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Full Length Research Paper

Farmers' perceptions of the effectiveness of strategies for managing wildlife crop depredation in Ghana

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Wildlife crop depredation represents a serious human-wildlife conflict around protected areas globally. It undermines farming livelihoods and local support for long-term conservation. Though studies have focused on different aspects such as the economics, spatiotemporal and vulnerability of farms to crop depredation, little attention has been given to the farmers' evaluation of the effectiveness of the strategies used to manage crop depredation. This paper aimed to examine the strategies used to manage wildlife by smallholding farmers who are among those closest to national parks, and how they evaluate the effectiveness of the strategies around Bui National Park in Ghana. Data were collected using semi-structured interviews, involving 17 farmers from Makala community living close to the park. The results indicated that farmers apply a single strategy and/or a multiple strategies, to manage crop depredation. The single strategy is generally ineffective in the long-term, but short-term and temporary successes were observed. However, farmers sought effective results by using strategies in different combinations depending on the major crop cultivated, the wildlife diversity involved, and the frequent experience of farm damage. Understanding the effectiveness of the strategies provides knowledge about how the strategies could be made effective against crop depredation to protect farms and facilitate local support for wildlife conservation.

Key words: Crop depredation, wildlife species, effectiveness, human-wildlife conflict, strategies, protected areas.

INTRODUCTION

Protected areas are the cornerstone of conservation around the world, covering over 32 million square kilometers, and representing about 15% of the world's land area (Juffe-Bignoli et al., 2014). They provide benefits to close communities, including income and employment through tourism (MacKenzie et al., 2017). However, their creation has also resulted in issues such as displacement of local communities, loss of extraction rights, losses due to wildlife interferences with livelihoods, inadequate compensation for losses, and human fatalities resulting from human-wildlife interactions (Namukonde and Kachalic, 2015; Ango et al., 2017). Among these, crop depredation by wildlife is a primary driver of human-wildlife conflicts (HWCs) around protected areas (Salerno

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et al., 2014; Goswami et al., 2015; Anand and Radhakrishna, 2017). This conflict has significant consequences for the communities' farming livelihoods as it causes food insecurity, economic loss and increases income poverty (Kaswamila et al., 2007; Mackenzie and Ahabyona, 2012). As such, it has been a source of a long-standing grievance, decreasing communities' tolerance for wildlife conservation (Hill and Wallace, 2012). The communities often respond by actions such as injuring or killing these wild animals, thus creating conflicts with wildlife authorities and undermining conservation efforts, particularly when wildlife are becoming vulnerable to extinction (Palita and Purohit, 2008).

Crop depredation is expected to intensify with the increasing human-dominating landscape through farming near protected areas (Dakwa et al., 2016). Impoverished communities engaged in farming livelihood around protected areas will experience heavy crop losses, undermining household food security (Nyamwamu, 2016). As a result, crop depredation has emerged as a major food security concern around protected areas as it undermines the role of protected areas to adequately engage with the important United Nations Sustainable Development Goals of ending poverty and hunger.

Studies on crop depredation are extensive and diverse. The central focus of some studies has been to investigate the patterns and spatiotemporal correlates of crop damage so as to better inform conflict management strategies (Hsiao et al., 2013; Karanth et al., 2013; Ango et al., 2017). Other studies have focused on economics (Kaswamila et al., 2007; Mackenzie and Ahabyona, 2012), benefits, problems and solutions (MacKenzie et al., 2017), vulnerability of farming to crop depredation and the technical effectiveness of management strategies through field verification (Vollrath and Douglas-Hamilton, 2002; King et al., 2009). Other studies have focused on specific species like elephants and the strategies for managing them (Mackenzie and Ahabyona, 2012; Seifu and Beyene, 2014). Some focus on strategies, including lethal control such as regulated hunting in developed countries where legislation is strong (Bisi et al., 2007; Strum, 2010), and selective removal of identified problem animals through government intervention (Gurung et al., 2008). Other studies report of strategies such as increasing the size of buffer zones, fencing, human patrols, use of scares and repellents, and barriers (McGuinness and Taylor, 2014; Ango et al., 2017). Particularly, small-scale farmers in Africa use strategies such as crop guarding, hunting, burning, traps, snares, hedges, use of dogs and bees as an 'eco-deterrent' against wildlife depredation (Hill, 2000; Vollrath and Douglas-Hamilton, 2002; Sitati et al., 2005). Other strategies are identified as serving as incentives to support conservation. These include trophy hunting, planting agro-forestry buffers and non-palatable crops, as well as financial assistance to support non-farm projects such as ecotourism, to ease dependency on protected areas (Leader-Williams and Hutton, 2005; Sitati et al., 2005; Kaswamila et al., 2007). In the literature, it is also argued that some strategies are unsustainable and illegal. For instance, Rusch et al. (2005) identified that the use of fire was common in Serengeti and is incompatible with conservation. With regards to the compensation payment for loss due to crop damage, it is viewed as an effort to increase community tolerance of problem species (Madhusudan, 2003; Naughton-Treves et al., 2003; Schwerdtner and Gruber, 2007). However, it is also argued that compensations have often led to a neglect of preventive measures or made people dependent on payments (Bulte and Rondeau, 2005). Even with this, bureaucratic inadequacies and practical barriers in filing complaints were reported to have resulted in an additional transaction cost for the rural poor, often discouraging them from pursuing it (Ogra and Badola, 2008; Seifu and Beyene, 2014).

Even though recent studies focus on the hidden dimensions of HWC (e.g., Barua et al., 2013), studies exploring the crop depredation management strategies and their effectiveness from farmers' perceptions are limited worldwide as most studies have focused on strategies, quantifying of crop damage and suggesting solutions rather than sharing what works and what does not in terms of reducing crop damage by wildlife species. Ignoring farmers' perceptions for improving strategies would undermine their food security and further engender negative attitudes towards wildlife conservation. According to Madden and McQuinn (2014), effective management of crop depredation is an essential precondition for the coexistence of farmers and wildlife. Also, it would help address food security around conservation areas (Adams, 2012). This paper aimed to examine strategies used to manage wildlife crop depredation by smallholding farmers that are among the most vulnerable who live near to conserved areas, and how they evaluate the effectiveness of the strategies around a protected area in Ghana. The purpose was to stimulate the policy-makers and management of protected areas to support the design of locally appropriate and effective management strategies that would reduce wildlife crop depredation, enhance food security and improve protected areas-community relationship.

MATERIALS AND METHODS

Study area

The study was undertaken in Makala community close to the Bui National Park in Ghana. It is located in the Banda District in Brong Ahafo Region lying within latitudes 7º and 8º 45` North and longitudes 2º 52` and 0º 28` West. An estimation of 78.6% of the population in the District engages in subsistent farming, with crop farming as the main agricultural activity (Ghana Statistical Service, 2014).

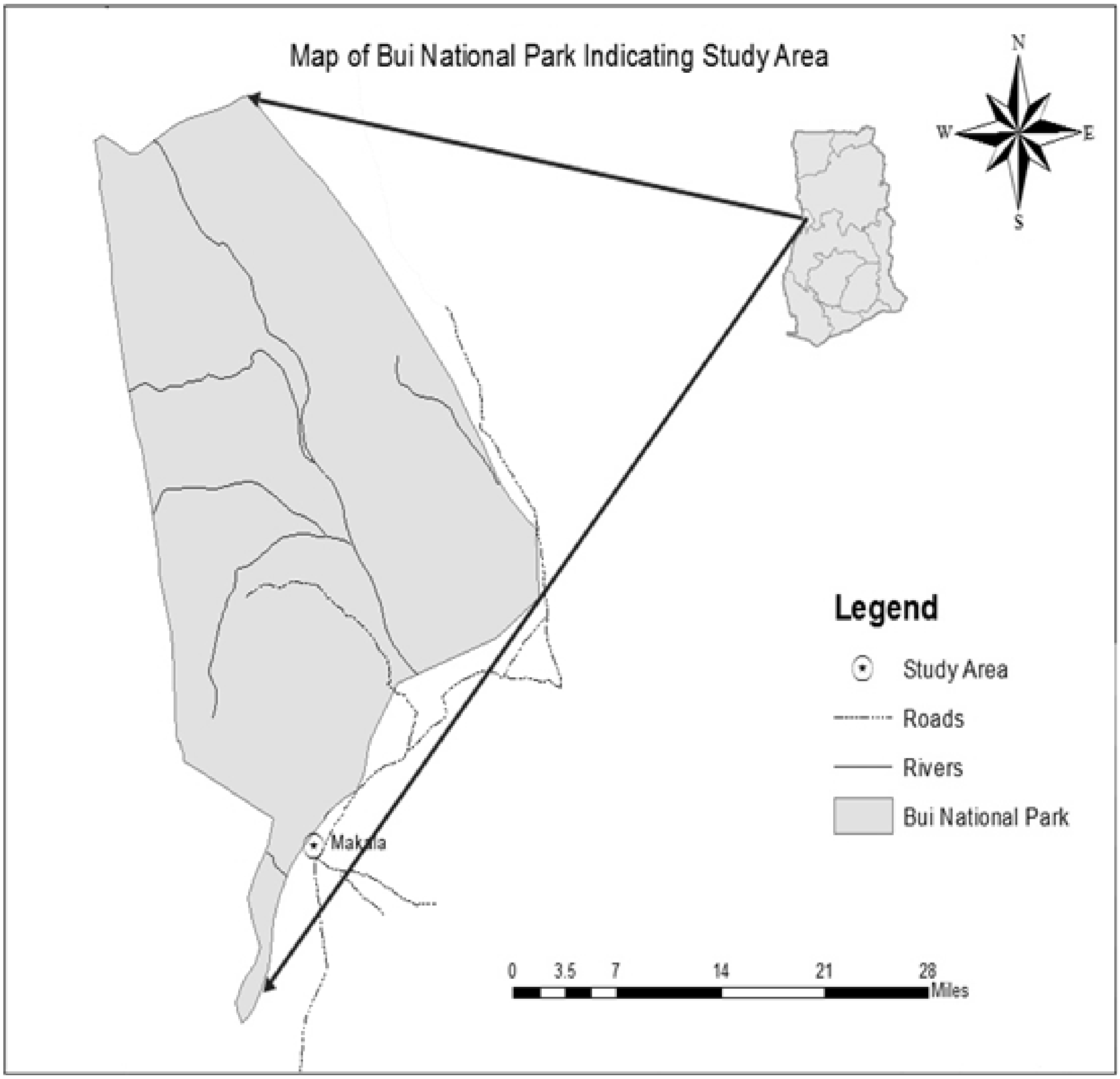

Figure 1. Map of Bui National Park showing Makala.

The temperature is generally high averaging about 24.5°C and the average rainfall regime is between 1,140 and 1,270 mm. The relative humidity is quite high averaging about 75% per year. These conditions account for the moist semi-deciduous forest and the guinea savannah woodland vegetation character of the area. It also accounts for the agrarian livelihood lifestyle of the community. The community has an average household size of 5.5 persons, coupled with a high level of poverty (Ghana Statistical Service, 2014).

In 2009, a government-sponsored hydroelectric power project dammed the Bui Volta River. This has created a lake, covering an area of 444 km² which accounts for an estimated 23% of the total area of the park which is now submerged, altering the ecology and displacing the wildlife to areas outside the park, including farms (Monney et al., 2010). The proximity of Makala community to the park (Figure 1) explains the experience of recurring crop damage on farms. This phenomenon is not only undermining local farming livelihoods and food security but also engendering negative attitudes towards wildlife conservation (Monney et al., 2010; Binlinla et al., 2014).

Case study approach

This study used a qualitative case study approach to examine the perceptions of farmers about strategies for managing crop depredation and their effectiveness, by relying on multiple sources of evidence to provide a clear understanding of the experience rather than generalizing findings (Veal, 2006; Yin, 2011). Most often than not, studies on crop depredation have used surveys based on predetermined categories of responses (e.g., Kaswamila et al., 2007; Monney et al., 2010) ignoring farmers' perceived reality of the experience. In this regard, Hill (2004) recommended assessing farmers' perceptions of crop depredation. As such, Makala, a farming community, was selected as a case based on the following criteria: (1) close proximity to Bui National Park; (2) Household dependence of subsistence agricultural farming for survival; and 3) Prevalence of wildlife crop depredation. These criteria reflect the merit of conducting a study in terms of collecting relevant data, and making the findings relevant to the farming community, Ministry of Food and Agriculture, District Assembly, and Wildlife Division of

Forestry Commission, interested in identifying effective and locally appropriate strategies to ensure household food security and foster local support for wildlife conservation in the locality.

Recruitment of research participants

After obtaining all the necessary permissions from the chief and elders of the community, farmers were recruited using purposive sampling. It was used as the sampling procedure in selecting farmers who have had, and are experiencing, crop damage by wildlife (Veal, 2006). This sampling method was supplemented with snowball sampling, where the initial participants helped to locate other farmers whose farms are nearby (that is, less than 1 km) to Bui National Park and who experienced crop depredation. Seventeen out of 30 farmers targeted for the study responded to participate. The study was conducted in June, during the raining season when farmers were busy preparing their lands for cultivation. They often leave home before 6 am and return after 5 pm. As a result, the other farmers could not participate, because they were either not available or did not have the time to participate in the study. It is worth noting here that, the farmers shared common experiences and not interviewing the other 13 farmers was not likely to significantly affect the nature of the data obtained as data from the four informants were used to understand and validate the experiences of farmers around the protected area. The ages of the farmers ranged from 27-78 years and all were married. As a tradition, men farm with their wives and it was required that they provide farming experiences. Also, key informants such as the chief, and representatives from Ministry of Food and Agriculture (MOFA), District Assemblies, and Bui National Park, were selected and interviewed prior to the engagement with the farmers. They provided background information on farming practices, crop depredation incidences, and local strategies for managing crop depredation in the area. Other secondary sources of information such as reported crop depredation and local attitudes towards wildlife conservation were sought. These sources guided the questions posed during the interviews with the farmers and also used to validate and probe relevant issues during the interviews.

Data collection

In collecting the data, semi-structured interviews were used to elicit farmers' perceptions of the strategies and their effectiveness. According to Brinkmann and Kvale (2015, p. 6), a semi-structured interview is defined as "an interview with the purpose of obtaining descriptions of the lifeworld of the interviewee in order to interpret the meaning of the described phenomena". The interviews were conducted in the house of farmers where they felt comfortable. Farmer’s participation was voluntary and verbal consent was sought from each one before conducting and recording the interviews with a tape recorder. Each interview was then downloaded onto a laptop for safekeeping before the next interview. Confidentiality and anonymity were ensured by the use of pseudonyms for all the farmers involved. Interviews were conducted in the local language (that is, Twi dialect) familiar with both the researcher and participants. On average, each interview lasted for 40 min. Farms were also visited to observe the strategies used and gain an understanding of the level of the effectiveness of the strategies. The fieldwork lasted for four weeks in the month of June 2016.

Data analysis

The recorded interviews were initially translated from the local language (that is, Twi) to the English language. These were then transcribed and all grammatical corrections made before saving them as word documents. These were further uploaded into Nvivo 9, which served the functions of supporting the storing, retrieval and manipulation of texts or documents as well as supporting the creation and manipulation of nodes. Using Nvivo 9, the texts were disassembled or broken down into smaller fragments by assigning labels or codes to the fragments in a process called coding. These fragments were reassembled into themes based on the emerging patterns in the texts (Yin, 2011). The themes emerging from the texts were supported by relevant quotations that represent and justify these themes as discussed in the results part.

RESULTS

Livelihood vulnerability to crop depredation

All the farmers practiced subsistent farming with farm holdings (that is, less than 1.6 ha) located close to the park (that is, less than 1 km). Mixed cropping is the norm but the major food crops cultivated were cassava, yam, cocoyam, groundnut, maize, beans, tomatoes and pepper. Cash crops such as cashew and gourd were identified as well. Yam, cassava and cashew were the most major cultivated crops. Farmers depended heavily on farm produce to feed their households and surplus crops are sold for income to support other household needs such as hired labour, school fees and other food crops not planted.

The interviews revealed three factors explaining farms vulnerability to crop depredation. These were: (i) proximity to the boundary, (ii) wildlife displacement because of increasing submerging areas of the park and (iii) wildlife food preference. Farming close to the boundaries of the park exposed farms to regular wildlife attacks. For instance, Kontoh narrated that: “My farm is close to the park and animals find it easy to come and destroy the food crops”. This is a common experience of all the farmers. Interestingly, they claim that they farm close to the boundary because of limited access to fertile land elsewhere. Also, the damming of the Bui Volta River in the park has submerged about 23% of the total area of the park, destroying wildlife habitats. As a result, farmers perceived that animals are forced out of the park to their farms, because of limited grazing grounds for the wildlife species. Zellem, who has lived in the community for over 50 years, claimed he now encounters more wildlife in his farm than before; attributing this observation to the rising water level in the park.

The feeding behaviour of wildlife is perceived to have changed due to long exposure to cultivated crops close to the park. Farmers claimed that as the animals feed on the crops, they have changed their feeding behaviour and developed a preference for cultivated crops. They have become selective with the kind of food they eat as they raided farms with such food crops. For instance, Abel shared his experience when he narrated that; ‘They like the food crops I grow especially the yam and cassava. It is only the food crops on my farm they destroy always”. Interestingly, farmers are not changing the cultivation of these food crops because they are their main sources of

Table 1. Wildlife species identified as causing crop depredation.

Common names	Scientific names	Encounter	Frequency	Damage
Bushbuck	*Tragelaphus scriptus*	Footprint/droppings	Low	Medium
Patas Monkey	*Erythrocebus patas*	Direct encounter	High	High
Green Monkey	*Chlorocebus sabaeus*	Direct encounter	High	High
Partridge	*Perdix perdix*	Direct encounter	High	High
Ground Squirrel	*Spermophilus* sp.	Direct encounter	High	High
Cane rat	*Thryonomys swinderianus*	Direct encounter	High	High
Buffalo	*Bison bison*	Footprint/droppings	Low	Medium
Porcupine	*Erethizon dorsatum*	Footprint/droppings	Low	Low
Francolin	*Francolinus francolinus*	Direct encounter	Low	Low
Brown Rat	*Rattus norvegicus*	Direct encounter	High	High
Red forest duiker	*Cephalophus natalensis*	Footprint/droppings	Low	Low
Red flank duiker	*Cephalophus rufilatus*	Footprint/droppings	Low	Low

Table 2. Techniques used to manage crop depredation.

Techniques	Detail description	Period
Scarecrow*	Forming human looking structures to scare animals	Not specific
Guns**	Used for giving warning shots or killing problem animals	Not specific
Traps**	Use of metals, wires and wood as traps for animals	Not specific
Repellents*	Dirty oil is sprinkled on food crops to make them unpalatable	Not specific
Noise*	Shouting by farmers/use of noise-making metals to scare animals	Not specific
Farm guards*	Farmers guard or hire guards to protect farms in the night	Night
Dogs*	Dogs are trained to chase animals off the farms	Day
Fire**	Wood is burnt to produce smoke that drives animals	Night
Touch lights*	They are switched on throughout the night in the farm	Night
Radios*	Are played throughout the day on farms to scare animals	Day
Catapults*	Used for giving warning shots or killing problem animals	Day

1. *: Acceptable 2. **: Prohibited.

income. The experience of crop damage reduces household food reserves and income expected from harvest. A farmer lamented that the recurring wildlife damage to their farms limits their abilities to cater adequately for needs such as feeding their children and paying their school fees, because they are not compensated for crops damaged.

Wildlife causing crop depredation

Farmers identified a number of problem wildlife animals causing crop depredation. They based their identifications mainly on observations of footprints and droppings, though there were direct encounters of animals on farms. In all, 12 wildlife species were identified. However, the monkeys, antelopes, rats and the ground squirrels were described as very destructive by farmers and were ranked high, while the others were ranked either low or medium in terms of the perceived level of farm damage caused and frequency of encounter (Table 1).

Based on the interviews, farmers indicated that the level of damage caused by monkeys, antelopes, rats and the ground squirrels is because they visit farms often and/or in their excessive numbers. They uproot and destroy the yam, cassava and groundnut plants. Animals like buffaloes, duikers and porcupine are lone species that only browse the leaves of the cultivated crops. They also cause damage through trampling on the cultivated crops such as groundnut, beans, tomatoes and pepper. They are not often encountered. The other animals, mostly birds, visit often and in high numbers. They feed on ripped corn and the level of damage can be worrying to farmers during harvesting.

Strategies for managing crop depredation

Farmers' have developed strategies for managing crop depredation, targeted at problem wildlife species (Table 2). The strategies that are adopted aimed at deterring, capturing, or killing the animals. Two major strategies

Table 3. Wildlife and strategies for controlling damage.

Common names	Strategies
Bushbuck	Trap/guns/repellent/fire
Patas Monkey	Trap/gun/ guards /catapult/noise
Green Monkey	Trap/gun/ guards /catapult/noise
Patridge	Scarecrow/catapult/radio/noise
Ground Squirrel	Trap/catapult/radio
Cane rat	Trap/gun/repellent/catapult/dog
Buffalo	Trap/gun/repellent/fire
Porcupine	Trap/catapult/radio
Francolin	Trap/catapult/radio
Brown Rat	Trap/gun/repellent/catapult/dog
Red forest duiker	Trap/gun/repellent/fire/guards
Red flank duiker	Trap/gun/repellent/fire/guards

observed were: single technique strategy and multiple technique strategies. Both strategies are locally designed and rudimentary techniques applied in either singly or different combinations depending on the problem wildlife species that are causing damage, the frequency of wildlife encounter, major cultivated crop, and the perceived level of farm damage (Table 3). For instance, where the major cultivated crop was maize, the scarecrow or noise-making using metals were the single technique used, even though some farmers coupled it with catapults and radio which mimic human presence and deterred animals, preventing depredation during the day. Farmers noted learning from other farmers who were using an effective technique for an identified animal. For instance, the application of a single technique can be a knowledge acquired from another farmer using it. According to Joe, "I use pieces of metals on sticks, placed in different places in my maize farm to drive away birds. Another farmer who is a friend showed me this strategy". Also, a typical case was some farmers learning that gas oil sprayed on the leaves of plants reduced browsing. However, where farmers practiced mixed cropping and were exposed to a variety of problem wildlife species, the use of a multiple technique strategy was the norm.

The use of some techniques is a period of time specific. While some farmers use radios and dogs during the day, others use fire, torchlight, and farm guards to deter and prevent depredation during the night. Techniques such as the use of guns, chemical repellent and traps are commonly used but not a period of time specific. The chemical repellent is commonly used in farms, particularly vegetable farms, where either the leaves or fruits of the cultivated crops are the preferred food by wildlife but not humans

Some of the techniques are acceptable while others (such as traps, fire and guns) are prohibited by the park management because of their fatality on the wildlife species and the potential of inducing poaching behaviour among farmers in the locality (Table 2). These techniques are used to harm, immobilize or kill animals to prevent further depredation. Particularly, the use of guns to harm or kill wildlife species is strongly prohibited by park management. However, the use of guns is attributed to the experience of frustration from the destruction of crops. Particularly, the monkeys, antelopes, rats and ground squirrels were found to be very destructive by farmers. They were subjected to different unacceptable techniques to reduce the damages they cause. Interestingly, most identified problem animals are subject to multiple techniques despite the major crop on farms (Table 3).

Effectiveness of strategies

The effectiveness of the strategies used in managing wildlife crop depredation was evaluated by farmers in terms of the efficacy in the use of a single technique, or in combination depending on the major crop cultivated, the animals perceived to be causing damage and the frequency of wildlife encounter and perceived farm damage. They considered a strategy to be effective when farm damage is reduced to a perceived tolerable limit as farmers agree that crop damage cannot be prevented.

Generally, the use of a single technique strategy is viewed as ineffective in the long-term because of the exposure of the farms to a variety of wildlife species and the recurrent nature of farm damage. The extent of damage can be worrying to farmers as it affected household food reserves and expected income from harvest. The ineffectiveness of the single technique is also based on the temporality of the technique in deterring wildlife from the farms as farmers claimed that wildlife species learn to avoid or maneuver around the techniques. However, short-term and temporary successes were observed with this strategy. For instance, farmers noted that the use of scarecrows, traps, fire, and

Table 4. Evaluation of the effectiveness of strategies in scenario agrosystem (major crop).

Major crop	Strategies	Animals	Effectiveness
Maize	Scarecrow	Birds	Less effective
Yam	Traps	Rat	Less effective
Cassava	Traps	Duikers/antelopes	Less effective
Vegetables	Repellent	Duikers/antelopes	Less effective
Maize	Scarecrow/ noise-making /radio	Most animals	Effective
Yam	Traps/gun/repellent/catapult/dog	Duikers/antelopes	Effective

effective in the short-term as each is able to reduce the frequency of wildlife encounter and farm damage. But these techniques need to be coupled with others to ensure a good harvest. In effect, they pointed to the evolutionary applications of techniques, initially from a single technique to multiple techniques as a result of identifying other problem animals in the farms over time. This trend is based on farmers learning from others, who have been a success with techniques against certain problem wildlife. For example, Kwame explained that he was not successful in reducing damage to his maize farm until he was introduced to the use of radio as an effective technique, particularly in the day, against birds.

The application of a multiple technique strategy is viewed as an effective strategy because, in both the short and long-term, multiple techniques reduce the frequency of wildlife encounter and farm damage through the harnessed combined effects of the techniques. Farmers sought for effective results by using these techniques in different combinations depending on the major crop cultivated, the diversity of species involved, and the frequent experience of farm damage (this is explained using agrosystem scenarios as shown in Table 4). As such, a multiple technique strategy is now the norm (because of the different mixed cropping systems in the locality) in order to reduce crop damage and ensure food security. This strategy is also evolutionary as farmers learn from others using effective techniques to combat wildlife species.

DISCUSSION

Subsistence farming livelihoods of local communities around the protected area are exposed to recurring crop depredation by wildlife species. Such vulnerability results from proximity to the boundary, wildlife displacement and wildlife food preference. In sustaining such livelihoods, farmers have developed strategies to manage the wildlife crop depredation. Wildlife species such as monkeys, antelopes, rats and the ground squirrels were viewed as very destructive, because of the high numbers involved and frequency of damage associated with them. Even though other problem animals were reported in other studies, monkeys seem to be a single wildlife species commonly reported as problem animals on farms (Ango et al., 2017; MacKenzie et al., 2017). For instance, Ango et al. (2017) who studied human-wildlife conflict in an agri-forest landscape in Ethiopia also identified monkeys as one of the crop destructive wildlife. As found in this study, farmers use prohibited techniques to manage them.

In struggling to ensure food and income security, despite the rudimentary nature of the strategies, farmers often apply either single or multiple combinations of techniques depending on the major cultivated crops, diversity of problem animals from the park, and frequency of wildlife encounter and perceived farm damage. Single technique strategy on a farm is a planned intervention, dictated by a foreknowledge of a common problem wildlife species. However, this study demonstrated that the single technique strategy is generally perceived as ineffective in the long-term because of the recurrence of crop depredation even though temporary successes were observed. This is consistent with a study in Bardia National Park by Thapa (2010), who reported that communities deployed techniques that are effective, but just for a short period. The general observation from years of studies on crop depredation suggests that wildlife damage is still prevalent around protected areas, giving reasons such as technical faults, high capital requirement, poor cooperation among farmers, lack of commitment of the farmers, and limited resources (Osborn and Parker, 2003; Graham and Ochieng, 2008; Ango et al., 2017). However, the ineffectiveness of this single technique strategy is explained by the application of stand-alone techniques requiring low capital investment and expertise typical of poor farmers. Interestingly, the study found that the single technique strategy may evolve into a multiple technique strategy based on the transfer of local knowledge. Such local knowledge has become instrumental in cases where single techniques strategy is ineffective in reducing crop damage to a tolerable limit. Such observation was found to be a reactive behaviour dictated by the encounter of more problem animals on farms over time.

Generally, multiple technique strategy is found to be a norm because of the practice of mixed cropping systems, which attract a variety of wildlife species. The strategy is effective because the harnessed combined effects of the techniques deters a variety of wildlife species in the long-term and reduces the level of farm damage within a perceived tolerable limit that guarantees food and income security to farmers. These findings contradict other studies in which farmers' evaluation were based on two indicators: (i) animals should be kept away from damaging or eating the crops and (ii) the strategy should be easy and cheap to maintain (King et al., 2009; Hsiao et al., 2013). This study, however, differs because of the elements of farmers' perceived period of effectiveness (that is, long-term) and the limit of farm damage for determining the effectiveness of the two strategies. Though the techniques are traditional and rudimentary, the multiple technique strategy seems to work for the farmers and may help support food security concern around protected areas in Africa as enshrined in the important United Nations Sustainable Development Goals of ending poverty and hunger. However, it raises uncertainty about local support for wildlife conservation as the strategy include the use of prohibited but fatal techniques emanating from frustration relating to a recurrence of crop depredation and lack of compensation for crop losses. Even though some studies suggest that the use of such fatal techniques are often unsustainable, have limited effects and undermine conservation efforts (Rusch et al., 2005; Tweheyo et al., 2005; Holmern et al., 2007), this study found otherwise. The use of fatal techniques such as chemical repellent, fire, traps and guns, though considered illegal or prohibited around the protected area, is particularly appealing to farmers as they acknowledge their efficacies in deterring wildlife against crops in the long-term.

Conclusion

Crop depredation is prevalent human-wildlife conflict around Bui National Park. With this conflict expected to intensify, it may pose serious threats to subsistent farming of communities around the park. Because of the heavy dependence on farming livelihoods, farmers have evolved dual strategies that are traditional but integrative, to manage crop depredation to reduce crop losses and ensure food and income security. The single technique strategy is generally ineffective based on the recurrence of the conflict, though short-term and temporary successes were observed. This strategy is also found to evolve into multiple technique strategy. The use of this strategy reflects a farmer's reactive behaviour supported by the transfer of local knowledge. The multiple technique strategy is a norm, because of the common practice of mixed cropping that attracts a variety of wildlife species. It was observed to be more preferable and effective in the short and long-term as the harnessed and combined effects of the techniques deter a variety of wildlife species and reduce the level of farm damage within a perceived tolerable limit that guarantees food and income security after harvest. However, the use of some illegal strategies, questions the certainty of local support for wildlife conservation and co-existence despite success with multiple technique strategy. With protected areas increasingly becoming embedded in the agricultural landscape, human-wildlife conflict is expected to increase as wildlife habitats are continuously being fragmented by farming activities. The prospects of engaging protected areas to achieve zero poverty and hunger will have to take into account local support for wildlife conservation by encouraging the wide application of a legal multiple technique strategy, which is effective. These strategies need to be supported and up-scaled by policy makers and park management because they are locally designed based on learning and required low capital and expertise, unlike the modern techniques which are beyond the capacity of poor farming communities around protected areas. As well, views of farmers concerning what they can do apart from farming should be explored in future studies to discourage farming near the boundaries of protected areas.

Limitations of the study

Strategies for managing crop depredation and the effectiveness of these strategies were investigated with the focus on farmers with the experiential reality of this phenomenon and farming close (less than 1 km) to the boundaries of a protected area. Farmers with similar or dissimilar experiences farming far away from the boundaries of the national park were not considered because this study sought to improve wildlife-community coexistence, food security and community attitudes towards wildlife conservation. However, their perceptions could have improved the exhaustiveness of the techniques in the locality and enriched the understanding of local evaluation of the effectiveness of the strategies. Also, how certain social factors such as gender, ethnicity and cultural beliefs mediate and shape this conflict and evaluation, were outside the domain of this study. These factors could have explained better the behaviours of farmers, for instance, the application of illegal strategies to manage crop depredation. Future studies are suggested to explore the role of social factors such as gender, ethnicity and cultural beliefs in shaping this conflict and evaluation of the effectiveness of techniques by other farmers beyond the boundaries of the park, to encourage locally evolved strategies likely to deliver long-term solutions to improve food security and coexistence between wildlife and farming communities within the context of the Sustainable Development Goals of zero poverty and hunger around protected areas.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Species' composition and relative abundance of Lakeshore bird species around Lake Hawassa, Ethiopia

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Ecological investigation of species diversity and relative abundance of birds was conducted from January to September 2017 at the shoreline of Lake Hawassa, SNNPR, Ethiopia. Three habitats namely-Tikurwuha wetland, Human settlement and Farmland were identified for the study. A total of 60 bird species under 14 orders and 37 families were identified. In general, 2720 individuals of 81 species of birds were recorded during the wet season and 1557 individuals of 49 species during the dry season. During wet season, Tikurwuha wetland habitat had the highest diversity (H'=3.469) whereas the lowest diversity was recorded in farmland (H'=2.864). Analogously, during dry season the highest and the lowest diversity were recorded in Tikurwuha wetland habitat (H'=2.845) and farmland habitat (H'=2.584), respectively. The overall seasonal species' composition and relative abundance between dry and wet seasons were statistically significant (P < 0.05). In spite of the fact that the lake supports good number of birds' populations, anthropogenic activities going on near the lakeshore such as farm land and human settlement expansions are shrinking available habitats to birds through altering the vegetation composition and structure that ultimately affects birds' abundance and survival. Accordingly, since the existence of lakeshore bird species is based on the lake ecosystem, anthropogenic pressure such as farming activities and human settlement very close to the lake should be banned.

Key words: Birds, relative abundance, species composition, species diversity.

INTRODUCTION

Ethiopia is a country endowed with great natural and cultural diversity. It covers an extraordinary number of the world's broad ecological zones with a high plateau and a central mountain range divided by Great Rift Valley. The country contains remarkable altitudinal range from the Danakil depressions in the Afar 100 masl (meter above sea level) to the mountain top of Ras Dashen in the north 4,620 masl. The diverse ecosystems endowed Ethiopia with a diverse biological wealth of flora, fauna, and microbes. Protected areas in the country comprise 21 National Parks, two Wildlife Sanctuaries, three Wildlife Reserves, 20 Controlled Hunting Areas, six Community Conservation Areas, two Wildlife Rescue Centers, two Community Managed Ecotourism and Hunting Areas, six Open Hunting Areas, three Commercial Ranches, two Botanical Gardens and Herbariums, four Biosphere

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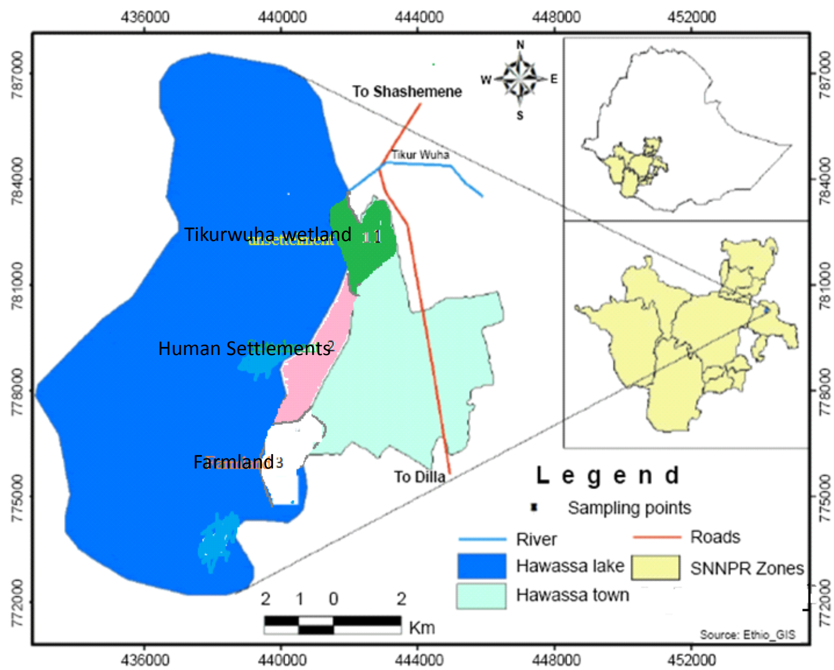

Figure 1. Map of the study area.

Reserves, 80 National Forest Priority Areas and three Municipal Parks (Weldemariam, 2016).

The country harbors 926 species of birds of which 639 are residents and 224 are regular seasonal migrants, including 176 from the Palearctic and 48 inter-African (Lepage, 2016). It is also indicated that 24 species are endemic to Ethiopia whereas additional 13 are shared only with Eritrea. So far in the country, 73 hotspots have been identified as Important Bird Areas (IBAs). Of these, 30 sites (41%) comprise wetlands, while the rest are representatives of other types of ecosystems. Nationally, Ethiopian IBA sites have been grouped into three conservation categories based on distribution and abundance as Critical (19), Urgent (23) and High (31) (Mengistu, 2003).Despite the rich bird assemblages in Ethiopia, due to enormous habitat degradation, fragmentation and loss, survival of many bird species including the endemic and globally threatened ones are endangered (Lepage, 2016). Particularly, expansion of agriculture, livestock encroachment and deforestation by the ever increasing human population has been often mentioned as the major causes of birds' habitat degradation, fragmentation and loss in the country ultimately affecting their survival (Girma et al., 2011).

The lakeshore birds are among the most popular and interesting of birds. They are small to medium size characterized by slender, probing bills and longish legs (Laurent et al., 2012). Shorebirds come in many shapes and sizes, but all of them share certain characteristics, both physically and behaviorally. Nearly all shorebirds have a distinct preference for wet habitats and shorelines, both on coasts as well as along inland waterways, marshes or general riparian habitats most shorebirds are carnivorous and eat a range of insects, mollusks, crustaceans and worms. Physically, these birds have round heads; longer legs and very useful bills (Melissa, 2017).

Lake Hawassa is one of the most productive and aesthetically attractive rift valley lakes in Ethiopia with many ecosystem services. It is one of the eight rift valley lakes in the country and is among the first row of the places where people choose to have an outdoor recreation. The lake hosts diverse wildlife particularly avian fauna. However, although many former studies on the hydrology, water chemistry, fish diversity and other related researches on the lake have been carried out, ecological studies on lakeshore birds are not yet researched. Therefore, the study aimed at gathering primary information on the species composition and relative abundance of lakeshore birds around Lake Hawassa.

MATERIALS AND METHODS

Description of the study area

Lake Hawassa is located in the Southern Nations Nationalities and Peoples Regional State (SNNPR) about 275km south of Addis Ababa with the geographical coordinates of 7°3'N latitude and 38°28'E longitude (Figure 1). It is the smallest of all the Ethiopian rift valley lakes having a total surface area of 95 km^2 and a total drainage area of 1, 371.6 km^2. Its mean depth is 11 m with maximum depth of 22 m. The lake is found at 1,686 masl which is about 16 km long and 8 km wide with an estimated water volume of 1.3 billion m^3 (Zinabu, 2010). The average monthly maximum and minimum temperature of the study area is recorded in March (30.3°C) and December (10.0°C), respectively. Furthermore, the highest and lowest average rainfall records occur in September (233.8 mm) and December (0.2 mm), respectively (NMSA, 2016).

Lake Hawassa contains four main watersheds namely; the Ungauged sub catchment around the lake draining onto the surface of the lake, the Tikurwuha sub watershed draining through the Tikurwuha river, the Wondokosha and the Muleti closed sub watersheds (Yemane, 2004). The Lake is one of the freshwater shallow lakes found in the central Ethiopian Rift Valley. The sum totalities of aquatic and terrestrial habitats adjoining the lake facilitate the rich diversity of flora and fauna compared to other Ethiopian Rift valley lakes. Scores of species with sundry forms of flora, fauna and micro-organisms make the lake extremely rich in biodiversity (Sairam, 2014). The lake is among one of the biggest bird sanctuaries in the rift valley and homeland for several hundred species of water birds, including local and palaearctic migrants with large population of Marabou storks. Further, the lake is a major source of income through eco-tourism while the inhabitants depend on the lake for fishing and recreation (Sairam, 2014).

Preliminary survey

A reconnaissance survey was carried out for a week to be well acquainted with the study area. The area was divided into sampling strata and units that cover the whole area based on habitat type following Buckland et al. (2001). Three different habitat types found near the lakeshore were selected namely; tikurwuha wetland, human settlement and farmland.

Sampling design

Point count method (Manley et al., 2006; Lambert et al*.,* 2009) was used to study abundance and composition of birds in the study area. Data were recorded by distributing points in the given habitat and selecting points from the distributed points on a random basis. (Geographical positioning System (GPS) was used to locate the geographical points for the bird counting stations. Accordingly, 10, 12 and 8 counting stations were used for tikurwuha wetland, human settlement and farmland, respectively. One counting station on each habitat was laid for 300 m length with a fixed width of 100 m (50 m on either side) and two times a month bird survey was made for each habitat. Numbers, types and locations of birds were recorded during a fixed amount of time at each point. Counting stations were marked using a conspicuous colored polyteen sheet at each station. The radius of point counting stations was set at bands based on the birds' delectability test during reconnaissance survey (Norvell et al., 2003; Rosenstock et al*.*, 2002).

Data collection and analysis

Data collection methods

Data collection was carried out from January 2017 to September, 2017. Hence both dry (January to May) and wet (June to September) seasons were considered (Amare, 2005). Bird identifications and counting of individuals were conducted by direct observation aided with binoculars. Observations were made by standing in the middle of the point transect and observing 360° round quietly and gently up to a distance of 50 m radius. Each point transect was 100 m far away from road side to avoid edge effect and 300 m far away from each other to avoid double counting of the same individual of a species following (Shimeles and Afework, 2008). Observation time of 5 to 15 min was used for the count depending upon how conspicuous the birds were. To minimize disturbance during the count, a waiting period of 3 to 5 min prior to counting was applied (Sutherland and Green, 2000). In each observation, bird species were identified and numbers of individual observed within the 50 m radius were recorded on data sheet prepared for this purpose. Data collection was carried out early in the morning from 06:00 to 10:00am and in the late afternoon from 04:00 to 06-30 pm when the activity of birds becomes prominent (Tsigereda, 2011). Identification and categorization of birds to their respective taxonomic groups' done following field guide books (Sinclair and Ryan, 2003; Redman et al*.*, 2009).

Data analysis

Analysis of the data was made using different diversity indices and encounter rates to estimate relative abundances. The species diversity of the area for each month was given in terms of Shannon-Weaver diversity Index. Shannon-Weaver diversity Index is calculated as:

$$H' = \sum_{i=1} (pi)\ (\ln pi) \tag{1}$$

where, i is the proportion of the species relative to the total number of species (pi) multiplied by the natural logarithm of this proportion (ln pi) (Gaines et al., 1999). For estimating the relative abundance of birds in the study area, encounter rate was used to give a crude ordinal scale of abundance following Bibby et al*.* (1998):

$$Encounter\ Rate\ (ER) = \frac{\text{Nuumber of birds recorded}}{Number\ of\ hours\ spent\ searching} X10 \tag{2}$$

Hence, the abundance categories: < 0.1, 0.1-2.0, 2.1-10.0, 10.1-40.0 and > 40 were used. For each category, the following abundance score was given: 1(rare), 2 (uncommon), 3 (frequent), 4 (common), and 5 (abundant), respectively. Therefore, the relative abundance of each bird species was determined on the ordinary scale of rare, uncommon, frequent, common and abundant. Furthermore, by using SPSS (Version.22) software, Chi- square test was employed to determine the effects of season and habitat types on bird's relative abundance and distribution.

RESULTS AND DISCUSSION

Species composition

In the present study a total of 60 bird species belonging to 14 orders and 37 families were identified. Order Passeriformes was represented by the highest number of species (35%). Such higher representation of passerines or perching birds is common as Order Passeriformes is the largest and most diverse order of birds, comprising over half of the world's known bird species (Sibley and Monroe, 1990). On the other hand, the lowest number of species was recorded under Coliformes, Columbiforms, Cuculiform, Acciptriforms and Gruiform orders with one species each. Most of the birds in the study area were observed throughout the study period. Out of the total species recorded in the study area, two species (3.3%) were endemic to Ethiopia, three(5%) species were endemic to Ethiopia and Eritrea, 18 (30%) palertic migrant and 26 (43.3%) resident and the rest species were partially migrant (Table 1).

The present study revealed that lake Hawassa provides important habitat that supports large number of bird species including the two endemic species- Banded Barbet (*Lybius undatus*) and Thick billed raven (*Corvus crassirostris*) as well as other three species-Black winged love bird ((*Agapornis taranta*), Ethiopian Oriole (*Oriolus monacha*) and Wattled Ibis (*Bostrychia carunculata*) which are both endemic to Ethiopia and Eritrea. In addition, the occurrence of winter birds in a significant number (n=18) is an indication that the area is important site for migratory birds too. In a similar study that has been carried out at the southern tip of Lake Tana, 21 species of migratory birds were recorded (Shimeles and Afework, 2008).

Species composition of birds in different seasons was also computed for study sites. In general, during wet season the diversity of bird species in all habitat types was high. During this season, Tikurwuha wetland habitat had the highest diversity (H'=3.469) whereas the lowest diversity was recorded in farmland (H'=2.864). Moreover, the highest evenness record (H'/Hmax=0.9493) was from human settlement habitat whereas the lowest was in Tikurwuha wetland habitat (H'/Hmax=0.9176). On the other hand, during dry season the highest and the lowest diversity were recorded in Tikurwuha wetland habitat (H'=2.845) and farmland habitat (H'=2.584), respectively. The species evenness during this season H'/Hmax was 0.9529, 0.9054 and 0.9463 for human settlement, tikurwuha wetland and farmland habitats, respectively (Table 2). The overall seasonal species composition between dry and wet seasons was statistically significant ($P<0.05$).

Species diversity is the species richness in an area with consideration for species abundance. Richness is an indicator of the relative wealth of species. A combined measure of abundance and richness is however a crucial source of information in determining conservation priorities (Geofrey et al., 2013). The measure of species diversity in the area can be affected by several factors. The sampling method used (Pomeroy, 1992), the size of the study area (Bibby et al*.,* 1998) and habitat heterogeneity (Pomeroy, 1992). Detection probability should also be taken into account because each species in a given habitat has its own probability of being detected, which is usually less than 100% (Shiferaw, 2008). In general, in all habitat types of the present study, bird species diversity during wet season was high due to high species richness and/or evenness.

A total of 60 species of birds belonging to 37 families have been recorded during the present study. Such record of the bird species showed that diversity is very high in the study area. Presumably, this is due to the availability of multiple and variety of alternative food resource and favorable climatic condition for nesting and breeding. According to Borgesio (2004) lakeshore habitats provide ample food resources such as fish, frogs, worms and insects to many bird species. Furthermore, De Filippo (2003) concurs with this idea by pointing out that birds require water as essential component of nutrition and medium for other activities. Among the three habitat types in the present study, relatively the highest species diversity was recorded in Tikurwuha wetland habitat. This is due to the fact that as compared to other habitats, anthropogenic activity in this habitat is very limited which in turn provides good food availability. Smith (1992) described that food resources are one of the key factors to determine species diversity in the particular area. Similar observation has been reported from a study conducted in LakeTana, Yiganda wetland (Shimeles and Afework, 2008). Moreover, high diversity generally indicates more complex and healthier communities since a greater variety of species are allowed for more species interactions hence, greater system stability. On the other hand, in the farmland habitat relatively less bird diversity was observed. This is due `to the fact that the area is covered with vegetables such as onion, cabbages, spinach and carrot and also maize is cultivated. These cash crops are cultivated twice a year in the study area by irrigation of water from the lake. Therefore, birds do not get adequate place for nesting and breeding. According to Meyer and Turner (1992), the conversion of wetlands for agriculture and urban industrial ports affect the nesting and breeding sites of many bird species. The use of irrigation from the lake is steadily increasing not only along the shore line of the lake but also in many of the natural drainage basins that used to recharge the wetland and eventually end up in the lake. In Ethiopia it has been revealed that expansion of agriculture altered the habitats of birds negatively impacting their abundance and distribution (Girma et al*.,* 2011; Pennington and Blair, 2011).

Relative abundance

The relative abundance during the dry season was uncommon (6.6%), frequent (31.6%), common (41.6%) and abundant (20%). On the other hand, during wet season the abundance score was uncommon (8.3%), frequent (30%), common (43.3%) and abundant (18.3%). Rare species were not registered at both seasons (Figure 2). The occurrence of birds at different abundance score was also recorded in all study habitats during both dry and wet seasons. In general, the 'common' abundance category was predominant as compared to other categories irrespective of habitat types and season (Table 3).

Common bird species were very abundant in the study

Table 1. Bird species recorded in the study area.

Order	Common name	Scientific name	Family
	Thick billed Raven♣	*Corvus crassirostris*	Corvidae
	Rufousscrub♥	Cercotrichas galactotes	Muscicapidae
	Ruppell's Robin chat	*Cossypha semirufa*	Muscicapidae
	Red winged warbler♥	Acrocephalusbaeticatus	Acrocephalidae
	Red billed Ox pecker •	*Buphaguserythrorhynchus*	Buphagidae
	Parrot billed Sparrow	Passer gongonensis	Passeridae
	Northen Masked Weaver •	*Ploceus taeniopterus*	Ploceidae
	Bronze Mannikil•	*Lonchura cucullata*	Estrildidae
	Beautiful Sunbird •	*Nectarinia pulchella*	Nectariniidae
Passeriformes	Barred Warbler •	*Sylvia nisoria*	Sylviidae
	African Citril♥	*Serinuscitrinelloides*	Fringillidae
	Collared Sunbird•	*Anthreptescollaris*	Nectariniidae
	Common bulbol•	*Pycnonotusbarbatus*	Pycnonotidae
	Ethiopian Oriole♠	*Oriolus monacha*	Oriolidae
	Fork-tailedDrongo•	*Dicrurusadsimilis*	Dicruridae
	Lesser masked Weaver •	Ploceusintermedius	Ploeceida
	Lesser whitethroat♥	Bucorvusabyssinicus	Sylviidae
	Gardenwarbler♥	*Sylviaborin*	Sylviidae
	Golden Breasted Starling	Lamprotornisregius	Sturnida
	Little Weaver •	*Ploceusluteolus*	Ploeceida
	PygmySunbird •	Hedydipnaplatura	Nectariniidae
	Cattle Egreat♥	*Egrettaalba*	Ardeidae
	Grey Heron♥	*Ardeacinerea*	Ardeidae
	Great Whitepelican•	*Pelecanusonocrotalus*	Pelecanidae
	Hadada Ibis•	*Bostrychiahagedash*	Threskiornithidae
Pelecaniformes	Hamer Kop •	*Scopusumbretta*	Scopidae
	Royal Spoon •	*Plataleaalba*	Threskiornithidae
	Sacred Ibis •	*Threskiornisaethiopicus*	Threskiornithidae
	WattledIbis ♣	*Bostrychiacarunculata*	Threskiornithidae
	African Black Duck	Anassparsa	Anatidae
	Egyptian Goose♥	*Alopochen aegyptiaca*	Anatidae
	Fulvouswhistling Duck•	*Dendrocygnabicolor*	Anatidae
Anseriform	White backed Duck♥	*Thalassornisleuconotus*	Anatidae
	Whitefaced whistling Duck♥	*Dendrocygnaviduata*	Anatidae
	Blue Winged Goose	Cyanochencyanoptera	Anatidae
Columbiforms	Bruce's green pigeon•	*Treronwaalia*	Columbidae
Charadriiformes	African Jackana♥	*Actophilornis africanus*	Jacanidae
	Black-tailed Godwt Green	*Limosalimosa*	Scolopacidae
	Blacked Eremomela	Eremomelacanescens	Cisticolidae
	GreyheadedGull •	*Chroicocephaluscirrocephalus*	Laridae
	Whiskered Tern♥	*Chlidoniashibridus*	Laridae
Coraciiforms	African Hoopoe♥	*Upupaepops*	Upupidae
	Grey headed kingfisher ♥	*Halcyonleucocephala*	Alcedinidae
	Malchites kingfisher •	*Alcedocristata*	Alcedinidae
	PiedKingfisher •	*Cerylerudis*	Alcedinidae
	Silver Checked Hornbil•	*Bycanistesbrevis*	Bucerotidae
	Giant Kingfisher	Megaceryle maxima	Alcedinidae
Piciforms	Greater Honey guide •	*Indicatorindicator*	Indicatoridae
	Banded barbet ♣	*Lybiusundatus*	Lybiidae

Table 1. Contd

Accipitriforms	African Fish eagle♥	Haliaeetusvocifer	Accipitridae
Suliformes	Reed Cormorant •	Microcarboafricanus	Phalacrocoracidae
	Great Carmorat♥	*Phalacrocoraxcarbo*	Phalacrocoracidae
	White breasted Cormorat	Phalacrocorax africanus	Phalacrocoracidae
Psittaciforms	Black winged Love bird♠	*Agapornistaranta*	Psittaculidae
	Baglafecht Weaver	*Ploceusbaglafecht*	Ploeceida
Coliformes	Speckled Mousebird•	*Coliusstriatus*	Coliidae
Ciconiform	Marabou Strock•	*Leptoptiloscrumenifer*	Ciconiidae
	Saddle-billed Stork♥	Ephippiorhynchussenegalensis	Ciconiidae
Gruiform	Reed Knobed Coot ♥	*Fulicacristata*	Heliornithidae
Cuculiforms	Blue-headed Coucal	Centropusmonachus	Cuculidae

♥:Palerctic migrants,♣: Endemic,♠:Endemic to Ethiopia and Eretria •:Resident Un marked species are partially migrant.

Table 2. Bird species diversity during dry and wet seasons.

No. of habitat	Abundance (season)	Species	individuals	D	H’	H’/H ‘max
Tikurwuha wetland	Dry	19	627	0.9371	2.845	0.9054
	Wet	35	1309	0.9668	3.469	0.9176
Human settlement	Dry	16	633	0.9323	2.724	0.9529
	Wet	27	872	0.9589	3.244	0.9493
Farmland	Dry	14	297	0.9207	2.584	0.9463
	Wet	19	539	0.9389	2.864	0.923

H´= Shannon-Wiener Index; H´/H´max= Evenness; D= Diversity Index; H´max= ln (S).

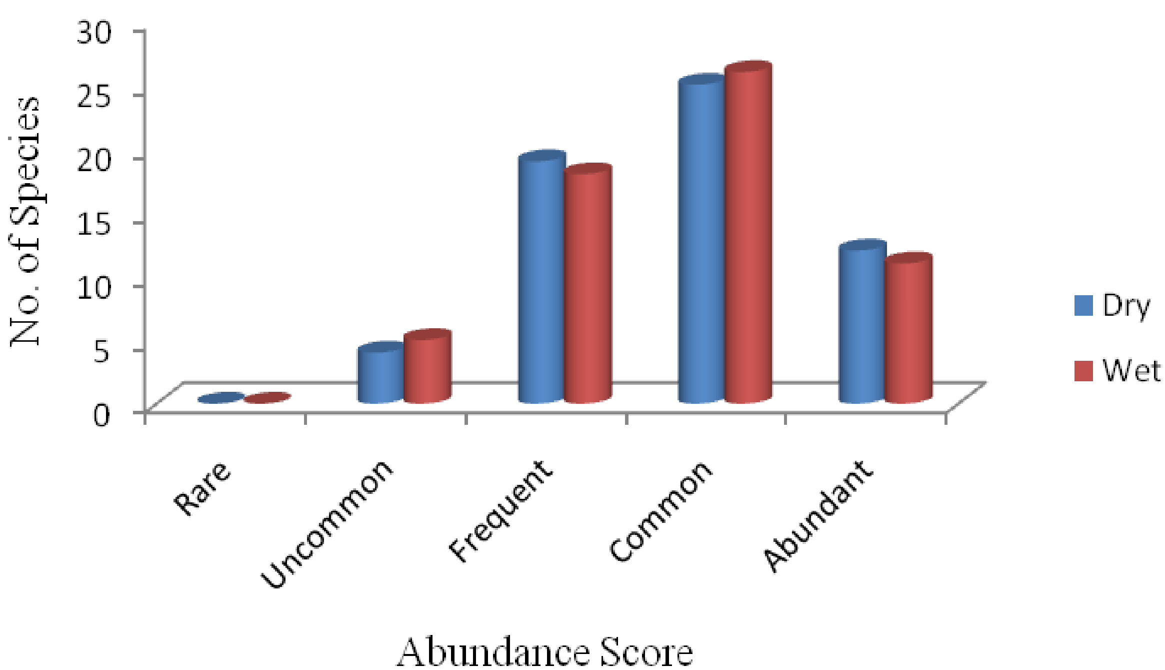

Figure 2. Abundance score of bird species in the study area during dry and wet season.

Table 3. Number of bird species in different relative abundance categories.

Habitat	Season	Uncommon	Frequent	Common	Abundant
Tikurwuha wetland	Dry	3	9	10	4
	Wet	3	10	13	5
Human settlement	Dry	1	7	9	5
	Wet	1	6	10	4
Farmland	Dry	-	3	6	3
	Wet	1	2	3	2

area due to the favorability of the area to satisfy their nutritional requirements during both seasons. These birds were observed foraging on food and water resources available around the lake. For instance, marabou stroke, Sacred Ibis, African Jacana and Hammer Kop were recorded in large number around fish market areas along the lakeshore of the study area. In human settlement areas where there are cafeterias, hotels and boating service delivery sites, White pelicans, Marabou stroke, Baglafecht weaver, Sacred Ibis, Royal spoon and Egyptian Goose were frequently observed foraging on leftover foods. The surrounding area of the lake is covered with dense strands of emergent, submerged and floating aquatic vegetation. Its surface and bottom provide lush habitats for a diverse variety of animal life and extends into swamps, creating an even greater diversity of inter-connected aquatic niches. This habitat diversity supported the floral and faunal richness of the ecosystem and rendered it a key feeding station for migratory birds.

The fishing activity in the lake affects many shore living birds; on the other hand around fish markets the head and internal parts of fish that are discarded during fish harvesting provide food for many bird species. In the present study, Marabou Stork, Great White Pelican, African Sacred Ibis, Little Egret, and Thick billed Raven species were frequently observed feeding on scraps of fish dumped by fishermen. Presumably, these birds forgo their natural pattern of foraging. Marabou storks and pelicans, in particular, were seen flying and crowed among AmoraGedel and Tikurwuhalake shore areas during the periods when fish scraps are dumped.

In the present study, relative abundance of bird species between seasons was significantly varied ($P < 0.05$). A total of 2720 individuals of 81 species of birds were observed during the wet season and 1557 individuals of 49 species during the dry season in the three types of habitats (Table 2). This could be due to the availability of food resources, habitat condition, breeding season and as well as the migratory behavior of the species. In a similar fashion Gaston and Blackburn (2000) explained that distinct seasonality of rainfall and seasonal variation in the abundance of food resource resulted in seasonal changes in the abundance of birds. Moreover, the temporal decoupling between food resource and bird number, variable climate harshness in different regions or the inability of individuals to reach isolated areas affect migratory bird population(Telleria et al., 2009).

In general, the lake shores are important feeding, and breeding sites for birds. Farmers along the shore of the lake cultivate the area when the water level recedes. Fruit trees such as mango and papaya and vegetables are becoming dominant in the study area. At present, the unusually high level of reduction in the size of the lake led many areas under permanent cultivation. Obviously, this could diminish bird's habitat unless appropriate community based conservation measures are taken.

Conclusion

The study area is home for varieties of lakeshore bird species. Among these some are globally threatened species as well as endemic birds of Ethiopia. A total of 60 bird species were recorded in three different habitats. High diversity of bird species was recorded in Tikurwuha wetland area whereas low diversity in farmland area. Both species composition and relative abundance of birds varied between seasons. The availability of food resources, habitat condition, breeding season, migratory behavior and the like might contribute to such variation. Most of the birds in the study area are common in the three habitats. In general, the 'common' abundance category was predominant as compared to other categories irrespective of habitat types and season.

Presently, although the lake supports good number of birds populations, anthropogenic activities going on near the lakeshore such as farm land and human settlement expansions are shrinking available habitats to birds through altering the vegetation composition and structure that ultimately affects birds' abundance and survival. Moreover, the leftover foods dumped from hotels, resorts and cafeterias surrounding the lakeshore affect the natural feeding habit and /or foraging behavior of birds as observed in Marabou Stork, Great White Pelican, African Sacred Ibis, Little Egret, and Thick billed Raven, in the present study.

Recommendations

Based on the result of the study the following recommendations are forwarded:

(i) As the existence of lakeshore bird species is based on the lake ecosystem, anthropogenic pressure such as farming activities and human settlement very near the lake should be banned.
(ii) Concerned authorities should give due concern to lakeshore bird species since these birds can be good sources for ecotourism.
(iii) To have complete ecological information about lakeshore bird species in the study area, additional ecological studies *viz*. feeding behavior, activity pattern, and reproductive behavior and so on should be studied in the future.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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