators could vary from locality to locality (Yirga and Bauer 2010). Concomitantly, because other factors such as local community economic activity and wildlife habitat quality also vary from region to region and locality to locality, stakeholder perceptions of the HWCs may differ (Rao et al. 2000). Traditional conflict management options could be unique among societies and localities due to uniqueness in wildlife species, economic activity, wildlife habitat conditions, and cultural conditions of a particular society (Hariohay and Røskaft 2015).

To enhance the mitigation of HWC impacts, there is a need to compile case-specific studies at various localities around the world (Messmer 2000, Food and Agricultural Organization [FAO] 2009). These case studies may help describe the best scenarios and experiences to solve similar problems elsewhere in the world and lead to the development of holistic models that could sustainably mitigate HWCs globally.

Our paper attempts to add to this body of knowledge by describing the causes, impacts, and management options of HWCs in and around Borena Sayint National Park (BSNP) in Ethiopia. Therefore, the aim of the study was ultimately to contribute to improving human–wildlife interactions by resolving HWCs.

## Study area

Borena Sayint National Park is located in the South Wollo Zone of Amhara National Regional State, Northern Ethiopia (Figure 1). The park is situated between 10° 50′ 45.4″ and 10° 53′ 58.3″ N latitude and between 38° 40′ 28.4″ and 38° 54′ 49″ E longitude. The park is in the inter-boundary regions of 3 woredas (districts), namely Borena, Sayint, and Mehal Sayint. The area is characterized by bimodal rainfall distribution with a long rainy season from June to September and a minor rainy season from March to April (Ethiopian National Metrological Service Agency [ENMSA] 2010). The mean monthly rainfall of the area varies from 9.50–235.70 mm (ENMSA 2010). The mean monthly maximum temperature ranges between 17.8°C (August) to 24.4°C (March), whereas the mean monthly minimum temperature ranges between 9.5°C (November) to 11.8°C (May; ENMSA 2010). The altitude of the area ranges from 1,900–3,699 m above sea level.

The BSNP is a home to 44 species of mammals, including the endemic gelada baboon (*Theropithecus gelada*), Ethiopian wolf (*Canis simensis*), and Menilk's bushbuck (*Traglaphus scriptus meneliki*; Chane and Yirga 2014), as well as 232 species of birds (Marino 2003). The area encompasses 3 vegetation zones: (1) Afro-montane belt (1,900–3,000 m above sea level) dominated by African juniper (*Juniperous procera*), African redwood (*Hagenia abyssinica*), and curry bush (*Hypericum revolutum*); (2) Sub-afro-alpine belt (3,000–3,200 m above sea level) dominated by tree heath (*Erica arborea*); and (3) Afro-alpine belt (>3200 m above sea level) dominated by everlasting flower (*Helichrysum* spp.) and common lady's mantle (*Alchemilla* spp.; Chane and Yirga 2014).

Cultivation of crops and livestock rearing are the dominant economic activities in the area (Asfaw 2014). Farmers cultivate cereal crops such as barley (*Hordeum vulgare*), wheat (*Triticum aestivum*), teff (*Eragrostis tef*), lentils (*Lens culinaris*), sorghum (*Sorghum bicolor*), beans (*Faba vulgaris*), and peas (*Pisum sativum*) during wet season and potato (*Solanum tuberosum*), maize (*Zea mays*), and onion (*Allium cepa*) during the dry season through irrigation. The communities have a high number of livestock due to their importance for milk production, land plowing, and food (Chane 2010). The average number of livestock head per household is 8.6 (Chane 2010). The local farmers predominantly cut grass, mainly Fistuca grass (*Festuca abyssinica*), to use as fodder for their cattle, to thatch their houses, and to earn some money by selling it in the local market. The woreda bordering the park supports a high population of humans. According to the Federal Democratic Republic of Ethiopia Central Statistical Agency (2007), the population of Borena woreda (borders the largest extent of the park) was 158,920.

## Methods

### Sampling design

We selected 3 kebeles (Fati Jeneberu, Miskabe, and Jelisa Libanos) to conduct our study. These kebeles were selected based on their proximity to the BSNP, existence of human–wildlife conflict, and accessibility out of the total 13 kebeles (smallest administrative region) found in and around BSNP (Figure 1). Based on the proximity to BSNP, we stratified villages in each kebele as near (<0.5 km), medium (0.5–1 km), and far (>1 km). Within each stratum, we selected 1 village per kebele. Hence, 9 villages were systematically selected and subject to the study. We determined the total number of households that were sampled in each kebele using the formula given by Cochran (1977), cited in Bartlett et al. (2001):

$$No = \frac{Z^2 * (P)(Q)}{d^2} \Longrightarrow n_1 = \frac{no}{(1+no/N)}$$

where No = desired sample size (Cochran 1977) when population was >10,000; $n_1$ = finite population correction factors when population was <10,000; Z = standard normal deviation, which is 1.96 for 95% confidence level; *P* = proportion of population to be included in the sample that was 10%; Q = 1-P (90%); N = total number of population; d = degree of accuracy desired (5%).

The populations in Fati Jeneberu, Miskabe, and Jelisa Libanos were 895, 804, and 921 respectively. Using the formula from Cochran (1977), we calculated a sample size of 132 households from the total population of 2,620. From the total number of households calculated, we proportionally distributed the number of households sampled in each kebele. Accordingly, 45, 41, and 46 sample households were selected from Fati Jeneberu, Miskabe, and Jelisa Libanos, respectively.

We categorized households of selected villages as rich, intermediate (medium), and poor based on local classification. Based on this classification, rich households have a total livestock unit of >5.5, medium households have a total livestock unit of 3.5–5.5, and poor households have a total livestock unit of <3.5. From each wealth class, we determined the proportion of female and male respondents and sampled based on their proportion.

## Data collection

We collected data from December 2016 to February 2017. Prior to the data collection, we obtained permission from the BSNP authorities and local administrative offices to conduct the research. We explained that the research was intended only to gather genuine relevant information to help in supporting the wildlife conservation effort of the BSNP through balancing the need of the people and wildlife.

We employed structured and semi-structured interviews, focus group discussion, direct observation, and secondary data collection to investigate human–wildlife conflict in BSNP following Anderson and Pariela (2005). We also requested the consent of respondents to participate in the household interview, and only voluntary respondents were interviewed. We collected quantitative data through structured (close-ended) and semi-structured (open-ended) questionnaire interviews (house to house survey) and qualitative data through focus group discussion and key informant interviews. We designed the questionnaire to assess the cause, impact, and traditional control measures of HWCs in the study area.

To complement the household survey, we collected basic qualitative (descriptive) information through a series of focus group discussions. We conducted a total of 4 focus group discussions following The Health Communication Unit (THCU; 2002). We selected discussants based on their knowledge about wildlife resources and duration of stay in the area. We conducted 3 of the focus group discussions with kebele administrators, youth and women representatives, elders, and religious leaders in each kebele separately. We held 1 focus group discussion with agricultural extension workers and wildlife experts of the park. In focus group discussions held in kebeles, 10 participants were involved, while 8 participants were involved in the focus group discussions with experts.

We selected 10 key informants based on their field of work, experience, and age. Key informants were park personnel, wildlife and forest experts, woreda agricultural office leaders, kebele administrators, woreda natural resource protection authorities, and elders in consultation with woreda and kebele administrators. This enabled us to obtain qualitative data through in-depth interviews and discussions with each respondent using an unstructured questionnaire. We conducted all interviews and focus group discussions in a local language, Amharigna. Furthermore, we completed direct observations by trekking through the study sites during the day when humans, livestock, and wildlife are active. We performed these observations 9 times, covering major HWC areas during the data collection period.

## Data analysis

We used SPSS version 16.0 computer software to analyze data. We used descriptive statistic in a form of percentage and frequency to analyze

**Table 1.** Respondents' perception about causes of human–wildlife conflict across villages bordering Borena Sayint National Park, Ethiopia, 2016–2017.

| Village | Number of respondents | | | | |
|---|---|---|---|---|---|
| | Increase in wild animal population | Human proximity to park | Subsistence agriculture expansion | Habitat disturbance | Total |
| Quranchle | 7 | 7 | 1 | 0 | 15 |
| Bode | 7 | 3 | 6 | 0 | 16 |
| Cheleleka | 6 | 7 | 1 | 1 | 15 |
| Alemtena | 7 | 4 | 1 | 1 | 13 |
| Gundbay | 6 | 4 | 3 | 1 | 14 |
| Kebena | 6 | 5 | 2 | 1 | 14 |
| Total | 39 | 30 | 14 | 4 | 87 |

**Table 2.** Crop loss and livestock attack by crop raiders and livestock depredators across villages bordering Borena Sayint National Park, Ethiopia, 2016–2017.

| Village | Damages (%) | | |
|---|---|---|---|
| | Crop loss and livestock attack | Crop loss | Livestock depredation |
| Quranchle | 86.7 | 6.7 | 6.7 |
| Bode | 87.5 | 12.5 | 0.0 |
| Cheleleka | 33.3 | 20.0 | 46.7 |
| Alemtena | 84.6 | 7.7 | 7.7 |
| Gundbay | 100.0 | 0.0 | 0.0 |
| Kebena | 92.9 | 7.1 | 0.0 |
| Seka Gobena | 100.0 | 0.0 | 0.0 |
| Lega Gora | 86.7 | 0.0 | 13.3 |
| Dabo Grar | 100.0 | 0.0 | 0.0 |
| Average | 85.6 | 6.1 | 8.3 |

socioeconomic profiles of the respondents. We compared responses of respondents about causes of HWCs and identification of crop raider and livestock predator wildlife species using a chi-square test. We also performed a chi-square test on selected variables including impacts of HWCs on wildlife and traditional control measures employed in the area at alpha level 0.05. We carried out a multi-linear regression test to predict crop loss in terms of cost based on factors like sex, age, family size, wealth status, distance of villages from the park boundary, land size, and marital status at alpha level 0.05. Predicted cost due to crop loss was equal to Y – distance of households from the park boundary – sex + family size, where distance from the park was coded as 22 = near, 23 = medium, and 25 = far; sex was coded as 1 = male, 2 = female; family size was coded as 25 = 1_3, 26 = 4_6, and 27 = >6; and Y = the cost of crop lost. Similarly, we carried out a multi-linear regression test to predict depredated livestock units based on factors like sex, age, family size, wealth status, and distance of villages from the park boundary. Predicted loss due to livestock depredation was equal to X – land size – distance from the park boundary, where land size was coded as 28 = 1 ha, 29 = 2–3 ha, 30 = 4–5 ha; distance from the park was coded as 22 = near, 23 = medium, and 24 = far; and X is equal to cost of livestock loss. The amount of crop loss was converted to costs by multiplying with the average local market price of each crop. Similarly, the amount of

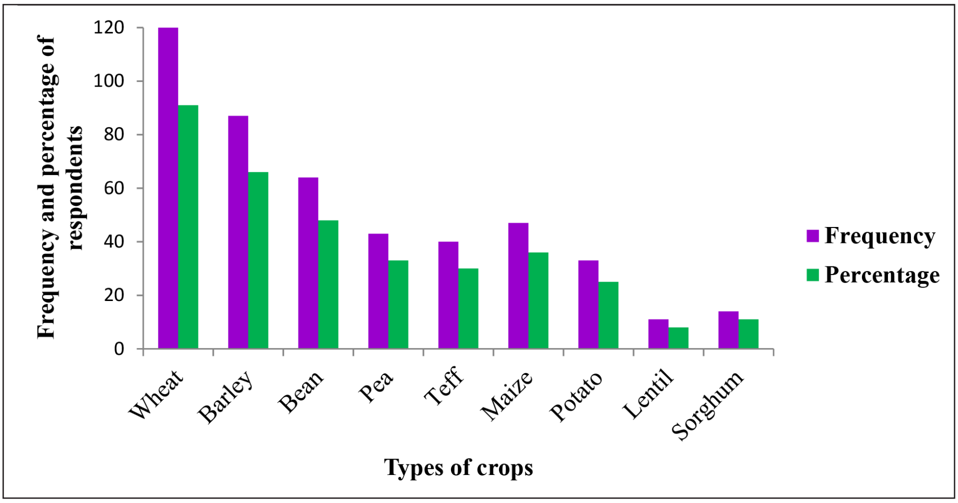


**Figure 2.** Frequency and percentage of crops damaged by crop raider wildlife species around Borena Sayint National Park, Ethiopia, 2016–2017.

livestock loss due to depredation was converted to costs by multiplying with the average local market price of each livestock type.

The crop loss and livestock kills have been estimated using information obtained from Borena Woreda Agricultural Office ([BWAO] 2016, unpublished data). According to BWAO (2016), the average costs of cereals per quintal (100 kg) in the locality, in U.S. currency, were: maize ($19), teff ($52), barley ($17), bean ($52), potato ($9), pea ($54), and wheat ($24). On the other hand, the average costs of adult livestock in the local market were: cow (*Bos taurus*; $167), goat (*Capra aegagrus*; $59), sheep (*Ovis aries*; $67), donkey (*Equus asinus*; $148), and ox (*Bos taurus*; $333). Note that $1 in U.S. currency is equal to 27 Ethiopian birr.

## Results

We interviewed 132 people. Most of the respondents (74%) were males, married (73%), illiterate (53%), and owned <1 ha (68%). Thirty-nine (30%) of the respondents own a land size of 2–3 ha. Based on the local wealth status classification, about half (49%) of the respondents were considered poor. The main causes of HWCs in the BSNP were reported to be an increase in the number of wildlife populations and human proximity to the BSNP (Table 1). The reported causes across villages did not differ ($\chi^2_{24} = 18.02$, $P = 0.09$).

Ten wildlife species were reported by the local respondents as crop raiders and/or livestock predators. These were: gelada baboon (*Theropithecus gelada*), leopard (*Panthera pardus*), spotted hyena (*Crocuta crocuta)*, common jackal *(Canis aureus*), grivet monkey (*Cercopethicus aethiops*), crested porcupine (*Hystrix cristata*), common duiker (*Silvicapra grimmia*), starck's hare (*Lepus starckii*), klipspringer (*Oreotragus oreotragus*), and rock hyrax (*Procavia capensis*). All of the respondents perceived the endemic gelada baboon, leopard (130 respondents; 99%), and crested porcupine (122 respondents; 92%) as major problematic wildlife species.

Most of the respondents (113; 86%), reported both crop losses and domestic animal depredations due to nuisance wildlife species. All respondents in Gundbay, Seka Gobena, and Dabo Grar villages reported both crop loss and livestock attacks (Table 2).

The type of damages caused by wildlife differed across villages ($\chi^2_{16} = 48.65$, $P \leq 0.001$). Focus group discussants also noted human injury as an impact of HWC in the area. Wheat, barley, and bean were the most frequently raided crops, while lentils and sorghum were the least raided crops by raiders (Figure 2).

Family size, sex, and proximity to the BSNP were significant predictors of crop loss ($P$ = 0.05, 0.04, and 0.04, respectively). Crop losses at villages closer to the BSNP were on average $12 greater than the crop loss costs of households at medium distance villages from the park. Also, the losses reported by male household heads were on average $12.60 greater than female.

**Table 3.** Livestock depredations over the last 5 years across villages bordering Borena Sayint National Park, Ethiopia, 2016–2017.

| | Livestock | | | | |
|---|---|---|---|---|---|
| Villages | Cow | Goat | Sheep | Donkey | Total |
| Quranchle | 2 | 28 | 47 | 4 | 81 |
| Bode | 0 | 18 | 34 | 0 | 52 |
| Cheleleka | 0 | 12 | 32 | 0 | 44 |
| Alemtena | 2 | 23 | 11 | 1 | 37 |
| Gundbay | 0 | 17 | 5 | 1 | 23 |
| Kebena | 0 | 29 | 9 | 0 | 38 |
| Seka Gobena | 0 | 71 | 76 | 0 | 147 |
| Dabo Grar | 0 | 22 | 24 | 0 | 46 |
| Lega Gora | 0 | 18 | 24 | 1 | 43 |
| Total | 4 | 238 | 262 | 7 | 511 |
| Percentage | 0.78 | 46.58 | 51.27 | 1.37 | |

Moreover, the crop damage losses estimated by household heads increased by $11.90 when family sizes increase from 1–3 to 4–6 people.

One hundred twenty-four respondents (94%) reported livestock depredation by wildlife species. In the 5 years previous to the study, respondents reported losing 511 livestock heads. These losses included 262 cattle, 238 sheep, 7 goats, and 4 donkeys, respectively (Table 3). The highest numbers of livestock depredations were reported in Seka Gobena and the lowest in Gundbay villages (Table 3).

Distance of households from the BSNP boundaries ($P \leq 0.001$) and private land size available for livestock grazing ($P = 0.05$) predicted livestock depredation risks. Depredated total livestock units near the park were higher by a factor of 0.25 livestock units than depredation in medium distances. In terms of land size, the rate of depredation was 0.16 times higher in owners of 1 ha than 2–3 ha. Furthermore, focus group discussion and key informant interviews reported human injuries in the study area. They reported that 7 humans were attacked by leopards from 1999 to 2009 in an attempt to guard their livestock from attack.

## Response to HWCs

In response to livestock depredation and crop loss, retaliatory killing of wildlife species has been reported in the area. Respondents in Gundbay reported the highest incidence of retaliatory killing (Figure 3). Statistically, retaliatory killing of wildlife differed among villages ($\chi^2_8 = 71.75$, $P \leq 0.008$). Focus group discussants also pointed out 2 leopards were killed in the last 10 years.

Among several socioeconomic, demographic, and economic variables affecting the attitude of respondents, sex and marital status were the major factors responsible for negative attitudes toward wildlife conservation in the area (Table 4). There was an association between attitude and gender ($\chi^2_1 = 7.77$, $P = 0.04$) and marital status ($\chi^2_1 = 7.99$, $P = 0.03$).

Farmers utilized several methods to keep their farm and livestock from damage by wildlife in the study area. These measures taken to minimize crop damage were guarding (watching, dog), chasing, physical barrier (walls and fence), and chasing and scarecrow (Table 5). The number of respondents who reported guarding as an effective control measure to minimize crop damage was highest in Gundbay (85; 64 %) and lowest in Cheleleka (53; 40%). Most of the respondents (75; 57 %) also reported guarding as the most effective method in minimizing livestock depredation. A considerable number of respondents (57; 43 %) reported building a barn/caw shed as an effective method of minimizing livestock depredation (Table 5).

# Discussion

Local community perceptions about wildlife population increase could be due to the

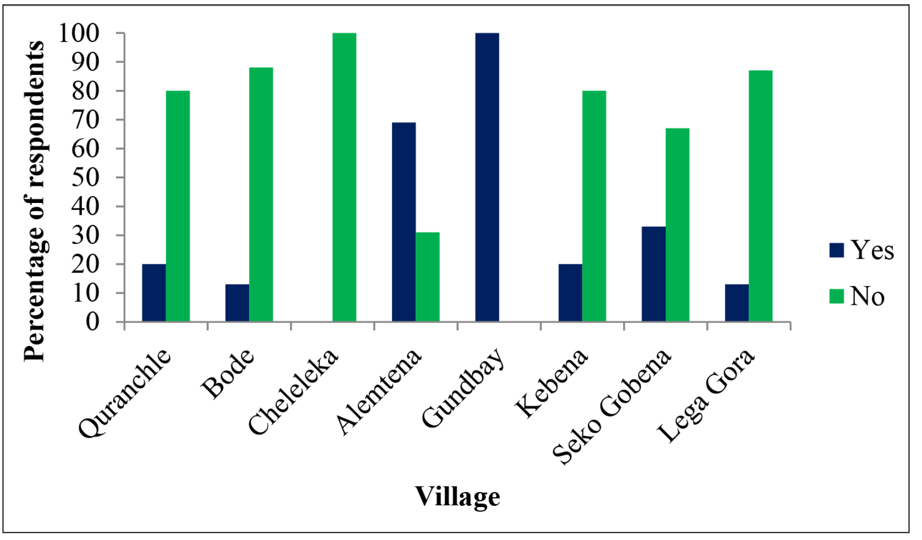


**Figure 3.** Retaliatory killing of wildlife species among villages around Borena Sayint National Park, Ethiopia, 2016–2017.

establishment of the BSNP, which has reduced poaching and wildlife habitat threats such as livestock grazing and deforestation (Chane and Yirga 2014). This in turn could increase wildlife numbers through improving the quality of the wildlife habitat in terms of food, cover, and water (Yazezew et al. 2011). Similar studies elsewhere in Africa and Ethiopia have witnessed the establishment of protected areas such as national parks and wildlife reserves to increase wildlife abundance (Deboer and Baquete 1998, Yihune et al. 2009, Kala and Kothari 2013, Issa 2015, Leta et al. 2016). On the other hand, the increased number of wildlife could lead to resource scarcity and result in competition between humans and wildlife. Wildlife resource scarcity, forage of herbivores, and natural prey for predators could force the wildlife species to raid crops and depredate livestock, inflicting human–wildlife conflicts.

Human proximity to park areas has been perceived to be the major causes of HWCs (Woodroffe et al. 2005). Since the livelihood of the local community is dependent on subsistence agriculture and extractive use of forest resources, the people living in close proximity to the BSNP overlap with the needs of wildlife. Humans utilize the park for grazing and water source grounds, which in turn reduces the foraging opportunities and access to water sources for wildlife species and increases disturbance to wildlife leading to human–wildlife conflict. Human proximity to park areas increases the interaction of people and carnivores, which may trail human attack or death by wildlife. Studies elsewhere in the world have reported the same findings (Woodroffe et al. 2005, Yigrem et al. 2016).

Crop damages perhaps are viewed seriously in the communities because agricultural practices are the major source of income for most households. This is in line with Rao et al. (2000), who reported that crop losses are serious for farmers who mainly depend on agricultural practices and were found to be the major cause for HWC. Similar findings have been reported in Ethiopia (Abie and Bekele 2016, Leta et al. 2016).

The top ranking of gelada baboon as most problematic wildlife species could be due to its omnivores feeding behavior and its wide range of distribution in the area. Sillero-Zubiri and Switzer (2001) reported gelada baboon as omnivorous species that take a whole range and diversity of foods including many crop species and livestock. The endemic gelada baboon has been reported to cause crop loss and occasionally to depredate on livestock throughout its range (Abie and Bekele 2016). Generally, primates have been widely cited in literature as notorious crop raiders (Hoffman and O'Riain 2011, Fairet 2012, Abie and Bekele 2016, Alelign and Yonas 2017). Grivet monkeys in particular have been reported to cause group damage on an average 83.8 kg/ha per year

**Table 4.** Attitude of respondents toward wildlife conservation among demographic, socioeconomic and proximity to the park variables around Borena Sayint National Park, Ethiopia, 2016–2017.

| Variables | Attitude | | | |
|---|---|---|---|---|
| | *n* | df | $\chi^2$ | *P*-value |
| Sex | | | | |
| Male | 98 | 1 | 7.765 | 0.005* |
| Female | 34 | | | |
| Family size | | | | |
| 1–3 people | 60 | | | |
| 4–6 people | 55 | 2 | 2.428 | 0.297 |
| >6 people | 17 | | | |
| Distance from park | | | | |
| Closest | 36 | | | |
| Medium | 46 | 2 | 3.477 | 0.176 |
| Far | 50 | | | |
| Age | | | | |
| 18–30 | 5 | | | |
| 31–45 | 62 | 2 | 2.519 | 0.284 |
| >45 | 65 | | | |
| Marital status | | | | |
| Married | 96 | | | |
| Divorced | 23 | 2 | 7.995 | 0.018* |
| Widowed | 13 | | | |
| Land size | | | | |
| 1 ha | 90 | | | |
| 2–3 ha | 39 | 2 | 0.609 | 0.738 |
| >3 ha | 3 | | | |
| Wealth status | | | | |
| Rich | 33 | | | |
| Medium | 34 | 2 | 1.474 | 0.479 |
| Poor | 65 | | | |

*Significance at 95% confidence interval

around church forest in the northern highlands of Ethiopia (Alelign and Yonas 2017). As a result, most of the local communities have negative perceptions about grivet monkeys, and the local community would like to kill them as a measure to reduce crop damage (Alelign and Yonas 2017).

The perception of respondents toward leopards being among the major problematic wildlife species could be due to its livestock depredation beha-vior and threatening human life. Leopards may cause a wide range of damages on human property and injure and kill humans (Yirga et al. 2013). Leopards have been frequently cited among the top livestock predators wherever its range overlaps with livestock (Ogada et al. 2003, Yirga et al. 2013).

The highest crop damage incidence in proximity households was probably attributed to the absence of a buffer zone between the park and farmlands. The absence of a buffer zone could increase the contact between the farmlands and wildlife, increasing the susceptibility of crop damage. Similar studies elsewhere in the world have revealed that local communities residing in close proximity are more susceptible to crop damage than the ones living far from protected areas (Plumptre et al. 1997, Woodroffe et al. 2005, Hofman-Kamińska and Kowalczyk 2012, Hariohay and Røskaft 2015, Alelign and Yonas 2017).

The difference in number of livestock depredation among villages could be due to the difference in village proximity to the national park (Miller et al. 2016). The number of livestock increased in close-proximity villages probably due to availability of water and free grazing land. This in turn provides readily available alternative prey for predator wildlife species. The wild natural herbivore prey could also decrease in number in response to the increased number of livestock, due to rangeland competition (Graham et al. 2005). As a result, livestock depredation could increase due to scarcity of wild prey available in the area. Particularly, livestock could be more vulnerable to predators due to their

**Table 5.** Traditional control measures taken to minimize crop damage by wildlife across different villages around Borena Sayint National Park, Ethiopia, 2016–2017.

| Village | Crop protection methods in % | | | |
|---|---|---|---|---|
| | Guarding | Chasing | Physical barrier | Chasing and scarecrow |
| Quranchle | 53.3 | 13.3 | 13.3 | 20.0 |
| Bode | 62.5 | 6.2 | 12.5 | 18.8 |
| Cheleleka | 40.0 | 13.3 | 20.0 | 26.7 |
| Alemtena | 46.2 | 7.7 | 15.4 | 18.7 |
| Gundbay | 64.3 | 14.3 | 0.0 | 21.4 |
| Kebena | 57.1 | 7.1 | 7.1 | 28.7 |
| Seka Gobena | 46.7 | 20.0 | 13.3 | 20.0 |
| Lega Gora | 60.0 | 13.3 | 20.0 | 6.7 |
| Dabo Grar | 53.3 | 6.7 | 13.3 | 26.7 |
| Average | 53.8 | 11.4 | 12.9 | 22.0 |

passive behavior to escape from predators than that of wild herbivores (natural prey), which have evolutionary acquired anti-predator mechanisms against natural predators (Patterson et al. 2004).

Retaliatory killing of wildlife species could be due to the absence of damage registration and lack of compensation schemes. A person who loses livestock, crops, or a family member due to wildlife may kill wildlife intentionally. For instance, the local community around a church forest in the northern Ethiopian highlands reported that it would like to employ retaliatory killing against grivet monkeys as a response to severe crop damage or would like to be compensated for the lost crops (Alelign and Yonas 2017). Alemayehu and Mathewos (2015) reported retaliatory killing of 2 lions (*Panthera leo*), 2 leopards, and 6 spotted hyenas by local communities around Chebera-Churchura National Park, southern Ethiopia, as a response to livestock depredation. Furthermore, species like the leopard could be killed due to their fear-inducing behavior to attack humans during livestock guarding (FAO 2009, Yirga et al. 2013).

Most households in Seka Gobena had negative attitudes toward wildlife conservation. The negative attitude of some respondents toward wildlife conservation could be due to livestock depredation, crop damage, and land deprivation for park establishment (Omondi 1994, Muruthi 2005, Malede and Girma 2015). However, despite the costs of living with wildlife, some communities have retained a positive attitude toward conservation (Newmark et al. 1993). This could be due to their awareness about the values of wildlife conservation. The local community reported that they have been aware about the values of wildlife conservation and the need to coexist with wildlife by the park authority, though an awareness campaign was limited and the level of awareness was not uniform among community members.

Positive attitudes of communities toward wildlife conservation might also be due to benefits that the local communities received from wildlife (DeBoer and Baquete 1998, West et al. 2006, Kideghesho et al. 2007). Most of the local communities reported that they benefit from the conservation of wildlife resources such as ecotourism activities. For example, local community members serve as tour guide, rent horses, and also serve as scouts of the park, though the ecotourism activity is limited. People who benefit from wildlife have more positive attitudes toward wildlife conservation than people who do not receive any benefits (Kideghesho et al. 2007, Asfaw 2010).

Guarding and building sheds were reported as effective measures to reduce livestock depredation. This was in line with studies conducted in Africa (FAO 2009), which reported that guarding livestock herds and taking steps to actively defend livestock from predators reduces the rate of depredation. Guarding livestock herds and keeping livestock in enclosures (sheds), especially during the night, was a common method in minimizing livestock depredation in Northern Tanzania (Hariohay and Røskaft 2015). Building livestock enclosures (sheds) was the most common strategy used to prevent livestock depredation in the Serengeti ecosystem (Angela et al. 2013). Studies conducted in Chebera Churchura National Park, Ethiopia also reported guarding as the major measure taken to reduce livestock depredation (Datiko and Bekele 2013).

## Management implications

The HWCs in and around BSNP were manifested through crop damage, livestock loss, and human injury. Increased wildlife population was perceived as a main cause of HWCs. The impact of HWCs on wildlife was retaliatory killing and enhancement of negative attitude toward conservation of wildlife in the area. Guarding was the most traditional control measure used to minimize crop damage and livestock depredation.

To better manage HWCs in the BSNP, it will be important to promote traditional management skills such as intensive human vigilance, guarding animals, and fencing integrating with related modern techniques through training the local community. It is also important to improve land use planning by effectively zoning the protected area (e.g., establishment of a buffer zone) and increase alternative crops, prey, and water points from an environmental management point of view.

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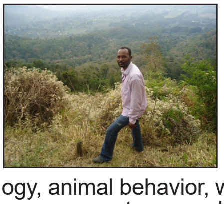

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