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International Journal of Biodiversity andConservation

August 2019
ISSN 2141-243X
DOI: 10.5897/IJBC
www.academicjournals.org

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Vol. 11(8), pp. 212-229, August 2019
DOI: 10.5897/IJBC2019.1314
Article Number: 680069661780
ISSN 2141-243X

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International Journal of Biodiversity and Conservation

Full Length Research Paper

Human-wildlife conflict around Midre-Kebid Abo Monastry, Gurage Zone, Southwest Ethiopia

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Received 9 July, 2019; Accepted 13 August, 2019

This human-wildlife conflict study was carried out around Midre-Kebid Abo Monastry. A descriptive survey design method was used and both qualitative and quantitative data were collected using questionnaires. Field experiment was carried out on two selected crops - maize and enset, to estimate crop damage by wild animals. Resource competition (46%), increased wildlife population (42.5%) and livestock populations (11.5%) were the major causes of conflict identified in the area. Wheat and maize were the most affected crops in the area with an estimate loss of 155.29 ± 12/kg/year and 106.15±12.3/kg/year, respectively. The average loss of enset obtained from estimation of 0.36 ha in four counts was 36 kg. On the other hand, the average loss of maize from estimation of 0.12 ha in four counts was 48 cobs (9.6 kg). Therefore, estimated damage based on the total coverage of enset (32 ha) and maize (42 ha) has become 3200 and 3360 kg, respectively. The most known problematic wild animals in the study area were apes (86.2%) followed by monkey (71.3%) and hyena (56.3%). Albeit there is an intense human-wildlife conflict in the study area, majority of the respondents (64.5%) have positive perception towards wildlife conservation. Different crop/livestock protection mechanisms, including guarding, chasing, hunting, fencing, cooperative guarding, guarding using dogs, trapping and scarecrow are used by the local community. The use unpalatable crops as buffer crops enforce environment and forest related laws and local government engagement in creating awareness about wildlife conservation and compensatory schemes are important to lessen the problem.

Key words: Crop loss, Human-Wildlife Conflict, Midre-kebid Monastery.

INTRODUCTION

Human-wildlife conflict is any interaction where there is an overlap between wildlife needs and human needs that resulted in costs to residents and wild animals (World Park Congress, 2003). It is a rising global problem, which is not restricted to particular geographical regions or climatic conditions, but it is common to all areas where wildlife and human populations co-exist and share limited resources (Emmanuel and Furaha, 2016). Direct contact with wildlife occurs in both urban and rural areas, but it is more common in rural areas where wildlife population density is higher. The major reasons for the occurrence of human wildlife conflict

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include: Human population growth, land use transformation, species habitat loss, degradation and fragmentation, growing interest in ecotourism, increasing livestock population and competitive exclusion of wild herbivores and increasing wildlife population (Decker et al., 2002).

Human-wildlife conflict lessens human welfare, health and safety and has economic and social costs. The economic costs are manifested through destruction and damage to property and infrastructure. Social destruction occurs when family members guard crops from crop raider animals that separate families, because males are involved guarding at night and school children during the day, thus preventing them from going to school as they engage in guarding (Griffths and Southery, 1995). On the other scenario, human-wildlife conflict ranked among the main threats of biodiversity conservation as species most exposed to conflict are more vulnerable to extinction (Ogada et al., 2003).

Human-wildlife conflict exists in different forms all over the world and is more experienced in developing countries (Leta et al., 2016). Crop raiding and livestock depredation are not a new phenomenon; they have most likely been occurring since humans had started practicing agriculture. Different crops and livestocks are targeted by marauding animals. In some areas, crop raiding by wild animals is a frequent cause of major conflict between wildlife and villagers. This is especially true in areas close to protected areas, which harbor large populations of wildlife (Sukumar, 1989). Similar to most developing nations, in Ethiopia, conflict between human and wildlife is a common concern in different parts of the country where people depend on agriculture. Much prior research that has been carried out by different scholars also verified this concern (Bezihalem et al., 2016; Yigrem et al., 2016; Leta et al., 2015, 2016; Muluken, 2014; Reddy and Workneh, 2014; Adem, 2009; Mesele, 2006). In the present study area, agriculture and livestock production are the major sources of livelihood. Maize, wheat, bean, potato and enset are major crops grown in the area. Hence, the local communities are suffering with crop raiders. Different wild animals are known to be involved in crop raiding and livestock depredation, albeit they are not systematically investigated so far. Therefore, conducting scientific investigation about human-wildlife conflict in the area has far reaching importance for the co-existence of both the local community and wildlife.

MATERIALS AND METHODS

Description of the study area

Gurage zone, which is part of the Southern Nations Nationalities and People's Region (SNNPR), is located in the southwest part of Ethiopia. The zone is bounded by Hadiya, Kenbata, Alaba and Tenbaro (KAT) zones in the south and Yem special woreda in southwest. It is also bounded by the Oromia Regional state in the northwest and east (PEDD, 1998). The zone is divided into 13 woredas and two city administrations - Wolkite and Butajira. The total population in the zone is 1,279,646 of which 622,078 are males and 657,568 are females (CSA, 2007). Majority of the people (95%) live in rural areas engaged in agriculture. The remaining 5% live in urban areas (PEDD, 1998).

Sodo woreda is located in the Eastern part of Guraghe zone, at 8°20'46.58" latitude and 38°34'33.83" longitude (Figure 1). It is bounded by Oromia regional state from the northwest and east and meskan woreda (district) from southwest. The main town of sodo woreda is named Buee. It is 103 km from Addis Ababa, 261 km from wolkite and 198 km from Hawassa, According to the last census in 2007, the total population of sodo woreda was 134,683 of which 67,130 were males and 67,553 were females (CSA, 2007). But according to the recent report from Sodo woreda finance and economic development office, the total population is estimated to be 180,263 of which 88,798 are males and 91,465 are females (SWFEDO, 2015). The total area of the woreda is 88,553.3 hectares. Its altitude is between 1800 and 3040 m above sea level and agro-climatically it is classified into Weina-Dega and Dega in which the average temperature ranges between 7.5 and 17.5°C. Majority (93%) of the inhabitants practice an orthodox Christianity faith. The Woreda is primarily inhabited by the Sodo Gurage and a small number of Oromo and Amhara ethnic groups. There are 4 urban and 54 rural kebeles under the district. The rural part of the district includes both highland and lowland kebeles. Moreover, 90.6% of the population is dependent on farming while 9.4% lives in town engaged in different jobs (SNNPR, CSA, 2012).

Midre-kebid Abo Monastery is located 18 km east of Buee. It is a historical and religious place. A big religious ceremony is celebrated twice a year. It is found 2400 meters above sea level. In the monastery compound different plant and animal species are found. According to CSA (2007) report, the total population which lives around Midire-kebid Abo monastery (Sewatina Gedam Kebele) was 1952, of which 971 are males and 981 are females. The total area coverage (including Midire-kebid Abo monastery) is about 1245 ha.

Research design

In this study a descriptive survey design method was used. Both qualitative and quantitative data were collected using questionnaires. Field observation was also used to gather data on crop damage.

Data type and source

During the study both primary and secondary data were used. Primary data was collected from sample households and field observation; whereas, secondary data was collected from office reports, published and/or unpublished articles related to the study and websites. A list of total households for the study villages was obtained from the respective kebele administration.

Sample size and sampling technique

From the total of 5 villages in the study area, 3 villages (Sewati, Geferssa and Wareni with a total household population of 99, 97 and 95, respectively) were randomly selected. Following Gay (1996), a sampling technique for small populations, 30% of the total households (total N = 291) was taken as a sample population (n = 87). Thereafter, an equal number of randomly-selected households (n = 29) were identified from each of the villages by using a systematic random sampling technique ($K = \frac{N}{n}$, where K is the sampling frame, N is the total number of households in the village and n is the sample size allocated in the village).

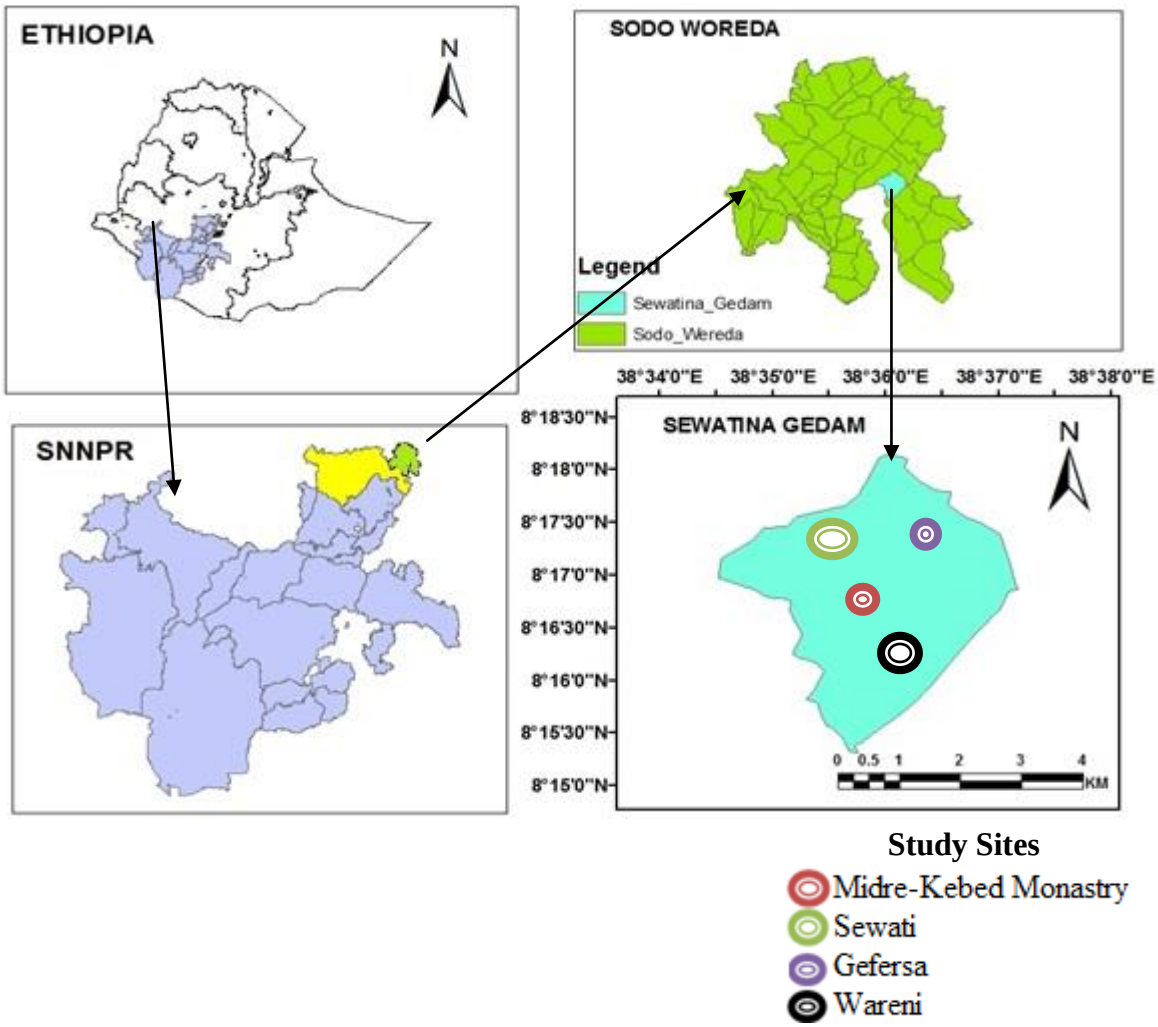

Figure 1. Map of the study area.

Data collection tools

In order to collect both qualitative and quantitative data, questionnaires, interviews and observation were used.

Questionnaire

The questionnaire integrated both closed and open-ended questions. Inconsistencies and/or clarifications in the text were modified based on pre-testing.

Observation

Field observation was carried out to estimate the extent of crop damage by wild animals. Estimation was carried out for two selected crops namely enset and maize. Three sites were selected randomly. For enset a grid was marked in each site with an area of 1200 m^2 (40 m × 30 m). Each grid was further divided into four equal parts (units) with an area of 300 m^2 (0.03 ha). For maize, a grid with an area of 400 m^2 (20 m × 20 m) was marked in each site. Each grid was further divided into two equal parts with an area of 200 m^2 (0.02 ha). Damage estimation was conducted four times during the month of June for enset and maize. The mean damage of each crop was calculated in kg/day. Current market price was used to determine the cost of each crop type 5 Birr/kg and 7 Birr/kg for enset and maize, respectively. Finally, the loss of each type of crop for the study sites (3600 m^2 for enset and 1200 m^2 for maize) was calculated.

Data analysis

Based on the objective of the study and nature of the data collected, different data analysis techniques were employed. Data analysis software – SPSS (Version 21.0) was used. One-way ANOVA was used to compare the mean differences of family size, farm land holding, annual crop production, owning of livestock, owning of private grazing land, loss of maize, wheat, bean, potato and enset between villages. Non-parametric statistics (one sample) was used to compare responses about causes of human-wildlife conflict and the problems caused by wildlife in each village and the study area. Non-parametric statistics (related samples) was also used to compare differences in respondents attitude between villages towards wildlife conservation. Graphs, tables and figures

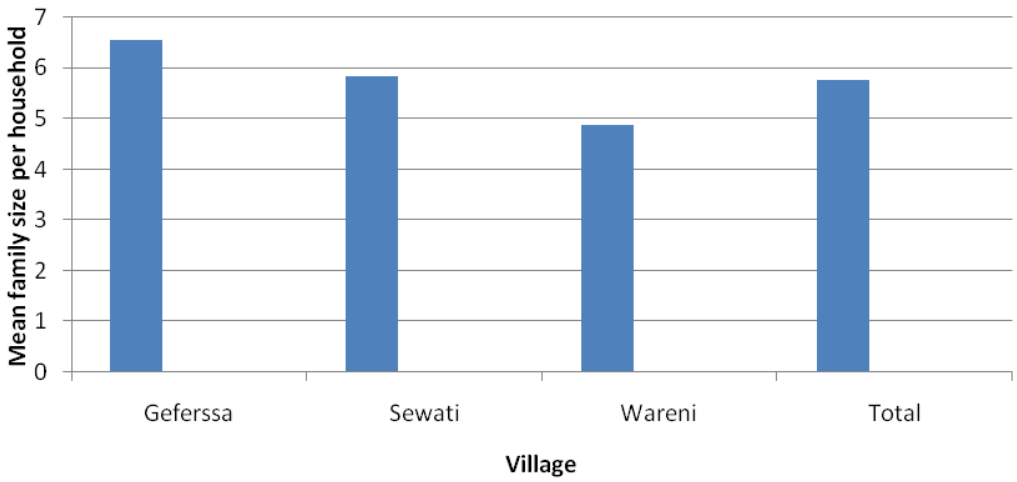

Figure 2. Mean family size per household.

Table 1. Educational level of respondents.

Village	Have no formal education (%)	Primary education (%)	Secondary education (%)	College/university education (%)
Geferssa	48.3	51.7	0	0
Sewati	58.6	41.4	0	0
Wareni	48.3	51.7	0	0
Total	**51.7**	**48.3**	**0**	**0**

were used to summarize and present the data.

RESULTS

Socio-demographic profile

A majority (47.13%) of the respondents were in the age category between 21 and 40. The age categories of 41-61 and above 60 were also represented by 37.93 and 14.94% of the total respondents, respectively. No respondents of age category below 20 were found. With regard to the gender composition of respondents involved in the study, of the total 87 respondents, 86.2% (n = 75) were males whereas 13.8% (n = 12) were females. The marital status of the respondents was categorized into four – married, single, divorced and widowed. Thus, most of the respondents (93.1%) were married and only 6.9% of the total respondents were found to be bachelor. Divorced and widowed respondents were not present in the sample population.

Family size of respondents ranged between 2 to 12 per household in the study area. Average family size was 5.77 (± 0.23). The mean number of family size varied across villages. For instance, there was a significant difference in the mean of family size between sewati and wareni ($F= 6.84$, $df = 6, 22$, $p< 0.05$) (Figure 2).

Concerning the educational level of the respondents, the highest level of formal education considering all the three villages was primary education (48.3%). In each sampled villages, this was 51.7, 41.4 and 51.7% for Geferssa, Sewati, and Wareni, respectively. On the other hand, 51.7% of the total sample households did not attend any formal education. This was 48.3, 58.6 and 48.3% for Geferssa, Sewati, and Wareni villages, respectively (Table 1).

Farmland holding of respondents ranged between 0.13 and 5 ha. Average farmland size was 2 ± 0.12 ha per household. Farmland holdings differed among villages. Thus, there was a significant difference in the mean size of farmland between Wareni and Geferssa villages ($F = 3.95$, $df = 5, 23$, $p <0.05$) (Figure 3).

In the study area, farmers have grown different types of crops, viz. wheat, maize, bean, teff, potato, pea, enset, barley and sorghum. According to respondents' responses, as well as field observation, wheat (100%), maize (83.91%) and bean (72.41%) were the top three crop types widely cultivated in all sampled villages. Sorghum (4.53%) was the least cultivated crop type in the study area (Table 2).

The amount of crop production in the study area ranged between 2 to 60 quintals per household per year.

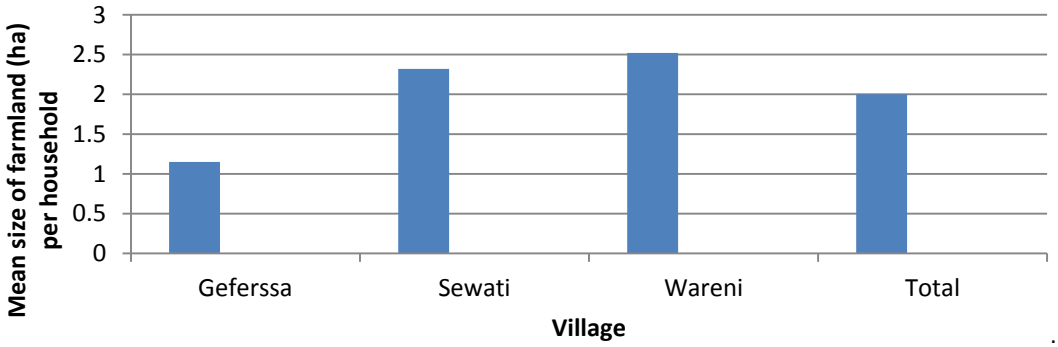

Figure 3. Mean size of farmland per household.

Table 2. Type of crops grown by farmers (based on respondents response and field observation).

Village	N	Wheat (%)	Maize (%)	Bean (%)	Teff (%)	Potato (%)	Pea (%)	Enset (%)	Barley (%)	Sorghum (%)
Geferssa	29	100	65.52	65.52	65.52	13.78	41.38	48.28	6.8	0
Sewati	29	100	93.1	65.52	34.48	6.8	13.76	41.38	65.52	6.8
Wareni	29	100	93.1	86.21	65.52	41.38	0	34.48	6.8	6.8
Total	**87**	**100**	**83.91**	**72.41**	**55.17**	**20.65**	**18.38**	**41.38**	**26.37**	**4.53**

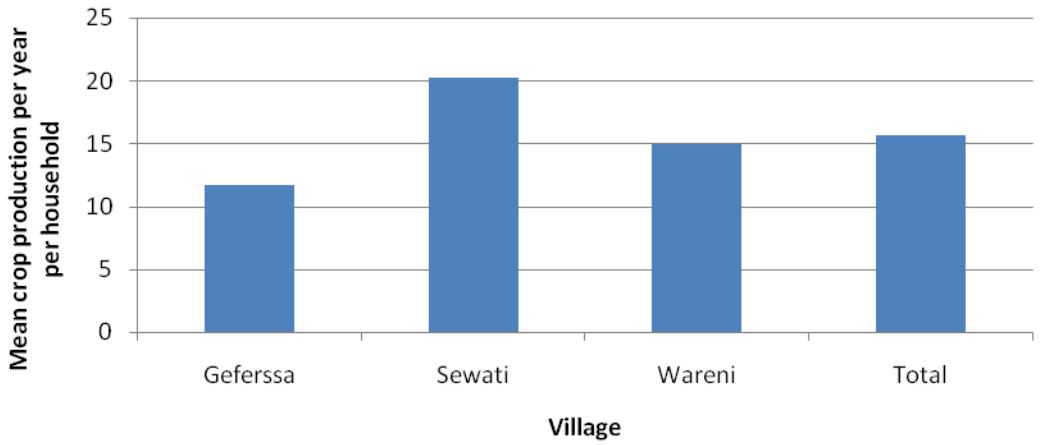

Figure 4. Mean crop production (Kg) per household per year.

Average crop production per year in the study area was 15.64 ± 1.37. Production varied among villages. Hence, there was a significant difference between Geferssa and Sewati villages ($F = 5.56$, $df = 8, 20$, $p < 0.05$) (Figure 4).

Among respondents involved in the study, 97.7% had livestock, but the rest 2.3% had no livestock (Table 3). Livestock found in the study area were cattle, sheep, goats, and others (that is, poultry, donkey, etc). The average number of livestock per household was 4.94 ± 0.3, 3.63 ± 0.3 and 1.22 ± 0.07 for cattle, sheep and goats, respectively. Variation was seen in the mean number of other livestock and cattle ($F = 3.46$, $df = 2, 84$; $p < 0.05$) and between other livestock and sheep and goats ($F = 5.29$, $df = 2, 84$; $p < 0.05$). But there was no significant variation in the mean number of cattle and sheep and goats ($F = 1.77$, $df = 11, 75$; $p > 0.05$). There was a significant difference in the number of cattle between Geferssa and Wareni ($F = 8.11$, $df = 7, 21$; $p < 0.05$) but the difference between Geferssa and Sewati was not significant ($F = 2.07$, $df = 7, 21$; $p > 0.05$). Moreover, the number of sheep and goats varied across villages. Accordingly, there was significant difference

Table 3. Response about possession of livestock.

Response	Frequency	Percentage
Yes	85	97.7
No	2	2.3
Total	**87**	**100**

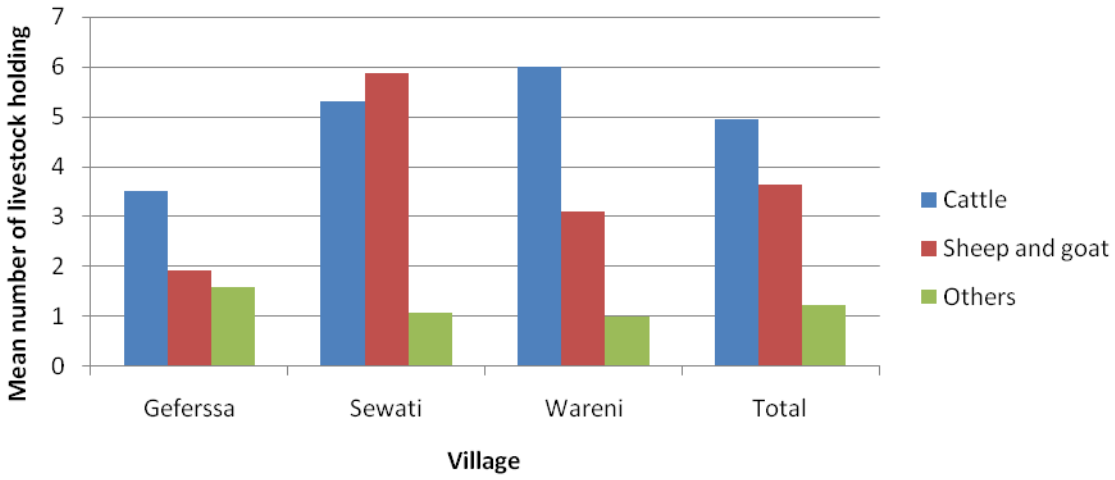

Figure 5. Mean livestock holding per household.

Table 4. Response about owning of private grazing land.

Response	Frequency	Percentage
Yes	20	22.99
No	67	77.01
Total	87	100

Table 5. Duration of grazing in their private grazing land.

Duration in months	Frequency	Percentage
1 - 3	6	30
3 - 6	6	30
6 - 9	2	10
9 - 12	6	30
Total	20	100

between Geferssa and Sewati ($F = 4.26$, $df = 4, 24$; $p<0.05$), Geferssa and Wareni ($F = 3.08$, $df = 4, 24$; $p < 0.05$) and Sewati and Wareni ($F = 3.3$, $df = 9, 19$; $p < 0.05$). However, there was no difference in the number of other livestock among villages (Figure 5).

A majority of the respondents in the study area (77.01%) had no private grazing land, whereas the remaining 22.99% had land (Table 4). However, the maximum size of private grazing land was 0.5 ha.

Respondents who owned private grazing land use the land at different durations within the year. Hence, 30% of the respondents used the grazing land for 1-3, 3-6 or 9-12 months whereas 10% of the respondents used it for 6-9 months (Table 5).

Table 6. Types of wild animals commonly known by respondents.

Types of wild animals mentioned by respondents	Frequency	Percentage
< 3	4	4.6
3 - 4	32	36.8
5 - 6	45	51.7
>6	6	6.9
Total	**87**	**100**

Table 7. List of wild animals get in conflict with the local community.

Wild animal	Frequency	Percentage	Rank
Ape	75	86.2	1
Monkey	62	71.3	2
Porcupine	40	46	4
Warthog	8	9.2	7
Fox	14	16.1	6
Hyena	49	56.3	3
Skunk	23	26.4	5
Gazelle	4	4.6	8

Table 8. Major causes of human-wildlife conflict in the study area.

Causes of human – wildlife conflict	Geferssa (%)	Sewati (%)	Wareni (%)	Total (Study area) (%)
Increase in wildlife population	58.6	34.5	34.5	42.5
Increase in livestock population	0	20.7	13.8	11.5
Resource competition between livestock and wild animals	41.4	44.8	51.7	46.0
Others	0	0	0	0
Total	**100**	**100**	**100**	**100**

Conflict and damage

In order to collect information about types of wild animals found in the study area, respondents were asked to list wild animals commonly found in the locality. Accordingly, 4.6, 36.8, 51.7 and 6.9% of the respondents were able to list less than 3, 3-4, 5-6 and more than 6 types of wild animals, respectively. Therefore, 88.5% of the respondents knew 3-6 different types of wild animals in their locality (Table 6).

Based on respondents' information and field observations, major wild animals found to be in frequent conflict with the local community are: Ape, monkey, porcupine, warthog, fox, hyena, skunk and gazelle. The most known problematic wild animals in the study area were apes (86.2%) followed by monkey (71.3%) and hyena (56.3%). On the other hand, the least identified problematic wild animals were gazelle (4.6%) followed by warthog (9.2%) and fox (16.1%) (Table 7).

Regarding the major causes of human-wildlife conflict in the study area, 46% of the respondents mentioned that resource competition between livestock and wild animals was the major cause. However, wildlife population increment and increase in livestock population were also mentioned as causes by 42.5 and 11.5% of respondents, respectively. Causes of human-wildlife conflict varied significantly in the study area (p= 0.000) (Table 8).

Crop damage, livestock depredation and disease transmission were the major types of damages that occurred in the study area by wild animals. Of the total respondents, 59.8% have experienced problem of crop damage, whereas 23 and 17.2% faced disease transmission and livestock predation, respectively. However, in one of the study locations, village-Wareni, livestock predation was not a problem. Problem caused by wildlife varied significantly in Geferssa (P = 0.003) and Wareni (p = 0.026) but not in Sewati (p = 0.122). In general, there was a significant difference in problems

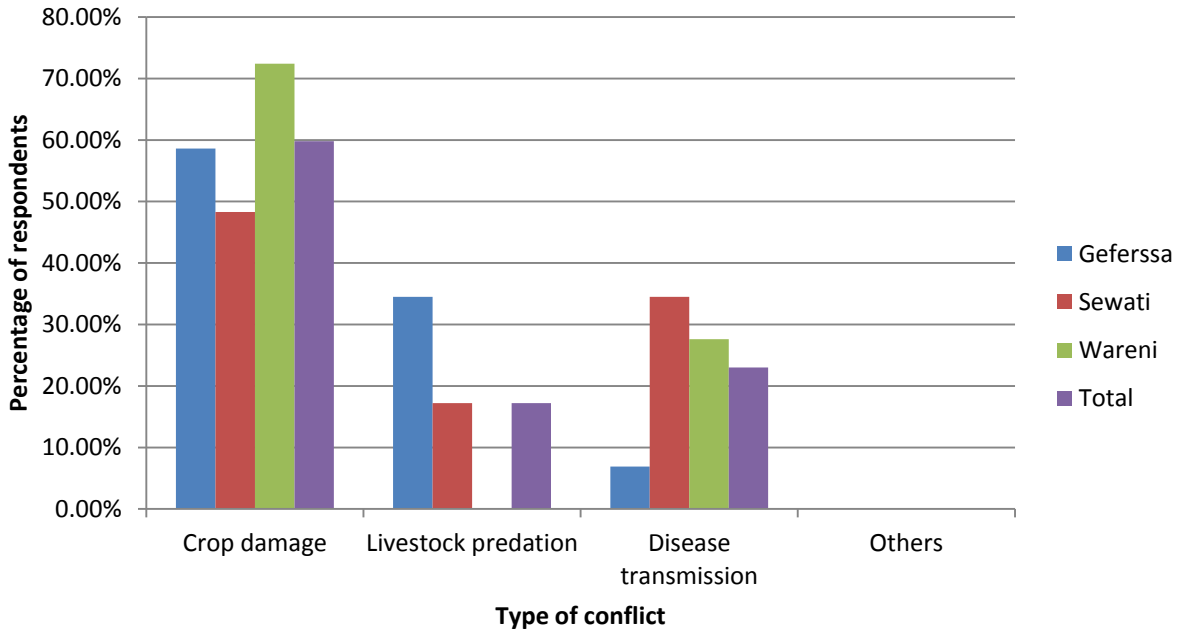

Figure 6. Percentage of respondents that faced problems due to wildlife.

Figure 7. A goat injured by a monkey.

caused by wildlife in the study area (p = 0.000) (Figure 6). Sheep, goat, hen, and donkey were livestock most frequently attacked by wild animals in the study area (Figure 7).

The most reported crop riders in Geferssa and Sewati were apes and monkeys, respectively. In Wareni both apes and monkeys were equally important crop riders. Gazelles and warthogs were not reported from Geferssa and Wareni but in a small proportion from Sewati. Overall, the majority of the crop damage in the study area was occurred by ape (83.9%) followed by monkey (71.3%) and porcupine (32.2%). Only 2.3 and 6.9% of the respondents reported crop damage by gazelle and warthog, respectively (Figure 8).

Based on respondents' responses, the average losses of maize, wheat, bean, potato and enset in kilograms were 106.15±12.3, 155.29±12, 57.93± 17.7, 68.39±10.8 and 29.84 ± 7.3 per household per year, respectively (Table 12).There were significant differences in the mean loss of different crop types between villages. Hence, there was significant difference between Geferssa and Wareni ($F = 2.95$, $df = 5, 23$; $p < 0.05$) in maize crop, between Geferssa and Wareni ($F=3.89$, $df= 6,22$; $p< 0.05$) in wheat crop, between sewati and wareni ($F=3.62$, $df= 2, 26$; $p< 0.05$) in bean crop, between Geferssa and Wareni ($F= 17.77$, $df= 5, 23$; $p< 0.05$) and Geferssa and

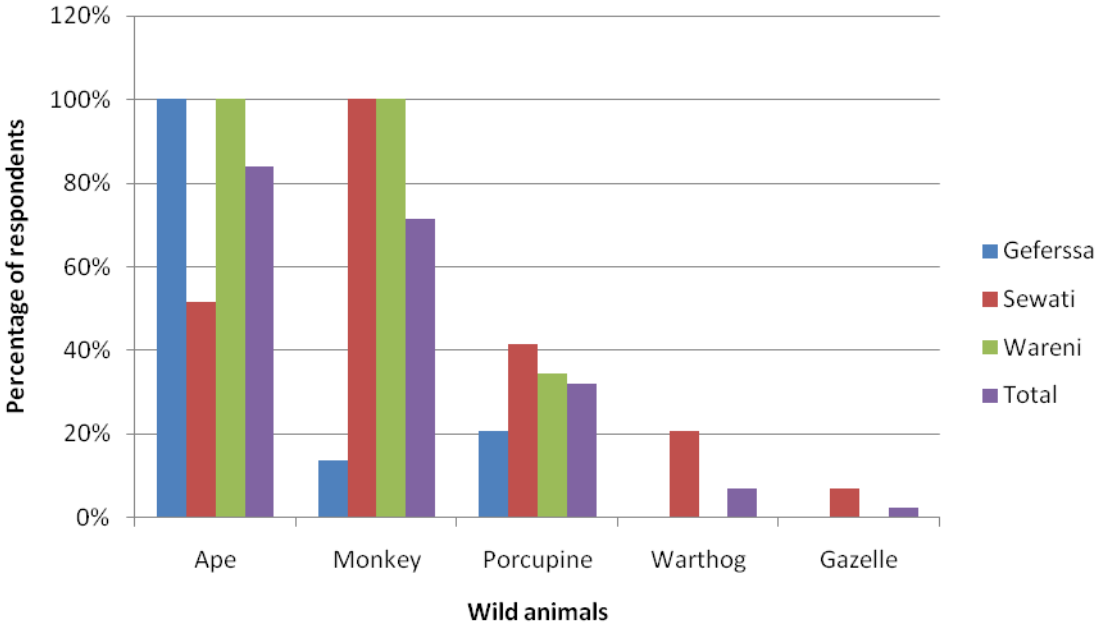

Figure 8. Crop raiders in the study area.

Figure 9. Women working cooperatively to produce '*kocho*' from enset.

Sewati (F= 1.05, df= 5, 23; p< 0.05) in enset crop (well known staple food in the study area) (Figure 9). However, the difference in the mean loss of potato between villages was not significant (p > 0.05). Generally, the mean loss of all crop types by wild animals accounted for 680.55, 239.48 and 332.76 kg for Geferssa, Sewati and Wareni, respectively (Table 9). Figures 10 to 12 show crop damage by different animals.

Based on the field experiment, the average loss of enset obtained from estimation of 3600 m^2 (0.36 ha) in four counts was 36 kg per day or 180 Birr. Hence, estimated damage on enset was amounted to about 3200

Table 9. Average crop loss per household per year.

Crop type	Average crop loss (kg)			
	Geferssa	Sewati	Wareni	Mean
Maize	151.73	81.89	84.83	106.15
Wheat	231.03	115.52	119.31	155.29
Bean	162.06	10	1.72	57.93
Potato	103.45	18.97	82.76	68.39
Enset	32.28	13.10	44.14	29.84
Total	**680.55**	**239.48**	**332.76**	**417.6**

Figure 10. An enset plant whose tuber was damaged by a porcupine.

Figure 11. A potato plant damaged by an ape.

kg/day or 16000 Birr/day in the whole study area (total enset crop coverage is 32 ha). Estimated loss of enset in the three study villages is given in Table 10. On the other hand, the average loss of maize from estimation of 1200 m^2 (0.12 ha) in four counts was 48 cobs/day (9.6 kg/day) or 67.2 Birr/day. Therefore, estimated damage on maize was amounted to about 3360 kg/day or 23520 Birr/day in the whole study area (total maize crop coverage is 42 ha). Estimated loss of maize in the three study villages is given in Table 11.

Figure 12. A maize plant damaged by an ape.

Table 10. Estimated loss of enset in the three sites (with average cost of 5 birr/kg).

Site	Type of crop and damage estimation in kg/day	Total cost in Birr
	Enset	
Geferssa	12	60
Sewati	8	40
Wareni	16	80
Total	**36**	**180**

Table 11. Estimated loss of maize in the three sites (with average cost of 7 birr/kg).

Site	Type of crop and damage estimation in kg/day	Total cost in Birr
	Maize	
Geferssa	4	28
Sewati	2.4	16.8
Wareni	3.2	22.4
Total	9.6	67.2

Table 12. Preferred time for wild animals to attack crops or livestock.

Time of attack	Frequency	Percentage
Day	46	52.9
Night	41	47.1
Total	**87**	**100**

Crop raiding and/or livestock depredation in the study area occurred both during daytime and at night. However, according to 52.9% of the respondents, day time is mostly preferred by the animals. On the other hand, 47.1% of respondents argued that night is the most preferred (Table 12).

Most of the respondents reported that severe crop damage and/or livestock depredation occurred during the months of September to November (47.13%). However, 19.54, 5.75 and 27.6% of the respondents mentioned that the damage also occurred on the months of December to February, March to May and June to August, respectively

Table 13. Respondents response about months at which severe crop damage/livestock depredation occurred.

Village	Sep-Nov		Dec-Feb		Mar-May		Jun-Aug		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Geferssa	17	58.6	2	6.9	0	0	10	34.5	29	100
Sewati	12	41.4	9	31	2	6.9	6	20.7	29	100
Wareni	12	41.4	6	20.7	3	10.3	8	27.6	29	100
Total	41	47.13	17	19.54	5	5.74	24	27.59	87	100

Figure 13. A monkey killed by a boy in vengeance.

(Table 13).

The major human impacts on wildlife identified by respondents were; hunting of wild animals for different purposes, burning and clearing of forests, chasing wild animals to make them abandoned the locality, killing wild animals in retaliation, etc. (Figure 13). Furthermore, 97.7% of the respondents reflected their view that human-wildlife conflict in the locality is increasing (Table 14). These respondents further mentioned that due to the ever-increasing, human-wildlife conflict in the locality, previously well-known carnivores like leopard have now been extirpated.

With regard to reporting the conflict to the concerned governmental authorities, most of the respondents (88.5%) replied that they did not report at all where as 11.5% argued that they report the case to the local government (Table 15). Reasons for not reporting the case include: remedies given by themselves, they do not know where and to whom to report the case and they believe that reporting will not bring any change.

Perception towards wildlife

The perception of the respondents towards wildlife was assessed. Accordingly, 64.4% of the respondents had a positive attitude about wildlife, that they thought wildlife conservation is important. On the contrary, 35.6% of the

Table 14. Status of human wildlife conflict in the study area.

Village	N	Increasing		Decreasing		No idea		Total	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Geferssa	29	29	100	0	0	0	0	29	100
Sewati	29	27	93.1	2	6.9	0	0	29	100
Wareni	29	29	100	0	0	0	0	29	100
Total	**87**	**85**	**97.7**	**2**	**2.3**	**0**	**0**	**87**	**100**

Table 15. Reporting the human-wildlife conflict to the concerned authority.

Village	N	Yes		No		Total	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Geferssa	29	0	0	29	100	29	100
Sewati	29	4	13.8	25	86.2	29	100
Wareni	29	6	20.7	23	79.3	29	100
Total	**87**	**10**	**11.5**	**77**	**88.5**	**87**	**100**

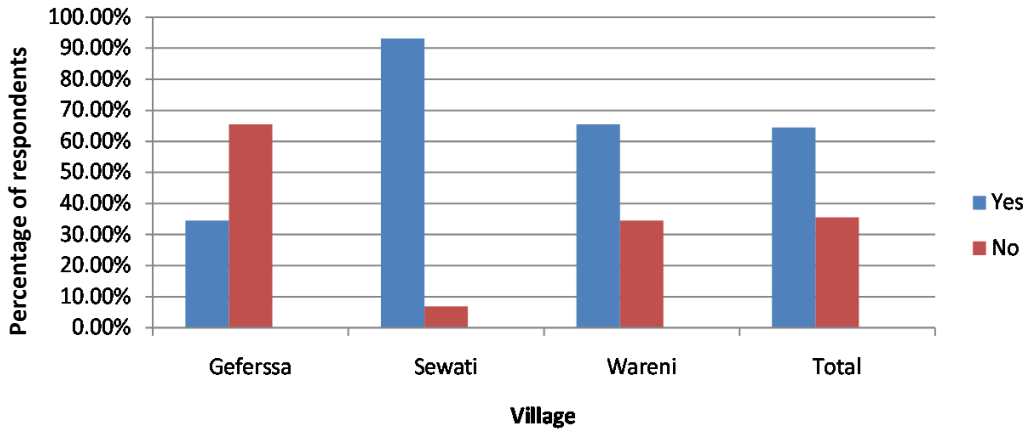

Figure 14. Response about the importance of wildlife conservation.

respondents argued that wildlife conservation had no importance. The main reason given for viewing wildlife conservation negatively was due to crop and livestock damage by wild animals. The attitude of the respondents compared across the study villages was highly positive in Sewati (93.1%) followed by Wareni (65.5%). On the other hand, it was highly negative in Geferssa (Figure 14). In addition, there was significant difference in the respondents attitude towards wildlife conservation across Geferssa and Sewati ($p = 0.000$), Wareni and Wewati ($p = 0.008$) and Wareni and Geferssa ($p = 0,004$).

Households strategies to protect crop/livestock from wild animals

In the study area, households used different mechanisms to protect their crop and livestock from damage by wild animals. Some of these techniques include: Guarding day and night (Figure 15), chasing, hunting, fencing, cooperative guarding, guarding using dogs (Figure 16), trapping (Figure 17) and using scarecrow soaked in naphtha. However, among these methods guarding with or without dogs, trapping and using scarecrow were commonly practiced by most households.

DISCUSSION

Causes of human-wildlife conflict

Human-wildlife conflict arises from a range of direct and indirect negative interactions between humans and wildlife (Ocholla et al., 2013). Habitat modification

Figure 15. A monk living in Midrekebid Abo Monastery guarding farms.

Figure 16. A dog used as fear provoking stimuli to guard crops in farms.

(Owusu and Bakker, 2009), human population expansion (Shibru, 1995; Ferguson, 2009) and climate change (Mustafa et al., 2005) are some among many causes for human-wildlife conflict. In the study area, the major causes of human–wildlife conflict identified were resource competition and increment of wildlife and livestock populations. Among these, resource competition was the most severe cause. As the local community livelihood is largely based on farming (90.6%) with the average family size of 5.77 (± 0.23), agricultural expansion that shrinks wildlife habitat is inevitable. Hence, this would ultimately result in an overlap between human and wildlife habitats that could bring direct conflict. As Forthman and Demment (1988) have noted, increase in the human population and the expansion of agricultural land usually forced wildlife into modified habitats. The rise in human

Figure 17. Traps used to catch vertebrate crop pests.

populations undoubtedly led to the expansion of agriculture into areas currently unused (Sillero-Zubiri and Switzer, 2000). Besides, 77.01% of the respondents indicated that they have no private grazing land. Consequently, their livestock directly compete with the free-ranging, wild animals for grazing. Yigrem et al. (2016) indicated that the causes of human–wildlife conflict are mainly wild animals' habitat disturbance, increased subsistence agriculture around forest edges and proximity to natural forest. Similarly, Fernando et al. (2005) identified that human-wildlife conflict occurs mainly because of the loss, degradation and fragmentation of habitats through human activities, such as farmland expansion, logging, animal husbandry and developmental projects.

Wildlife and livestock population increment were also other causes of conflict identified in the study area. Varieties of crops cultivated in the study area, as well as good number of livestock population, might provide an alternative source of food for wild animals that could escalate their population temporarily. Bayani et al. (2016) clarified that in some cases the population status of crop-raiding species can be linked with crop and livestock productivity. Furthermore, pest species are likely to flourish along the edges of natural habitat and agricultural lands, where they can eat both the food available in undisturbed habitats and the crops growing in the adjoining farmland (Sillero-Zubiri and Switzer, 2001). In the study area, 97.7% the respondents had livestock. Thus, livestock production is as common as crop cultivation in the area. Therefore, besides exacerbating the conflict with wild animals through direct competition for resources, some livestock such as sheep, goats and chickens could be victimized by hyena, fox and monkey, if not properly looked after by the households. Haylegebriel (2015) mentioned that the availability, variability and type of food sources in the area as well as high livestock density can increase human-wildlife conflict.

Damage caused by wild animals

In the study area variety types of crops such as wheat, maize, bean, teff, potato, pea, enset, barley and sorghum are grown. Thus, crop damage was one of the major types of damage occurred in the study area. Ape, monkey, porcupine, warthog, fox, hyena, skunk and gazelle were identified as pest animals in the area. In a similar study in Wondo Genet district, Muluken (2014) reported that the top six animals responsible for the most loss to crops are baboons, warthog, bush pig, vervet monkeys, porcupine and mole rat. Among identified pest animals in the present study, apes and monkeys were the top two known problematic pest animals. This result is in agreement with Strum (1991) who found that primates are particularly serious crop raiders especially due to their intelligence, adaptability and sometimes intimidating behavior. Moreover, Hill (2000) mentioned that primate pests cause more damage because people cannot predict when or whether they will visit an individual farm and that the protection methods available are not considered adequate. On the other hand, porcupines were the third known pest animals in the study area. Respondents mentioned that porcupines mostly damage enset tuber and potato crop in the area. In similar fashion, Andama (1999) noted that porcupines cause intensive damage to crops, and mainly on potatoes.

Maize and wheat were the most affected crop types in the study area (Table 9). Presumably, this is so because

of two reasons, firstly, these crops are widely grown by many households in the area as compared to the other crop types; secondly, they might be more preferred by pest animals due to their palatability and/or nutritious content. Damiba and Ables (1993) had also come to a similar conclusion that production of highly palatable and nutritious seasonal crops such as maize attracts primates and other wild animals. Leta et al. (2015) also reported that not all crops are equally damaged by crop raiders.

In the present study, respondents have estimated the amount of crop loss per annum due to crop raiders (Table 8). However, experimental observation to estimate the damage status has also been carried out on two selected crops - maize and enset. Hence, estimated damage was 3360 kg/day and 3200 kg/day with a worth of 23,520 and 16,000 birr for maize and enset, respectively. This is an indication that crop loss by wild animals in the area is very serious that may result in the local community suffering food insecurity. Moreover, this can reduce peoples' tolerance towards wildlife and may urge them to kill wild animals in retaliation (Figure 17). Hoare (1995) noted that damage caused by problem animals ranges from 10 to 90% depending on location and crop types. Naughton –Treves (1997) observed that crop loss caused by park animals along Kibale National Park boundary is between 4 to 7%. Furthermore, Sillero-Zubiri and Switzer (2001) have estimated crop losses of 19% for maize (range = 7.7-53%) and 25% for cassava (range = 4.5-61%) in the Budongo area. In Ethiopia, Yihune et al. (2005) reported an average crop loss per households of 117±10 kg due to baboons.

Crop raiding and/or livestock depredation in the study area occurred more during the daytime than at night. This might indicate crop and/or livestock protection in the area is not effective as more protection is expected during the day time. Furthermore, except for hyena, fox and porcupine, the other identified animals are diurnal; that are not active during the night. On the other hand, as reported by the respondents, damage by wild animals becomes more severe between September to November. This probably indicates that crops during this period become matured and more attractive to crop raiders.

Reporting the conflict and/or damage caused by wild animals in the study area is very low. Solving the conflict by one's self, lack of awareness where to find assistance, and to whom to report the case, and being despaired on the local government were major causes that hinder people not to report the case. Similarly, Tesfaye (2016) noted that although large numbers of farmers suffered with crop raiding, they failed to report any of the cases to the local government.

Perception towards wildlife

The assessment of peoples' attitudes and perceptions towards conservation has become an important aspect in many studies of wildlife conservation (Newmark et al., 1993). In the present study, despite 51.7% of the respondents have not attended any formal education (Table 4), their attitude towards wildlife conservation was positive (64.4%). Tessema et al. (2010) noted that educational status is not a sole criteria that determines perception; but there are other socio-demographic factors such as household income levels, age, size of livestock herd, length of residency, gender, sources of income, and household size. In some instances, despite the costs of living with wildlife, some communities have retained a positive attitude towards conservation (Hill, 1997). Similarly, Deresse (2003) mentioned that local communities cannot entirely be antagonistic to wildlife conservation.

In the study area, various methods were used to minimize crop and livestock loss by wild animals such as: Guarding day and night, chasing, hunting, fencing, guarding with/without dogs, trapping, visual stimuli (scarecrows) and traditional chemical repellents (naphtha and soap). Among these, guarding, trapping and using scarecrows are mostly practiced. Mesele (2006) and Naughton-Treves (1997) have also reported that guarding is the most important method to minimize crop damage. In other studies, different protection methods also are reported; for instance, fencing (Ogada *et al,* 2003), using dogs (Castelli and Sleggs, 2000), scarecrows (Heinrich and Craven, 1990) and chemical (Osborn, 2002).

Conclusion

Human-wildlife conflicts have occurred throughout man's prehistory and recorded history. The advent of farming and animal husbandry of the Neolithic Revolution increased the scope of conflict between humans and animals. Human population growth and activities such as agricultural expansion, habitat loss, deforestation, inappropriate site selection for settlement in forested areas and expansion of agricultural activities together have led to increased human encroachment on previously wild and uninhabited areas.

The major causes of human-wildlife conflict identified in the study area were resource competition, high livestock density and increased wild animal populations. As the livelihood of the local community is based on subsistence agriculture, modification of wildlife habitat is unavoidable. Besides, the presence of high livestock density (particularly grazers) further aggravates wild habitat modification as private grazing lands are very scarce in the area. Concerning wildlife population, it seems a paradox that high wildlife population is one of the causes of conflict although their natural habitat is shrinking with agricultural expansion. However, this would be true only for those pest mammals that have wide feeding adaptation and usually synchronize their population

increment with crops availability.

Major wild animals found to be in frequent conflict with the local community were: Ape, monkey, porcupine, warthog, fox, hyena, skunk and gazelle. Of these, primates (monkey and apes) were the most noxious pest mammals in the area. Among different crops grown in the study area, maize and wheat were the most affected crop types due to their wide coverage in the area and palatability and/or nutritious content. The crop loss estimated for maize (3360 kg/day) and enset (3200 kg/day) indicated that crop loss by wild animals in the area is very serious that may lead to food insecurity. A majority of respondents failed to report any conflict/damage to the local government. Though the respondents gave many reasons why they failed to do so, providing appropriate awareness about any compensatory schemes by the local government is very important.

Although the perception of the local community towards wildlife conservation indicated that they are committed to live in harmony with wildlife by protecting their crop/ livestock through various methods such as guarding, chasing, fencing, scarecrows, etc., continuing agricultural expansion is a threat to wildlife population in the area.

Recommendations

Based on the findings of the present study, the following recommendations are forwarded:

1. To avoid heavy losses or high guarding investments, highly palatable seasonal crops should not be grown near the forest edge.
2. Farmers should also be encouraged to concentrate on crops which are not prone (non palatable) to wild animals as buffer crops.
3. Farmers should look for alternative source of livelihood that does not promote further agricultural expansion.
4. Farmers should use private grazing land (if available) so that they can reduce conflicts by avoiding overlap of resources between wildlife and livestock.
5. Farmers should identify the best method of prevention and mitigation that is appropriate for each problematic wild animal (except killing).
6. Compensation scheme for crop damage should be designed by the government.
7. Environment and forest related laws should be enforced to minimize encroachment and forest habitat destruction.
8. Governmental bodies should create awareness about importance of wildlife conservation and use good governance to achieve co-existence between wildlife and the local community.
9. The local communities should develop a habit of reporting the conflict to the concerned body on due time.
10. The various conflict resolving methods should be applied with concern and in the context of local community.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGMENTS

The authors are so grateful to the cooperation and patience of the local community around Midre-kebid Abo Monastery during interview and field observation. Furthermore, they are very thankful to Arba Minch University for covering all financial expenses during the study.

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Vol. 11(8), pp. 230-240, August 2019
DOI: 10.5897/IJBC2019.1306
Article Number: 5133C6161859
ISSN 2141-243X

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Full Length Research Paper

Diversity and relative abundance of birds in Loka Abaya National Park, Sidama Zone, Southern Ethiopia

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Received 13 May, 2019; Accepted 11 July, 2019

Understanding avian diversity and abundance is important for its conservation in a protected area. A study was conducted to investigate species diversity and relative abundance of birds in Loka Abaya National Park, Sidama Zone, Southern Ethiopia, between August 2017and February 2018 during wet and dry seasons. Based on satellite image and preliminary survey, the study area was stratified into riverine forest, wooded grassland and wetland habitats. A total of 46 blocks were established to cover 20% of the 500 km^2 of the park area. Some of the blocks were 16 km^2; the remaining blocks were at the periphery of the park and are less than 16 km^2. Data were collected using transect lines. The length of transect lines varied, 1 km in riverine forest, 4 km in wooded grassland and wetland. Sighting distance, one side of the line was 75 m in riverine forest but 100 m in wooded grassland and wetland. Biodiversity indices were used for diversity data analysis and encounter rate to determine relative abundance of birds. The effects of habitat types and seasons on abundance were analyzed using Two-way ANOVA. A total of 134 bird species belonging to 99 genera, 53 families and 18 orders were recorded during the study. Culumbidae followed by Accipitridae and Ploceidae was the most abundant recorded family. Riverine forest had the highest bird species diversity (H' = 3.98) while wetland is the lowest (H' = 3.43). The result showed 7 abundant, 20 common, 45 frequent, 30 uncommon and 32 rare species. The number of individuals of a species during the seasons was not significantly different ($F_{1, 340}$ = 0.36, P > 0.05). However, habitat types showed significant difference ($F_{2, 340}$ = 8.40, P < 0.05). This study revealed that the park harbors diverse and rare species of birds. Hence, the park is an important conservation area. Thus, urgent conservation measures and other long-term studies on bird communities of the park is recommended.

Key words: Birds, diversity, habitat association, Loka Abaya National Park, relative abundance.

INTRODUCTION

In terms of its avifauna, Ethiopia is one of the well-known countries in Africa. The country is home to an impressive 926 species of birds that vary from residents to breeding, migrants to wintering birds (Lepage, 2006). Twenty-four of these species are national endemics and 19 are listed as globally threatened (Lepage, 2013). Ethiopia has numerous stop-over sites for millions of migratory birds crossing the Sahara desert (Sekercioglu, 2012). These

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consists of forests, wetlands and riverine ecosystems which are important sites for wintering or passage migrant birds. Hence, the availability of different habitat types contribute to the diversity of birds in Ethiopia. Presently, Ethiopia has 73 sites listed as Important Bird Areas encompassing the already thirteen existing protected areas excluding the present study area and many other additional sites have also been identified (Wonderfrash, 2003).

Among the elements of the diversity of nature, birds are both visually and acoustically conspicuous organisms of most ecosystems and the best known class of organisms (Sekercioglu, 2012). They are an integral part of an ecosystem and occupy many trophic levels in a food chain ranging from consumers to predators; and they play roles in ecosystem functioning and socio-economic contributions (Sekercioglu et al., 2004). Birds have been used as environmental health indicators, plant pollinators and seed dispersers as well as pest controller (Hadley et al., 2012; Ramchandra, 2013). Moreover, they provide opportunities for enjoyment to our lives, because of their distinctive colors, songs, calls, displays and dancing. Thus, birds are usefull organisms, and the reduction in their abundance and species richness are likely to have comprehensive ecological consquences, with diverse societal impacts ranging from the spread of diseases and loss of agricultural pest control to plant extinctions and trophic cascades (Gaston et al., 2000).

Globally, wildlife that includes birds is threatened by various natural and anthropogenic factors. As a result, the loss of biodiversity in general and wild fauna in particular is a comprehensive global environmental challenge (Cardinale et al., 2012; Krause and Zambonino, 2013). Habitat loss, over-exploitation of wildlife and forest resources and climate change are major causes of biodiversity loss (Brooks et al., 2002). The condition is most severe in the tropical regions (Leuschner et al., 2013). Human population growth, particularly in developing countries, has intense effects on consumption patterns of land and wild resources, which is considered as an indirect driver of biodiversity loss (Kideghesho, 2009). In the tropics including Ethiopia, habitat losses and habitat degradation are causing rapid decline in bird species, which in turn cause reductions in ecosystem processes, services and benefits they provide (Sekercioglu et al., 2004).

Loka Abaya National Park is one of the protected areas of Ethiopia with little information on ecology of its avifauna. Although much is not known about its wildlife, the Park is believed to have varieties of wild fauna. Despite not being systematic, Sidama Zone Bureau of Culture and Tourism (SZBCT) conducted a survey report and recorded many mammals and bird species. The area was designated as a protected area to protect these wild animals. However, it is evident that wild animals are at present under heavy human pressure. According to the survey report of Loka Abaya National Park prepared by Sidama Zone Bureau of Culture and Tourism (SZBCT) in 2009, the major prevailing threats of wildlife diversity in the park include poaching, cultivation, uncontrolled fire and livestock grazing as well as forest clearing for fire wood and charcoal productions. Unless these conservation problems are controlled properly, the survival of the wildlife diversity will be grim in the future. Consequently, it is useful to formulate a wildlife development and protection strategy to avert the looming danger on wild animals and conserve them for posterity. Therefore, study on avian diversity and abundance is important for the development of a sound management plan for a given protected area. The ornithological information that will be available is also used to indicate the effects of environmental change on biodiversity (Salahudeen et al., 2013); and this emphasizes the need to study their abundance and diversity to monitor these changes. Thus, the current study was carried out to investigate species diversity and relative abundance of birds in Loka Abaya National Park to contribute to the building the site's checklist of its avifauna, the conservation, development and management of the species in the area.

Study area

Loka Abaya National Park, which was established in 2009, is found in Loka Abaya "Woreda" in Sidama Zone of South Nations, Nationalities and Peoples' Region (SNNPR). The park was given the name after the name of the "woreda" where it is found (that is, Loka Abaya Woreda, which is one of the 19 "Woredas" of Sidama Zone). The park encompasses an area of approximately 500 km^2 of which 52 km^2 is water body (northern portion of Lake-Abaya) (Figure 1). It is located at 70 km south west of Hawassa and 340 km from Addis Ababa and occurs between 6°27'0" and 6°45'0"N latitude and 37°54'30" to 38°15'0"E longitude. The park is fortunate in possessing a number of water basins that drains to Lake Abaya which is the largest lake in the Ethiopian rift valley system. Bilate, Derba, Gidabo, Loka and Mencha are the major five river basins of the park that finally feed Lake Abaya located inside the park.

The study area harbors different vegetation types that comprise wooded grassland, hilly scrubland, riverine forest and wetland vegetation (Figure 2).The wooded grassland areas are mainly dominated by *Comberetum* spp., *Acacia drepanolobium*, *A. mellifera, A. seyal, A. tortilies, A. senegal, A. albida, A. nilotica, A. olifera, A. nubica, Aloe vera, Euophorbia tirucalli, Ricinus communes, Caparis tomoentosa, Balanites aegypitica and Balanites routindifolia*. The trees in Loka Abaya National Park are associated with a wide range of grasses, shrubs and herbs. Riverine forest comprises tree species like *Ficus sur, Ficus vasta, Petrolatum stelatium, Trechlea* sp*., Zizihpusspina-christi and Tamarindus indica.* The

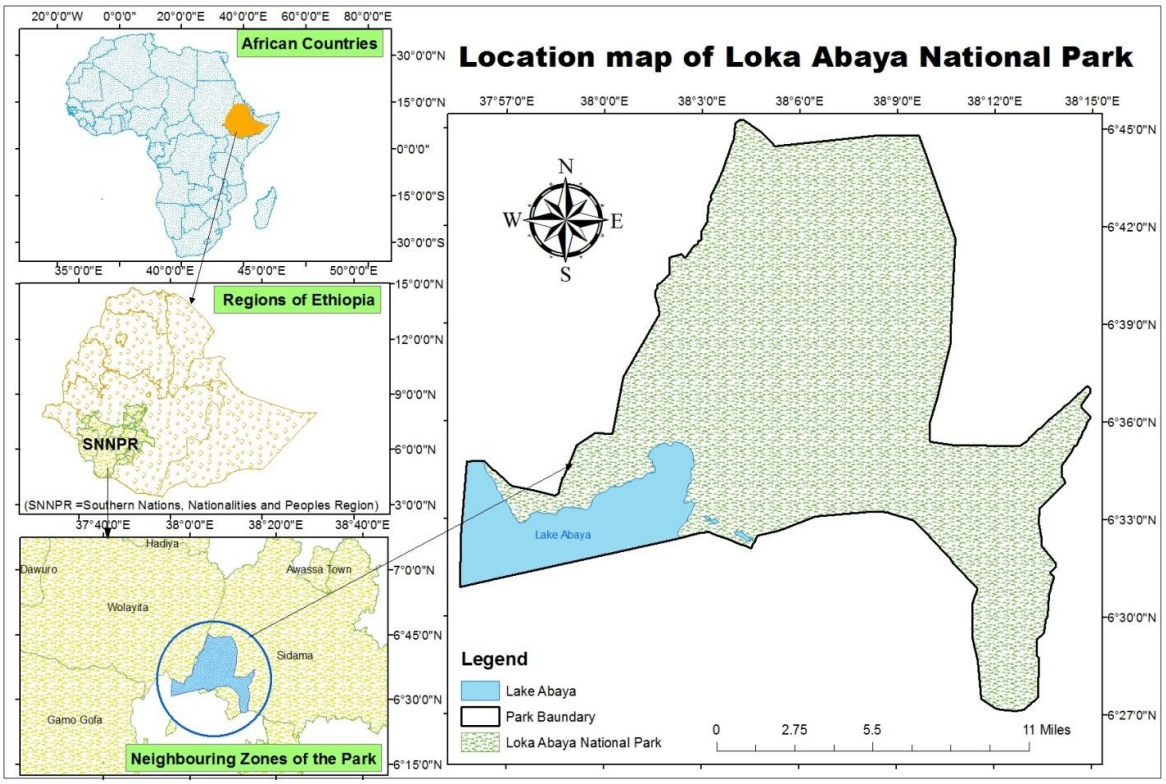

Figure 1. Map showing the location of the study area.

western area of undulating lands of the reserve including river banks of Bilate and Derba River are highly deforested for fire wood and charcoal production by the local communities; whereas, the eastern areas of the park are relatively in a better condition with thick woody species. The park is home for diverse species of mammals and birds. The most conspicuous and observed mammals of the park include Lesser Kudu (*Tragelaghus imberbis*), Defassa Waterbuck (*Kobus defassa*), Common Bushbuck (*Tragelaghus scriptus*), Lion (*Pantera leo)*, Leopard (*Pantera pardus*) and African Wild Dog (*Lycaon pictus*) (SZBCT, 2009).

MATERIALS AND METHODS

Materials used during the present study include: GPS (Garmin72), pair of binoculars (8x30 and 8x40), Field guides, Digital camera, and topographic map of LANP, data sheets, notebook, rulers and field tents. Motor cycles were used to travel through LANP.

Sampling design and Method

A preliminary survey was conducted from August 15 to 25, 2017. During this period, all available literature was reviewed concerning the accessibility, vegetation, fauna, topography and infrastructures of the park. The physical features of the overall landscapes of the study area were assessed. The type of each of the habitats of wild animals was observed and the coordinates of boundaries of each study site were also identified using GPS (Garmin 72).

Based on satellite images and preliminary survey, the study area was stratified into habitat types following Mengesha and Bekele (2008). Accordingly, three habitat types were identified for bird survey based on vegetation types: Wooded grassland (66.53%), Riverine forest (16.16%) and Wetland (6.17%) (Figure 2). In all the habitat types, a total of 46 blocks was established on the map of Loka Abaya National Park. Some of the blocks were 4 km × 4 km making a total of 16 km^2. The remaining blocks were at the periphery of the park area and are less than 16 km^2. The numbers of sampling blocks varied in each habitat type based on the size and the type of vegetation cover in the Park. To make sample representative 20% of blocks of each habitat type were considered (Bibby et al., 1992). Accordingly, 11 sampling blocks (6 from wooded grassland, 3 from riverine forest and 2 from wetland) were proportionally selected at random. Transect lines were laid out systematically in the selected blocks. The length and number of transect lines established was determined based on the size of selected grids of each habitat type. Thus, 68 transect lines in wooded grassland, 54 in riverine forest, and 2 in wetland were established on each of the selected sampling block. The length of transect lines was 1 km in riverine forest, 4 km in wooded grassland and wetland. The sighting distance (transect width) varied depending on the detection difficulties of birds in each habitat type due to size and nature of habitat. Thus, sighting distance (on either side of the transect line) was 100 m in wooded grassland and wetland and 75 m in riverine forest. Transect lines were 200 to 300 m apart from each other to reduce double counting.

Field data collection was carried out from August to October, 2017 (wet season) and from December to February, 2018 (dry season). Data were collected by walking along transect lines. The speed of walking on the transect lines depended on the number of birds present and difficulties to record them. In wooded grassland

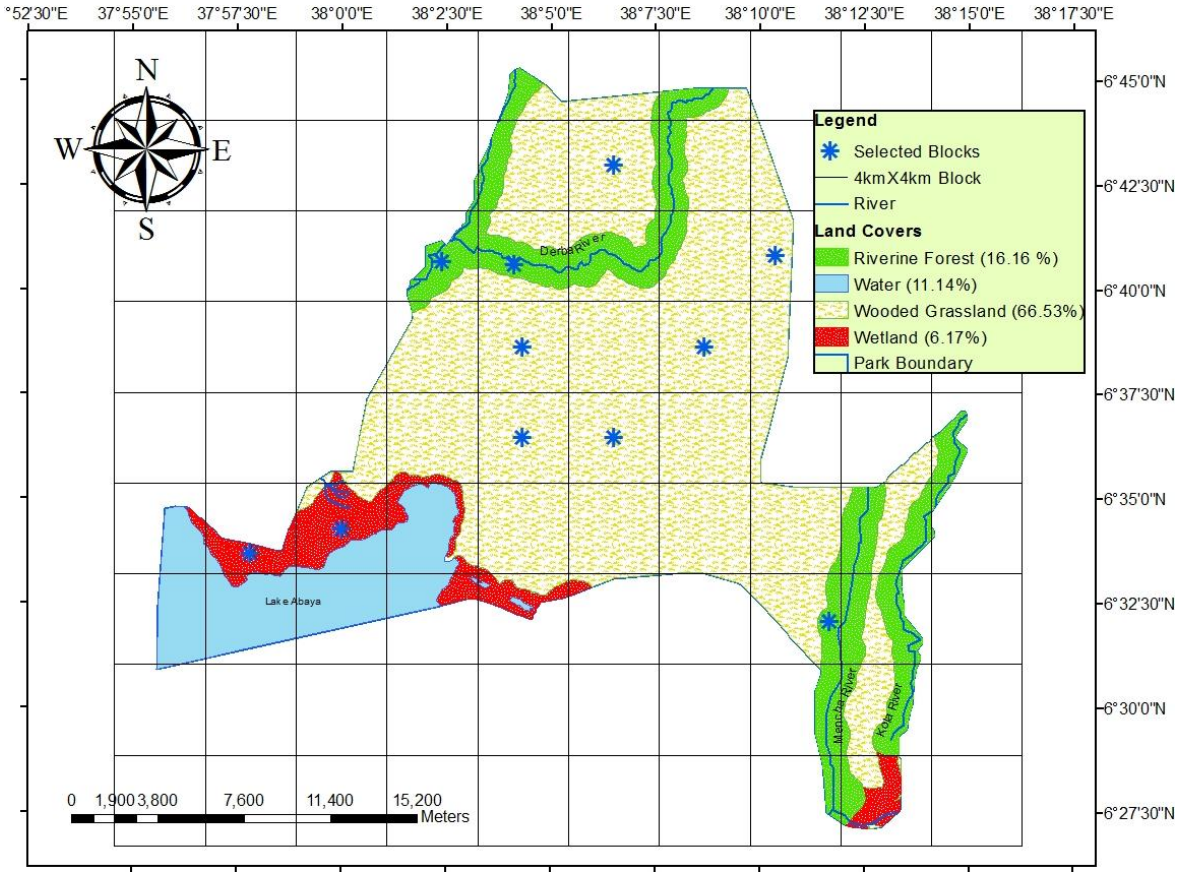

Figure 2. Map showing habitat types of the study area.

and wetland habitat type, a speed of about 2 km/h and riverine forest 1 km/h was followed (Bibby et al., 1992). GPS was used to find the position of each transect line. Each established transect line was surveyed eight times (four times during the wet and four times during the dry season). Data was collected early in the morning from 6:30 to 10:00 a.m. and the late afternoon 3:30 to 6:00 p.m. During the survey, name of bird species and number of individuals was recorded by direct observation. Estimated perpendicular distance from transect lines and time taken to accomplish each transect was recorded. Bird identification was aided by binoculars (8 × 30 and 8 × 40) and standard bird field guides (Redman et al., 2009). Photograph of birds was also taken using digital camera for further confirmation. Birds were also identified based on their calls.

Data analysis

Biodiversity indices were used to analyze the bird species diversity: the Shannon-Weiner diversity index (H') was used to compute the bird species diversity in different habitat types based on the abundance of the species recorded. The value of Shannon-Weiner index usually falls between 1.5 and 3.5, only rarely it surpasses 4.5. A value near 4.6 would indicate that the numbers of individuals are evenly distributed between all the species. Simpson's similarity index (SI) was used to determine the similarity of bird species between any two different habitat types. The relative abundance of avian species was calculated using encounter rates that give crude ordinal scales of abundance. Encounter rate incorporates field hours for each observer and the number of individuals of each species observed. The abundance categories (the number of individuals per 100 field hours) were: < 3.04, 3.04-6.08, 6.38-30.43, 30.70-122 and > 122. For each category, the following abundance score is given: 1 (rare), 2 (uncommon), 3 (frequent), 4 (common), and 5 (abundant), respectively. Hence, the relative abundance of each bird species was determined based on the ordinary scale of rare, uncommon, frequent, common and abundant based on the abundance categories. All calculations were performed using MINITAB 17 software. SPSS software (version 16) was also applied to analyze the data. Two-way ANOVA was used to analyze the effect of habitat type and season on abundance of birds. Means for variables whose F-values showed a significance difference were compared using Tukey's Multiple Comparison Test. Differences were considered statistically significant at 5 and 1% levels.

RESULTS

Species composition and relative abundance

A total of 134 species of birds belonging to 99 genera, 53 families and 18 orders were recorded during this study (Table 1). Of these, one endemic species to both Ethiopia and Eritrea (Wattled Ibis), one near-threatened species (Black-winged Pratincole), three critically endangered species (Hooded Vulture, Rüppell's Griffon and White-backed Vulture), and one rare species (Siberian Stonechat) were recorded. Migratory species including

Table 1. Relative abundance of the recorded bird species in Loka Abaya National Park.

Common name	Scientific name	Number of individuals per 100 field hours	Abundance score	Relative abundance
Abyssinian Ground-Hornbill	*Bucorvus abyssinicus*	18.29	3	Frequent
*Abyssinian Roller	*Coracias abyssinicus*	1.03	1	Rare
African Black-headed Oriole	*Oriolus larvatus*	16.49	3	Frequent
African Darter	*Anhinga rufa*	1.54	1	Rare
African Fish-Eagle	*Haliaeetus vocifer*	10.31	3	Frequent
African Gray Hornbill	*Lophoceros nasutus*	31.44	4	Common
African Jacana	*Actophilornis africanus*	18.04	3	Frequent
♣African Openbill	*Anastomus lamelligerus*	1.03	1	Rare
♣African Paradise-Flycatcher	*Terpsiphone viridis*	1.54	1	Rare
♣African Pipit	*Anthus cinnamomeus*	3.61	2	Uncommon
♣African Spoonbill	*Platalea alba*	0.26	1	Rare
Bare-faced Go-away-bird	*Corythaixoides personatus*	6.44	3	Frequent
Beautiful Sunbird	*Cinnyris pulchellus*	10.31	3	Frequent
Black Crake	*Zapornia flavirostra*	6.03	2	Uncommon
*Black Goshawk	*Accipiter melanoleucus*	0.52	1	Rare
Black Kite	*Milvus migrans*	4.64	2	Uncommon
Black-billed Woodhoopoe	*Phoeniculus somaliensis*	6.02	2	Uncommon
Black-crowned Tchagra	*Tchagra senegalus*	7.22	3	Frequent
Black-headed Batis	*Batis minor*	17.53	3	Frequent
Black-headed Heron	*Ardeamela nocephala*	3.61	2	Uncommon
*Black-winged Pratincole	*Glareola nordmanni*	22.16	3	Frequent
Black-winged Stilt	*Himantopus himantopus*	6.01	2	Uncommon
♣Blue-breasted Bee-eater	*Merops variegates*	3.61	2	Uncommon
*Blue-cheeked Bee-eater	*Merops persicus*	9.79	3	Frequent
Blue-headed Coucal	*Centropus monachus*	6.96	3	Frequent
*Blue-spotted Wood-Dove	*Turtur afer*	4.12	2	Uncommon
♣Bruce's Green-Pigeon	*Treron waalia*	3.09	2	Uncommon
♣Cardinal Woodpecker	*Dendropicos fuscescens*	1.55	1	Rare
Cattle Egret	*Bubulcus ibis*	44.33	4	Common
Common Bulbul	*Pycnonotus barbatus*	54.38	4	Common
♣Common Sandpiper	*Actitis hypoleucos*	2.58	1	Rare
Crested Francolin	*Dendroperdix sephaena*	446.65	5	Abundant
Crowned Lapwing	*Vanellus coronatus*	52.32	4	Common
Double-toothed Barbet	*Lybius bidentatus*	5.41	2	Uncommon
Dusky Turtle-Dove	*Streptope lialugens*	7.21	3	Frequent
Eastern Plantain-eater	*Crinifer zonurus*	4.12	2	Uncommon
Egyptian Goose	*Alopochen aegyptiaca*	13.40	3	Frequent
Emerald-spotted Wood-Dove	*Turturchal cospilos*	171.63	5	Abundant
Eurasian Hoopoe	*Upupa epops*	5.67	2	Uncommon
Fan-tailed Raven	*Corvus rhipidurus*	6.01	2	Uncommon
Fawn-breasted Waxbill	*Estrilda paludicola*	8.25	3	Frequent
Fork-tailed Drongo	*Dicrurus adsimilis*	57.47	4	Common
*Gabar Goshawk	*Micronisus gabar*	0.56	1	Rare
Giant Kingfisher	*Megaceryle maxima*	1.03	1	Rare
Goliath Heron	*Ardea goliath*	2.58	1	Rare
Gray Heron	*Ardea cinerea*	4.38	2	Uncommon
*Gray Kestrel	*Falco ardosiaceus*	0.26	1	Rare
*Gray Wagtail	*Motacilla cinerea*	4.12	2	Uncommon
Gray-backed Fiscal	*Lanius excubitoroides*	39.18	4	Common
Great Egret	*Ardea alba*	1.55	1	Rare

Table 1. Contd.

*Great White Pelican	*Pelecanus onocrotalus*	1.55	1	Rare
Greater Blue-eared Starling	*Lamprotornis chalybaeus*	81.44	4	Common
♣Greater Honeyguide	*Indicator indicator*	2.32	1	Rare
Grosbeak Weaver	*Amblyospiza albifrons*	13.66	3	Frequent
Hadada Ibis	*Bostryc hiahagedash*	16.49	3	Frequent
Hamerkop	*Scopus umbretta*	9.78	3	Frequent
Helmeted Guinea fowl	*Numida meleagris*	494.59	5	Abundant
Hemprich's Hornbill	*Lophoceros hemprichii*	18.04	3	Frequent
Hooded Vulture	*Necrosyrtes monachus*	6.03	2	Uncommon
Kittlitz's Plover	*Charadrius pecuarius*	6.70	3	Frequent
Laughing Dove	*Streptopelia senegalensis*	56.19	4	Common
Lesser Jacana	*Microparra capensis*	7.22	3	Frequent
*Lilac-breasted Roller	*Coracias caudatus*	2.06	1	Rare
♣Little Bee-eater	*Merops pusillus*	2.06	1	Rare
Little Ringed Plover	*Chara driusdubius*	5.15	2	Uncommon
*Little Stint	*Calidris minuta*	6.70	3	Frequent
Little Weaver	*Ploceus luteolus*	28.35	3	Frequent
Long-crested Eagle	*Lophaetus occipitalis*	5.67	2	Uncommon
Marabou Stork	*Leptoptilos crumenifer*	44.84	4	Common
Mariqua Sunbird	*Cinnyris mariquensis*	18.04	3	Frequent
Marsh Sandpiper	*Tringa stagnatilis*	8.25	3	Frequent
Mountain Wagtail	*Motacilla clara*	4.12	2	Uncommon
Mourning Collared-Dove	*Streptopelia decipiens*	22.16	3	Frequent
Namaqua Dove	*Oena capensis*	8.50	3	Frequent
Northern Black-Flycatcher	*Melaenornis edolioides*	255.15	5	Abundant
Northern Carmine Bee-eater	*Merops nubicus*	48.45	4	Common
Nubian Woodpecker	*Campethera nubica*	4.12	2	Uncommon
Pied Kingfisher	*Ceryle rudis*	2.57	2	Uncommon
*Pied Wheatear	*Oenanthe pleschanka*	5.67	2	Uncommon
Pin-tailed Whydah	*Vidua macroura*	2.06	1	Rare
♣Rameron Pigeon	*Columba arquatrix*	4.12	2	Uncommon
Red-and-yellow Barbet	*Trachyphonus erythrocephalus*	5.41	2	Uncommon
*Red-bellied Parrot	*Poicephalus rufiventris*	2.84	1	Rare
Red-billed Buffalo-Weaver	*Bubalornis niger*	18.04	3	Frequent
Red-billed Firefinch	*Lagonosticta senegala*	13.40	3	Frequent
Red-billed Oxpecker	*Buphagus erythrorhynchus*	7.21	3	Frequent
Red-cheeked Cordonbleu	*Uraeginthus bengalus*	55.67	4	Common
Red-eyed Dove	*Streptopelia semitorquata*	103.61	4	Common
Red-headed Weaver	*Anaplectes rubriceps*	10.31	3	Frequent
*Red-shouldered Cuckooshrike	*Malaconotus blanchoti*	1.55	1	Rare
Red-winged Starling	*Onychognathus morio*	32.47	4	Common
Ring-necked Dove	*Streptopelia capicola*	25.00	3	Frequent
*Rock Kestrel	*Falco rupicolus*	0.51	1	Rare
Rufous-crowned Roller	*Coracias naevius*	12.88	3	Frequent
Rüppell's Griffon	*Gyps rueppelli*	8.25	3	Frequent
Rüppell's Starling	*Lamprotornis purpuroptera*	17.26	3	Frequent
Rüppell's Weaver	*Ploceus galbula*	12.88	3	Frequent
Sacred Ibis	*Threskiornis aethiopicus*	15.46	3	Frequent
♣Saddle-billed Stork	*Ephippiorhynchus senegalensis*	0.52	1	Rare
♣Scaly-throated Honeyguide	*Indicator variegates*	1.55	1	Rare
Senegal Thick-knee	*Burhinus senegalensis*	41.75	4	Common
*Siberian Stonechat	*Saxicola maurus*	5.93	2	Uncommon

Table 1. Contd.

*Slate-colored Boubou	*Laniarius funebris*	1.55	1	Rare
*Slender-billed Starling	*Onychognathus tenuirostris*	3.61	2	Uncommon
Speckled Mousebird	*Colius striatus*	82.21	4	Common
Speckled Pigeon	*Columba guinea*	7.23	3	Frequent
*Spur-winged Goose	*Plectropterus gambensis*	3.61	2	Uncommon
Spur-winged Lapwing	*Vanellus spinosus*	136.08	5	Abundant
Squacco Heron	*Ardeola ralloides*	53.61	4	Common
Superb Starling	*Lamprotornis superbus*	51.80	4	Common
Swainson's Sparrow	*Passer swainsonii*	12.37	3	Frequent
Three-banded Courser	*Rhinoptilus cinctus*	3.61	2	Uncommon
Three-banded Plover	*Charadrius tricollaris*	6.05	2	Uncommon
Village Indigobird	*Vidua chalybeate*	10.82	3	Frequent
Village Weaver	*Ploceus cucullatus*	12.11	3	Frequent
Von der Decken's Hornbill	*Tockus deckeni*	25.26	3	Frequent
*Wattled Ibis	*Bostrychia carunculata*	1.03	1	Rare
Wattled Lapwing	*Vanellus senegallus*	18.29	3	Frequent
*Wattled Starling	*Creatophora cinerea*	19.07	3	Frequent
Western Yellow Wagtail	*Motacilla flava*	32.21	4	Common
*White Helmetshrike	*Prionops plumatus*	2.32	1	Rare
White-backed Vulture	*Gyps africanus*	37.63	4	Common
White-bellied Bustard	*Eupodotis senegalensis*	5.67	2	Uncommon
White-bellied Go-away-bird	*Corythaixoides leucogaster*	129.64	5	Abundant
*White-browed Coucal	*Centropus superciliosus*	1.03	1	Rare
White-browed Sparrow-Weaver	*Plocepasser mahali*	280.15	5	Abundant
*White-cheeked Turaco	*Tauraco leucotis*	0.26	1	Rare
♣White-faced Whistling-Duck	*Dendrocygna viduata*	1.55	1	Rare
White-headed Buffalo-Weaver	*Dinemellia dinemelli*	25.77	3	Frequent
White-rumped Shrike	*Eurocephalu sruppelli*	17.78	3	Frequent
*Woodchat Shrike	*Lanius senator*	2.06	1	Rare
Woodland Kingfisher	*Halcyon senegalensis*	2.84	1	Rare
Woolly-necked Stork	*Ciconia episcopus*	2.58	1	Rare
Yellow-necked Francolin	*Pternistis leucoscepus*	106.70	4	Common

♣Refers to species recorded only during wet season; *Refers to species recorded only during dry season.

Black-winged Pratincole, Pied Wheatear and Wattled Starling were documented during the study. Of the recorded bird species, 109 species were recorded during the wet season, while 120 species during the dry season (Table 1). Ninety-five bird species were common to both seasons, but 14 and 25 species were exclusive to the wet and dry season, respectively. The Columbidae family consisted the highest (11 species) number of species followed by Accipitridae and Ploceidae, each with 8 species. The result showed that 7 species were abundant, 20 common, 45 frequent, 30 uncommon and 32 rare species (Table 1).

Species diversity

The highest number of species was recorded from riverine forest (87) and the lowest from wooded grassland (59) during both seasons (Table 2). The number of individuals of species during the wet and dry seasons was not significantly different ($F_{1,340} = 0.36$, $P > 0.05$), but there was a significant difference among habitat types ($F_{2,340} = 8.40$, $P < 0.05$). However, season and habitat interaction was not significant ($F_{2,340} = 1.29$, $P > 0.05$). Tukey Multiple Comparison Test showed that the mean number of individuals of species did not differ significantly between wetland (25.08±8.73, N = 111) and riverine forest (34.75±7.66, N = 142), but the mean in wooded grassland (75.10±9.49, N = 93) was significantly different between the two habitat types. Bird species diversity was highest in riverine forest during wet season (H' = 3.92) and dry (H' = 3.89) season (Table 2). During the wet season, the wetland habitat (H' = 3.19) and during the dry season, the wooded grassland (H' = 3.01) had the least bird species diversity. When both seasons' data was combined, highest and lowest diversity of birds was

Table 2. Avifaunal diversity among the three habitat types during the wet and dry seasons .

Habitat type	Season	Species richness	Abundance	H'	E
Wetland	Wet	48	1099	3.19	0.83
	Dry	63	1717	3.40	0.82
	Both	71	2816	3.43	0.80
Wooded grassland	Wet	51	4587	3.60	0.92
	Dry	42	2531	3.01	0.81
	Both	59	7118	3.44	0.84
Riverine forest	Wet	67	2087	3.92	0.93
	Dry	75	2876	3.89	0.90
	Both	87	4963	3.98	0.89

H' refers Shannon-Weiner diversity index and E refers to Shannon-Wiener evenness index.

Table 3. Species similarity of birds among the three habitat types during wet and dry seasons.

Habitat type	Season	Simpson's similarity index (SI)		
		Wetland	Wooded grassland	Riverine forest
Wetland	Wet	-	0.24	0.38
	Dry	-	0.36	0.43
	Both	-	0.37	0.49
Wooded grassland	Wet	-	-	0.61
	Dry	-	-	0.44
	Both	-	-	0.56

obtained in riverine forest (H' = 3.98) and wetland (H' = 3.43) during both seasons, respectively (Table 2).

Species similarity among habitat types

During the wet season, bird species similarity ranged from 0.24 Simpson similarity index to 0.61 (Table 3). The strongest similarity (0.61) was recorded in between wooded grassland and riverine forest while the lowest (0.24) was recorded between wetland and wooded grassland (Table 3). During the dry season, the strongest similarity was recorded between wooded grassland and riverine forest (0.44), whereas the lowest was between wetland and wooded grassland with a value of 0.36 (Table 3).

DISCUSSION

A total of 134 species of birds were recorded in Loka Abaya National Park during the present study. The varied landscape and vegetation types of the park, presence of water bodies and other wetland habitat could be the reason for the existence of these different species of avian fauna in the park. This might have provided the bird species with a different array of foraging opportunities and nesting sites. Various studies indicated that diversity of vegetation within a habitat is one of the most important factors influencing the distribution of bird species (MacArthur and MacArthur, 1961; James, 1971; Cody; 1981; Radford et al., 2005; Soka et al., 2013). The park has a mosaic ecosystem that includes rivers, lake, forest, wetland and swampy areas as well as moist and wet savannas (SZBCT, 2009) that attracted various groups of birds. Temporary and permanent waters including ponds, burrowed pits, swamps, and lakes are important sites for many birds (Klem, 1990). These habitats of the park lead to occurrences of various species of birds.

The highest diversity of birds in riverine forest could be related to the presence of sufficient amount of food and availability of nesting materials owing to water availability in the habitat. Studies on birds indicated that bird species diversity is a factor of better foraging opportunities and nesting sites (Storch et al., 2003; Aynalem and Bekele, 2009; Mamo et al., 2016; Girma et al., 2017). Moreover, the highest avian diversity could be due to the diversity of vegetation strata that provides heterogeneous habitat for different avian species. The complexity of the riverine forest might be characterized by multiple vertical layers of

vegetation that provide dense understory, midstory and canopy strata (Jones, 2014). Structurally, complex habitats could harbor more species than sites with simple structure; because there are more niches providing different types of nesting and foraging resources (MacArthur and MacArthur, 1961; Radford et al., 2005; Thinh, 2006; Pennington and Blair, 2011; Soka et al., 2013). This could be the reason for the highest bird species in the riverine vegetation. Further other studies found that habitat structural complexity along riverine forest was a very important driver of bird distribution (Scott et al., 2003; Rumble and Gobeille, 2004; Fletcher and Hutto, 2008).

The decline in the diversity of birds in wooded grassland during dry season compared to wet season might be due to the decrease in vegetation productivity, reduction of food availability and sometimes low quality of nesting sites for birds. This may be due to non-availability of rain during this season, that is there was no availability of water for birds. Various studies indicated that seasonal changes results in seasonal variation in the availability of food and water resources, and as a result, birds shift between habitat types depending on their needs and availability of food and cover (Gaston et al., 2000; Chace and Walsh, 2006; Sua´rez-Seoane et al., 2008); in contrast, diversity of birds increased in wetland during the dry season. This could be related to the availability of moisture and then food resources for birds in the wetland during dry season. Lake Abaya is an important source of water for wild animals during the dry season. The lake could provide foraging ground for variety of bird species, with small fish, tadpoles, frogs, insect larvae and other invertebrates and edible aquatic plants.

The highest mean number of individuals in wooded grassland is due to high number of individuals of some species in this habitat type. Helmeted Guinea fowl (*Numida meleagris)*, White-browed Sparrow-Weaver (*Plocepasser mahali*), Crested Francolin (*Dendroperdix sephaena)*, Northern Black-flycatcher (*Melaenornis edolioides*) and Yellow-necked Francolin *(Pternistis leucoscepus*) were some of the species with high number of individuals in wooded grassland. The vegetation structure of wooded grassland could be important for these species to be dominant in the area. The tree species in wooded grassland is associated with a wide range of grasses, shrubs and herbs. The upper storey mainly contains different species of Acacia trees (SZDCT, 2009). Many birds are also habitat specific (Burgess et al., 2002). For example, Helmeted Guinea fowl prefers this kind of habitat since the species prefer open, dry grassland and savannah with scattered trees or shrubby cover and avoid thick forest, marshes and bare land (Smith, 1992). The highest mean number of individuals in wooded grassland could be also related to the more area coverage of wooded grassland compared to riverine forest and wetland. More number of individuals of species is likely to be recorded in large areas. This is probably because more space gives more room for birds and larger opportunities for foraging (Chamberlain et al., 2007). Studies have indicated that size of an area has a significant effect on the composition of bird species (Donnelly and Marzluff, 2004; Antos et al., 2006).

Abundance of bird species during wet and dry season was not significantly different. This is probably due to negligible contrasting effect of season on number of individuals. The inundation of the area during different seasons may not be so severe. According to Aynalem and Bekele (2008), the extended time of inundation of the aera during wet and dry season could contribute to the negligeble effect of season on bird communities. Another possibility is the fact that, due to low habitat quality in the community neighborhoods, the birds simply could move from habitat to habitat rather than leaving the area year-round.

The strongest similarity of bird species between wooded grassland and riverine forest is probably due to the similarity of foraging opportunities and nesting sites between the two habitat types. In line with this, studies have indicated that vegetation cover has a strong influence on bird species diversity (Estades, 1997; Lee and Rotenberry, 2005; Fahrig et al., 2011). In addition, the adjacent occurrence of the two habitat types could be an important source of similarity. Habitat types that are close to one another can share the same number of species. According to Morand (2000), two areas may share the same number of species not because they are similar in area and/or in vegetation diversity, but because they are geographically close which allows individuals to move easily from one island to another.

Helmeted Guinea fowl (*Numida meleagris*) was the most abundant species using encounter rate which could be related with the social and gregarious behavior of the species during foraging, except during the breeding season when the species breaks large flocks (Smith, 1992). This is most likely to boost the species abundance relative to the effort made during the survey as compared to many other solitary species in the study area. According to the study conducted in South Africa, Helmeted Guinea fowl must live in a group so as to survive in the wild, specially where habitat disturbance is a common phenomenon and the number of predators is high (Van Niekerk, 2010).

The large number of rare and uncommon species than abundant and common species occurrence could be associated with habitat condition and behavior of bird species. Rarity of several species appeared to be related with habitat condition (Wilson and Comet, 1996). Moreover, species that are constantly rare have either large home range or patchily distributed (Thiollay, 1994). Breeding nature, large home range, niche of the species and degradation of habitat could be a reason for the species to be uncommon (Ryan and Owino, 2006). Aynalem and Bekele (2009) suggested that habitat

degradation might make most species of birds uncommon. According to SZBCT (2009), cutting trees for fire wood and charcoal production and livestock grazing were common in the present study area. These activities lead to disturbances of birds during reproductive and feeding activities and results in the decrease in individual bird species. As human disturbance increases, birds move away from the area (Blumstein et al., 2005). Human activities such as cutting trees for fire wood and charcoal production were also observed during the study period.

CONCLUSION AND RECOMMENDATION

The present study showed that Loka Abaya National Park is rich in avian fauna and supports high diversity of bird species including rare, uncommon and migratory species. This reveals that the park can be considered as one of the important bird areas in Ethiopia. In terms of avian richness and diversity, riverine forest is the most diversified area. The most abundance of birds that were recorded in wooded grassland, compared to riverine forest and wetland, implies the significance of this habitat in harboring birds. It is likely that riverine forest and wooded grassland are more important for bird species of the area. In general, the park is an area which is priority for bird conservation. Therefore, in the current face of habitat destruction by humans; here is an urgent need for conservation measures for the species and other long-term studies on bird communities of the park for better understanding of the situation in the area on the species and for building on the park's bird species checklist.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGMENTS

The author extends their thanks to NORALD project for financial support provided. They express their indebtedness to Loka Abaya National Park administrator Ato Bezabih Beyene, the park development expert Ato Gezahegn Terefe and all scout members for creating a homely working environment and their unlimited friendly relationship during the field investigations in the park. Finally, they also extend their thanks to Wondo Genet Collage of Forestry and Natural Resources for vehicle services provided.

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