Addis Ababa University

School of Graduate Studies

College of Natural and Computational Sciences

SPECIES RICHNESS AND COMPOSITION OF BIRD COMMUNITYOFTHE HAMUMA FOREST IN ILUBABOR ZONE, ORMIA REGIONAL STATE, SOUTH-WESTERN ETHIOPIA

by

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A Thesis Submitted to

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In partial fulfillment of the requirements for the degree of Masters of Science (M.Sc.) in Ecological and Systematic Zoology

Advisor: Professor Afework Bekele

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Declaration

I, **Sena Gashe Hora,** declare that the thesis, which I hereby submit for the degree of Masters of Science in **Ecological and Systematic Zoology,** Addis Ababa University, is my own work and has not been previously submitted for a degree at this or any other tertiary institution.

Title: Species Richness and Composition of Bird Community in the Hamuma Forest, Ilubabor Zone, Oromia Regional State, Southwestern Ethiopia

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Abstract

Study on the species richness and composition of bird community in the Hamuma Forest of southwestern Ethiopia was conducted during wet season (July, 2017 for 20 days) and dry season (January-February, 2018 for 20 days). This study aims to compare bird species richness, population abundance; assemblage's composition and diversity across three habitat types (forest, cultivated and open land) and effects of vegetation variables were studied). Sampling sites were randomly selected and 0.5-1 km length transects were taken and bird data were collected using a point transect method. EstimateS 9.1.0 software is used to estimate and compare bird species richness across the three habitat types. SPSS and PRIMER software were used to compare mean bird species richness, abundance and composition similarity, and Shannon diversity index (H') was used for diversity comparison across land use types. Overall, 122 bird species in 12 orders and 41 families with 2 endemic, 10 sub endemic and 7 endangered species were recorded across the three habitat types. Bird species richness was similar in all the three habitat types during both seasons and bird abundance was higher during wet season. The species diversity was higher in cultivated land and species composition is similar in two habitat types (forest and cultivated) in both dry and wet seasons. There is no evidence that disturbance has negatively affecting bird species richness. Future research should focus on comparing guilds (*e.g.,* habitat, feeding and substrate use guilds) in order to better understand the bird species richness and population composition difference and similarity between the three land use types.

Keywords: Afro-tropical montane forest, avifaunal assemblages, Biomes, Hamuma Forest, birds, disturbance.

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1. Introduction

Topographical variability, climate, temperature, availability of suitable resources, barriers of dispersal and inter-specific interaction with organisms sharing the same area (Smithand Chow-Fraser, 2010) are identified as the most important global predictors of avian species richness (Karr, 1971; Davies, N. B., 2000). On the other hand, home range, territories and microhabitats are indicators of the distribution of individuals within an area of convenient habitats. These are governed by access to important resources. Furthermore, the range of species fluctuates depending on habitat change, competition, predation and climatic change (MacArthur, 1961). Correlations between habitat characteristics and species richness, abundance, diversity and composition indicate that bird assemblages in natural forest respond to a complex combination of factors as in other habitats. Some habitat characteristics may change over time (e.g., water depth level, vegetation cover, among others) and bird selection criteria might also change in response to these habitat changes (Riffel *et al.* 2001). Thus, the importance of habitat structure and complexity to avian ecology has been widely documented (Cody, 1985) and positive correlations between habitat cover, habitat area, species richness and local abundance have been observed (MacArthur, 1961).

There are over 10,000 different species of birds grouped under 29 Orders and 181 families across the world (BirdLife International, 2004), out of which, a staggering 1,313 (13%) are threatened under extinction. As the IUCN data, around 197 species are considered critically endangered, and 389 are listed as endangered. The rest are categorized under vulnerable. However, in Africa among the 2355 species, 245 are globally threatened with extinction.

Due to the wide ranges of altitudes, a variety of ecologically distinct areas and climate zones(tropical zone, the subtropical zone and the temperate zone) have led Ethiopia to haveecosystemdiversity and to be recognized asone of the most significant countries in Africa in terms of its avifauna(EWNHS, 1996). The country harbours 918 overall bird species, 18 endemic, 17 near endemic and 31 species are under global conservation concern from these 7 species are endangered, 12 are vulnerable and 14 are near threatened (Lepage, 2011).

Ethiopia is one of the top 25 biodiversity-rich countries in the world, and hosts two of the world's 34 biodiversity hotspots areas, namely; the Eastern Afro-montane and the horn of Africa hotspots.Three-biome assemblages of avifauna are known to occur in the country: the Afro tropical Highland Biome, the Somali-Masai Biome and the Sudan and Guinea Savannah Biome. The Afro-tropical Highland Biome has 48 species of birds of which 7 are endemics. The Somali – Masai Biome is the richest in terms of diversity representing 97 species. It includes 6 endemic species, 3 of which are globally threatened. The Sudan-Guinea savannah Biome is represented in Ethiopia by 16 species (EWNHS, 1996). Not only avian diversity, but also Ethiopia is supporting more than 2970 species of animals and 7,000 of higher plant species with 12% endemics, among the fauna 320 are mammals with 36 endemics, 1,249 arthropods with 11 endemics, 200 fish with 40 endemics, 202 reptiles with 17 endemics and 73 amphibians with 30 endemics (Weldemariam, 2016).

The northern and northeastern portion of East African tropical forest is represented by the remnant montaneforest in the south and southwestern Ethiopia. This region contains the last remaining montane rainforest fragments of the country (Friis, 1992;Sebsebe Demissew, 1993). Hence, the southwestern Ethiopian Montane rainforest is within the Eastern Afromontane Biodiversity Hotspot and Important Bird Areas of international significance. In addition, the southwestern Montane forest is a centre of origin and diversification of Coffea arabica.It is the only forest to contain the highest wild coffee genetic diversity in the world (Zewdie Jote *et al*., 2007). Some authors (Mittermeier *et al.*, 2005) still consider forest of this region as a typical example of tropical forest ecosystem with exceptional species richness, high degree of endemism but under great human pressure.

Diversity, distribution and habitat association of the avian fauna have been taken as good indicators of biodiversity. They are monitors of environmental changes, like the level of contamination and environmental impacts (Chapman and Hall, 1996). The conservation of important avian areas would ensure the survival of a correspondingly large number of other taxa (Stattersfield *et al*., 1998) and avian communities of forest residence have been central in the development of geographical patterns of biodiversity. Eventhough birds have a number of significant roles, degradation and destruction of habitats due to anthropogenic actions are major causes of the decline in populations of many species (Fjeidsa, 2006; Brooks *et al*. 2006).

In forests, alteration of vegetation structure and habitat fragmentation through deforestation and forest degradation are among the main threats affecting avian diversity (Sekercioglu, 2002; Heikkinen *et al*., 2004; Chace ; Walsh, 2006; Shimelis *et al*., 2013; Shimelis, 2016). Forest birds are particularly susceptible to alterations in vegetation structure and forest extent because of their complex social structures and dependence on vertical vegetation structure (Lens *et. al*., 2002; Powell, *et.al*., 2015; Martin and Possingham, 2005; Davies and Asner, 2014). However, studies of forest birds have demonstratedspecies responses to disturbances to be variable and dependent on a number of factors, including species-specific ecological traits and the severity of the disturbance (Newbold *et al*., 2013; Mandal and Shankar Raman, 2016). For example, many forest specialist species are negatively affected by forest disturbance, and insectivorous birds have disappeared from some heavily transformed forests (Canaday, 1997; Sekercioglu *et al*., 2002; Chace and Walsh, 2006 and Gove *et al*., 2008). In contrast, habitat generalist species that are better adapted to open and/or shrub habitats can positively exploit habitat changes induced by disturbance (Chace and Walsh, 2006; Gove *et al*., 2008 and Sekercioglu, 2012). Flexibility in conservation management is therefore needed in order to differentiate between aspects of anthropogenic development and their associated impacts on biotic communities, and to manage the drivers with the greatest ecological impact (Blair, 1996; Entwisle and Stern, 2005). Information necessary for these important conservation actions is often lacking in biologically important areas across the globe, especially tropical forests.

Birds are particularly susceptible to habitat destruction and alteration due to changes in the availability and abundance of food as well as nesting and safe-resting sites, with profound impacts on avifaunal assemblages (Martin and Possingham, 2005; Girma Mengesha *et al*., 2011). Reduction of vegetation cover due to overgrazing or deforestation and changes in soil properties from trampling or agricultural intensification can have severe impacts on vegetation structure and composition and subsequently bird assemblages (Jensen, 1985;Woldu and Mohammed Saleem, 2000; Chown, 2010a). Thus, any activity which results in habitat modification has the potential to significantly impact on bird assemblages.

Although the consequences of human disturbances in forest ecosystems are generally presumed to have negative consequences on biodiversity (Şekercioglu, 2002 and Chown, 2010b), studies have shown conflicting results. Some areas of natural habitats show a tendency to contain higher species richness and/or abundance of particular biological taxa than the surrounding altered or disturbed habitats (Recher, 1969; Heikkinen *et al.*, 2004; Kessler *et al.*, 2005, for plants andGirma Mengesha *et al*., 2011, for birds), whereas at other localities the opposite pattern has been documented (Kumar and Ram, 2005, for plants; Tabeni and Ojeda, 2005, for rodents;and Gove *et al*. 2013 for birds).

Similar results have been reported when a given animal community is grouped into functional guilds. For instance, Canaday (1997) studied the impact of disturbance on birds in Amazonian rainforest in Ecuador and found reduced numbers of insectivores in areas of greater human impact. Şekercioğlu *et al.* (2002) also documented the disappearance of insectivorous birds from tropical forest fragments near Las Cruces, southern Costa Rica. In contrast, Gove *et al*. (2008) found higher bird species richness in disturbed sites than relatively intact sites of montane forest in Ethiopia. This implies that the impact of habitat disturbance on biodiversity can be either positive or negative, depending on the type and severity of the disturbance and the biota or biotic group considered Chown (2010a). While some human-induced disturbances to forests result in a reduction of vegetation cover and subsequently habitat for some biological taxa (e.g. forest specialist mammals and birds) with negative consequences, it can also be a means of creating habitat heterogeneity for generalists and other groups of animals, including invasive species (Fahrig, 2003 andvan Rensburg *et al*., 2002). Globally, overexploitation is one of the main threats driving birds towards extinction globally.In order to sustain the livelihood of birds, these habitats should be managed and protected. So far, many researchers have dealt with the East African (mainly Kenya, Uganda and Tanzania) avian ecology. Few researchers have also conducted research on the diversity and ecology of avian species in some parts of Ethiopia

(EWNHS(1996). Information derived from such assessments could help decision makers understand the conservation importance and status of sites and develop appropriate conservation actions needed if the sites are to retain their conservation significance (ddisu Asefa and Kinahan, 2014; Addisu Asefa, 2015).

Despite the availability of diverse ecosystems in different regions of Ethiopia, like Metu-Gore-Tepi area priority forests of south-western Ethiopia in general, and Hamuma Forest, which is the subject of the present study, is one of such places of conservation concern and one of the 69 IBA (Important Bird Area) from the country. The ecology of most avian species is only little known in the country and in the study area particularly.

The Ilu-Ababora zone of the Oromia National Regional State is one of the southwestern zones of the region. Most of the land surface is under the stated Montane rainforest. In general, inaccessibility and the sparsely populated inhabitants are the two reasons considered to have role in maintaining the unique ecosystem in the zone, until recently. However, recent development activities, such as resettlement programs, in fewer than three decades, and the recent high movement of people in search of arable land for commercial farming are dramatically changing the previous conditions, putting pressure on the existing forest cover. This situation posed significant actual and potential impacts on the intact forest ecosystem and its biodiversity. To this effect, the government and some conservation groups tried to design strategies to save the unique forest and the associated biodiversity. For instance, as of 2012,five of the 38 forest priority areas designated by the OromiaNational Regional State are found in the Ilu-Ababor Zone (OFWE- IAB, 2016).The area includes the following National Forest Priority Areas: Syllem–

Wangas, Sheko, Yeki and Godere.But currently several forest fragment areas in the Ilubabor zone (at least one in the 17 of the 24 districts) are already included in this system.

These forests are thought to hold a high population number of globally threatened avian species.However, the forests are currently highly fragmented due to crop cultivation such as maize (*Zea mays*) and coffee (*C. arabica*) and due to illegal logging by migrants from Harargeh (OFWE- IAB, 2016).The other greatest threat to these forests is the development of estates growing cash-crops. Forests near Gore has been cleared and replaced by tea plantations, and near Alie and Burie Woredas, local villagesexpanded with settlers from northern Ethiopia. This not only increased the population, but also introduced new skills and attitudes such as the increased use of timber for making household items to sell in the expanding urban centers. Conservation in forest priority area, focus on the traditional system,only protecting on tree stands, allowing better condition for regeneration, perform some annual plantation and harvest trees for the state owned timber factories.

Generally, due to increasing population pressure, land is being heavily altered and degraded mainly through agricultural and settlement expansion, overgrazing and deforestation (OFWE-IAB, 2016), all of which could have a profound effect on the biodiversity in general and avifaunal assemblages found in the area. Therefore, biodiversity assessment,particularlyof the major well-known taxa such as birds,in poorly known areas of the country in general and of the study area in particular is required as a matter of urgency in order to understand the spatial and temporal patterns in their diversity and compositionto take appropriate conservation management actions. This proposed study is thereforeintended to add to existing information on birds and to reveal the anthropogenic impacts on avian assemblages of one of the fragmented priority forest of Ilubabor Zone (Hamuma forest).

1.1. Research Question

The study aims to answer the following research questions:

1) Do (and which) habitat type significantly higher in bird species richness, population abundance and diversity in the area?
2) What is the ornithological significance (species diversity and composition) of the Hamumma forest compared with other similar forests in the country?
3) Do (and how) habitat variability (tree abundance and cover, shrub abundance and cover, herb abundance and cover, grass abundance and cover, bare ground cover and canopy cover) significantly affect bird species richness, population abundance and composition in the area

1.2. Hypothesis

The study aims to test the following main hypotheses:

1) Bird species diversity, population abundance and composition of the Hamumma forest is comparable with other similar forests in the country.
2) Some habitat variables (tree, shrub, herbs, grassabundance and cover, bareground and canopy cover) significantly affect bird species richness, population abundance and composition in the area.
3) The area harbors many avian species of locally endemic and globally threatened species.

1.3. Justification

Birds are one of the best and in some cases the only monitors of environmental changes. They serve as natural bio-indicators; changes in bird communities, behaviors and reproductive potential help to examine the long term effects of habitat destruction on biodiversity and ecosystems (Birdlife International, 2001). Birds also can be considered as excellent indicators of biodiversity or productivity of a certain area (EWNHS, 1996). Furthermore, birdsplay critical rolesinappropriate ecological functioning and provisioning of ecosystem services such as, seed dispersal, scavenging offal and as predators of numerous insects and other pests, provide significant direct and indirect economic value on a potentially large scale (Shimelis, 2017). Even though birds offer several very important socio-economic and environmental values and benefits to humans, directly or indirectly, most species have been highlythreatened, particularly in developing tropical countries like Ethiopia, due to ever-increasing pressure on land resources as a result of increasing human and livestockpopulations (Addisu Asefa, 2013 and Haddis Tadele*et.al*., 2014) .Such unbridled human and livestock population has led toincreasing demand of more agricultural and livestock grazing land and other forms of natural resource uses such as fuel wood and construction materials. The ultimate consequences are, the sheer dependence of the people on natural resources and rapid alterationofnatural habitats and decline in diversity and population of birds that rely on such habitats (Gessesse and Kleman, 2007; Addisu Asefa, 2013). Information derived from such assessments could help decision makers understand the conservation importance and status of sites and develop appropriate conservation actions needed if the sites are to retain their conservation significance (Addisu Asefa and Kinahan, 2014; Addisu Asefa, 2015).The study will provide: 1) information on the avifaunal assemblage composition and species richness and abundance of bird community in the Hamuma forest, 2) effects of vegetation variables on avifaunal assemblage composition and species richness and abundance of bird community, 3) the ornithological importance of the area and offer recommendation for future conservation of this taxa in particular and overall biodiversity in general, and 4) effect of forest conversion to cultivated land and illegal settlement in and around the Hamuma forest of south-western Ethiopia. This information, in turn will aid decision makers to objectively evaluate the conservation importance and status of the fragmented forests and develop appropriate conservation actions needed if the area is to retain its conservation significance (Addisu Asefa and Kinahan, 2014; Addisu Asefa, 2015).

2. Objective

2.1. General Objective

The general objective of thisstudy is to examine species richness, population abundance and composition of bird community in the Hamumma forest in the southwestern Ethiopia.

2.2. Specific Objectives

1. To examine bird species richness of the study area.
2. To examine bird population abundance, and composition of the study area.
3. To explore the effect of disturbance and habitat variables on bird species richness, population abundance and assemblage composition.
4. To explore the bird species diversity of the area.

3. Materials and methods

3.1. The study area

Hamumma forest is one of the 17 fragmented priority forests of Ilubabor Zone of southwestern montane forests of Ethiopia.It ispart ofMetu–Gore–Tepipriority forests, a general name used for the forests found along the western edge of the plateausof the country. This forest is located between two Woredas of Ilubabor Zone (Alie and Burie). The majority of this forest is located in Allie Woreda of the Zone and positioned in the geographical coordinates of 07^{o}10'-08^{o}15'N/ 34^{o}55'-35^{o}35E' and 640km away from the capital city of the country AddisAbaba (IBA, 1996).The altitude of the area is between 1,500– 1,900m asl.,and receives a maximum rainfall of 2400mm. The area experiences the rainfall for nine months (OFWE- IAB, 2016). The driest month for the area is December-February. The mean annual temperature of the area is 18.3^{o}c (23.5^{o}c max and 13.1^{o}c).

Floristically, the area shares bothtransitional and afro-montane forests andis the richestforest-type in Ethiopia, with over 100 tree species and a diverse understory(Friis, 1992). Among these tree species, *Aningeri adolfi-friederici* is the largest and most important timber speciesand *Podocurpus falcatus* is also a common timber tree species in the higher altitude of the forest. According to Friis (1992), the most interesting tree canopy are *Ocotea kenyensis, Sapium ellipticum, Macaranga capensis, Olea capensis, several Albizia* species, *Polyscia fulva, Schefflera abyssinica* and several *Ficus* species. There are also several interesting understory trees like Tree fern *(Cyatea manniana)*, found in moist and near water fall forests, *Dracaena steudneri, Coffee Arabica* and *Phoenix reclinata*.

Interms of mammal species, Squirrels, Vervet Monkey, Blue Monkey, DeBrazas Monkey, Colobus Monkey, Anubis Baboon, Jackals, Hyaena, Leopard, Warthog, Giant Forest Hog, Bush-Pig and Common Bushbuck have been seen during surveying priods. Lion is also present rarely.

Most of the area is occupied by farmers who cultivate maize and root crops, keep bees, and collect and/or cultivate forest species, particularly coffee and the endemic spice *Aframomum corrorima*. Thegreatest threat to these forests is the development of estates growing cash-crops (Gumaro tea state) on the side of AlieWoreda, the forest has been cleared and replaced by tea plantations, and settlement with agriculture expansion mainly Maize farm is becoming high

(OFWE-IAB, 2016).

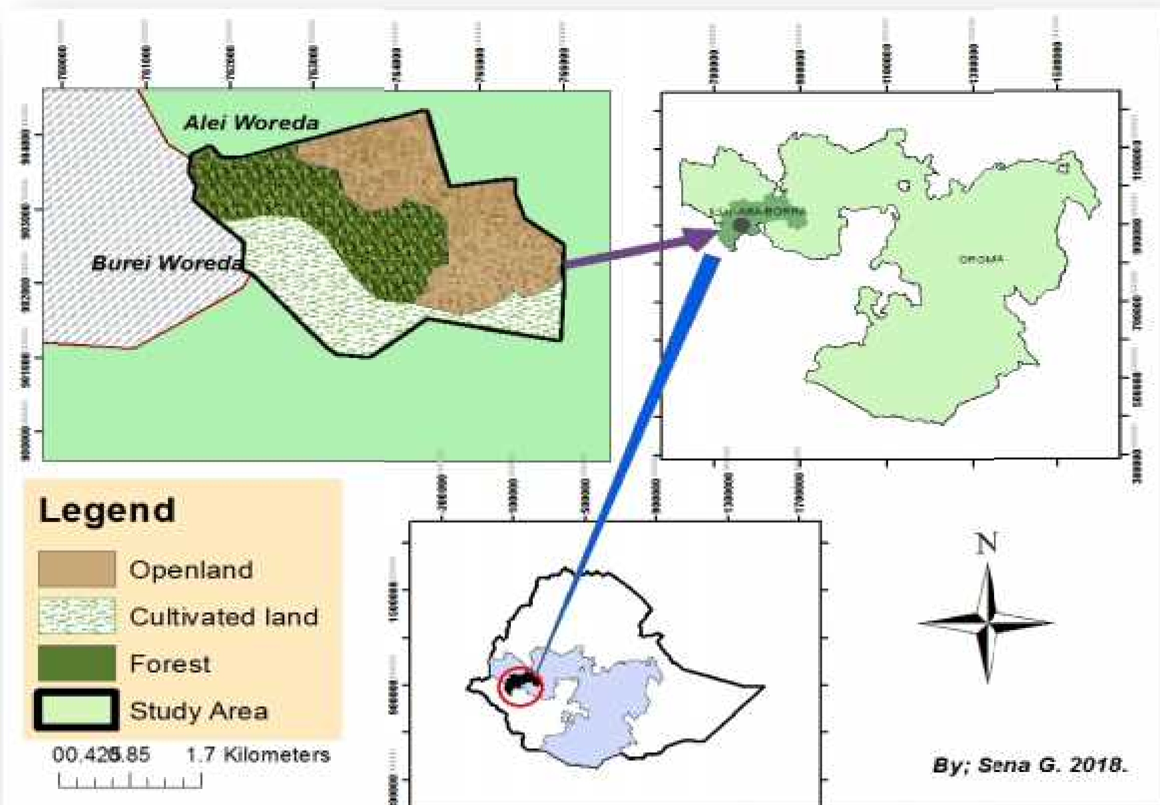

Fig. 1. Map of the study area.

3.2. Materials

Materials used to undertake the study were: GPS, Binoculars, Field Guide Books, Digital Camera, Topographic Map, Bird sound tape recorder, compass, tape measure, rangefinder, sleeping bags, tent and data sheet with pencil and pen and clipboard.

3.3. Methods

3.3.1. Data Collection

3.3.1.1. Bird survey

Most of the time, it is tricky to census of all individual of the population in the forest and in large habitat as well to investigate population size. So, sample count is crucial specially when the population is large, therefore, it is indispensable to select random sample sites depending on the habitat variation of the study area. Based on the vegetation characteristics and level of disturbance. The study area classified in to three different habitat types: Intact forest (with low human disturbance), open land (grassland, wetland and shrub lands), and cultivated land (forest land converted to agriculture and settlement). Sampling units which represent each habitat type were then selected based on Stratified random sampling technique (Gibbons *et al*., 1996; Bibby *et al*., 1998; Buckland *et al*., 2001 and Gregory *et al.*, 2004). GPS coordinates of ach sampling points were used to position the sample sites randomly within each block or grid squares (Bibby *et. al*., 1998). Thirty four line transects (12 in the intact forest, and 12 in cultivated land/ forest converted to agriculture, and 10 in the open land randomly placed parallel to each other along on altitudinal gradients of (1500 – 1800 m asl.) on the north to south direction . Each transect was 0.5-1 km long and adjacent transect in each habitat type were spaced by limiting a minimum of

200 m and 300 m from each other, to reduce double counting and a total of transects were 32.5 km .

Along each transect a 50m radius points were established systematically at every distance of 200 m from each other, to reduce double counting (to reduce pseudo-replication). Point transect counting was used because it has been considered more suitable for sampling cryptic, shy and skulking species in forest habitats where detection probability is reduced by dense vegetation cover, and to relate bird occurrences with habitat features (Gibbons *et al*., 1996; Bibby *et al*., 1998; Buckland *et al*., 2001 and Gregory *et al*., 2004). Points along each transect were selected systematically to avoid effects of habitat edges and double counting between adjacent points. The first fixed points of each transect were selected by ensuring a minimum of 50 m distance from the edge of the forest boundary, and this works for cultivated lands to avoid sampling forest species in cultivated land and open land habitats. The geographic coordinates of each point counting station were also captured and used to navigate to the stations which also ensured that the same transects were re-sampled over time. Bird surveys were carried out in the wet seasons (July) of 2017 for 20 days and dry (January to February for 20 days) of 2018. Each transect in all habitats was surveyed twice on a given day (early morning and late afternoon) in each season, thus, each transect was visited four times in the course of the study. Several authors (e.g. Gibbons *et al.*, 1996 and Bibby *et al.*, 1998) have recommended a sampling period of seven to ten minutes at each counting station, depending on the type of habitat and birds surveyed. Thus, a sampling period of eight minutes was used in the present study with an additional two minutes allocated for birds to settle before commencing counting at each point. Within the eight minutes, birds seen and/or heard within a radius of 50 m were recorded along with their number and estimated sighting distance (in bands of 5 m intervals). Birds flushed away from the census point while approaching the station and those that flew away while counting were recorded from the point they were first seen (van Rensburg *et al*., 2000 and Gregory *et al*., 2004). Birds that were seen flying over the census area and not necessarily making use of the habitat (e.g., swifts, swallows, scavengers and some raptors) were not recorded. However, some predatory birds that hunt from tree canopies (e.g., African Goshawk) and seen making use of the habitat at the time of observation were recorded**.** Counts were conducted early in the morning, between 07h30min and10h30min, and late in the afternoon, between 14h30min and17h30min when the majority of birds are active.

3.3.1.2. Habitat variables

In addition to avian data, six habitat variables were recorded for each habitat type at the same points where point counts were conducted. Vegetation structure variables recorded were: tree abundance (woody species with height > 3m), percentage canopy cover (recorded to the nearest 5%), percentage cover of shrubs (woody plants with height < 3 m) and basal cover of forbs and grass. For trees, sampling was within quadrats of 20 m × 20 m set up at each of the bird counting points. Abundance of each tree species was counted within the quadrates and canopy cover was visually estimated (Newton 2007). At the corners of each of the 20 m × 20 m quadrates, four 5 m × 5 m sub-quadrates were established to estimate shrub, forbs and grass percentage cover. Further, proportion of bare ground was also recorded at each of the sub-quadrates.

3.4. Data Analysis

3.4.1. Bird species richness and abundance

Individual-based sampling procedure was used to calculate species richness. Individual-based sampling was used instead of a sample-based approach because my primary interest was to estimate (compare) species richness (the total number of species at a particular site) rather than species density (the number of species per unit area) (Colwell et al. 2012).

Chao 1 estimator was used, an appropriate estimator for individual-based data (Colwell et al. 2012), to estimate species richness S(est), the total number of species expected in an area, including those species not observed during the survey period for each habitat type and to assess sampling completeness by using the observed species S(obs).

$$S_{obs} = \frac{f_1(f_1 - 1)}{2(f_2 + 1)}, \quad when\ f_1 > 0\ and\ f_2 > 0$$

The total number of species (S_{est}) *calculated from the sample* (S_{obs}),

$$S_{est} = \sum_{k=1}^{S_{obs}} fk$$

$S_{obs} = Observed\ number\ of\ species\ during\ sampling$

$S_{est} = Estimated\ number\ of\ species\ estimated\ from\ sample$

$f_1 = species\ with\ single\ individual$

$f_2 = species\ with\ more\ than\ 1\ individuals$

The summed abundance for each habitat type of the number of individuals of each species recorded in each point was used as the input for the individual-based richness computation. The estimated species richness (S(est)) was calculated using EstimateS 9.1.0 software (Colwell 2017). To compare estimated species richness between habitat types, S(est) of the three habitat types were computed with 95% confidence intervals (CI). These analyses were conducted for each habitat type in each season and for all seasons combined. Following the recommendations of Walther and Moore (2005), Colwell *et al.* (2012), and Colwell (2017), non overlapping 95% CIs of S(est) was used as a criterion difference. In addition, two-way ANOVA in SPSS software (IBM Corporation, 2011) was used to compare mean number of species and bird abundance among habitat types and between seasons a significance level at alpha = 0.05.

3.4.2. Bird species diversity

To compare avian species diversity among habitat types and between seasons, I used Shannon' diversity index (H').

$$H' = -\sum_i p_i \, ln\,(p_i), (i = 1,2,3, \dots), 0 \leq H' \geq \infty$$

p_i = proportion of individual species i', H'= shannon' diversity index

3.4.3. Assemblage composition

Bray-Curtis similarity index was used to calculate similarities in bird species composition among assemblages using PRIMER V6 Software (Clarke and Gorley, 2006). Data were square-root transformed before analysis to down weight common species relative to rare ones (Clarke and Gorley, 2006). Then, an analysis of similarity (ANOSIM) was performed to assess differences in bird species composition between habitat types both within and between seasons (Clarke and Gorley, 2006). Global R values were used to determine the degrees of similarity among treatments. The closer this value is to 1, the more dissimilar are assemblages (Clarke and Gorley 2006). Significances of differences were tested at alpha = 0.05 level.

3.4.4. Habitat variables and their association with bird diversity

For each habitat variable, averaged values from the dry and wet seasons surveys were calculated for each quadrat (bird sampling point) and mean comparison was carried out using One-Way ANOVA in SPSS software. Tukey's multiple mean comparison was used to test significant differences between each pair of habitat type. Regression model was used to examine the effects of habitat variables on bird species diversity and population abundance in SPSS. This was undertaken separately for each habitat type. However, none of the habitat variables showed significant relationship with species richness or bird abundance for all habitat types. Therefore, these results were not presented and discussed in the remaining sections of the thesis.

4. Results

4.1. Bird species richness

The estimated species richness S(est) comparisons between habitat types were made based on observed species richness S(obs) on the three habitat types and by comparison of mean number of species of each habitat between and within seasons. Comparisons of observed and estimated (Chao 1 estimator) species richness for each dataset showed that sampling completeness among habitats was $\geq$85% (Table 1).

Table 1. Observed S(obs) and Chao 1 etimated S(est) species richness, Population abundance, and sampling completeness (percent observed relative to estimated richness) of birds in the study area

Season	Habitat	S(obs)	S(est) Choa 1	Abundance	Sampling completeness
WS	CUL_WS	85	97	1090	87%
	FOR_WS	76	82	1283	93%
	OPL_WS	44	52	329	85%
DS	CUL_ DS	80	86	1144	93%
	FOR_DS	85	97	1208	88%
	OPL_DS	58	65	279	89%
WS		108	116	2702	93%
DS		117	128	2631	92%

S(obs) = number of species observed during survey, S(es)= number of estimated species, CUL_WS=cultivated wet season, CUL_DS=cultivated dry season, FOR_WS=forest wet season, FOR_DS=forest dry season, OPL_WS=open land wet season, OPL_DS=open land dry season, WS=wet season, DS=dry season

A total of 5,333 individuals comprising 122 bird species in 12 order and 41 families were recorded across the three habitat types throughout the study. A total of 2,631 individuals from 117 species in the all habitat types (85 Forest, 58 open land, 80 cultivated) were obtained during the dry season and 2,702 individuals from 108 species in all habitat types (76 forest, 44 in open land and 85 in cultivated land) during the wet season (Table 1 and Table 2).

Table 2. List of species recorded in and around Hamuma forest of the southwestern. Nomenclature follows the checklist of African Bird Club (2012).

Order	Family	English Name	*ScientificName*
Anseriformes	Anatidae	Egyptian Goose	*Alopochen aegytiaca*
		Yellow-billed Duck	*Anas undulata*
Ciconiiformes		Black-headed Heron	*Ardea melanocephala*
	Threskiornithidae	Hadada Ibis	*Bostrychia hagedash*
	Ardeidae	Little Egret	*Egretta garzetta*
	Threskiornithidae	Sacred Ibis	*Threskiornis aethiopicus*
Coliiformes	Coliidae	Speckled Mousebird	*Colius striatus*
Columbiformes	Columbidae	Blue-spotted wood Dove	*Turtur afer*

		Laughing Dove	*Streptopelia senegalensis*
		Lemon Dove	*Aplopelia larvata*
		Namaqua Dove	*Oena capensis*
		Red-eyed Dove	*Streptopelia semitorquata*
		Ring-necked Dove	*Streptopelia capicola*
		Tambourine Dove	*Turtur tympanistria*
Coraciformes	Meropidae	Little Bee-eater	*Merops pusillus*
Cuculiformes	Musophagidae	African-emerald Cuckoo	*Chrysococcyx cupreus*
		Black Cuckoo	*Cuculus clamosus*
		Blue-headed Coucal	*Centropus monachus*
		Klaas's Cuckoo	*Chrysococcyx klaas*
		Red-chested Cuckoo	*Cuculus solitarius*
		White-cheecked Turaco[SE]	*Tauraco leucotis*
Falconiformes	Accipitridae	African Fish Eagle	*Haliaeetus vocifer*
		African Harrier-Hawk	*Polyboroides typus*
		Augur buzzard	Buteo rufofuscus

		Bateleur[END]	*Terathopius ecaudatus*
		Hooded Vulture[END]	*Necrosyrtes monachus*
		White-backed Vulture[END]	*Gyps africanus*
		White-headed Volture[END]	*Trigonoceps occipitalis*
Galliformes	Phasianidae	Chestnut-naped Francolin[SE]	*Pternistis castaneicollis*
Gruiformes	Rallidae	Rouget's Rail[SE]	*Rougetius rougetii*
Passeriformes	Estrilidae	Abyssinian Crimsonwing	*Cryptospiza salvadorii*
	Motacillidae	Abyssinian longclaw[E]	*Macronyx flavicollis*
	Oriolidae	Abyssinian Oriole[SE]	*Oriolus monacha*
	Estrilidae	Abyssinian waxbill[E]	*Paludicola ochrogaster*
	Turdidae	Abyssinian-ground Thrush	*Zoothera piaggiea*
	Cisticolidae	Abyssnian-slaty Flycatcher[SE]	*Melaenornis chocolatinus*
	Fringillidae	African Citril	*Serinus citrinelloides*
	Cisticolidae	African Paradise Flycatcher	*Terpsiphone viridis*
		African-dusky Flycatcher	*Muscicapa adusta*
	Timaliidae	African-hill Babbler	*Streptopelia semitorquata*

Ploceidae	Baglafetch Weaver	*Ploceus baglafecht*
Hirundinidae	Barn Swallow	*Hirundo rustica*
Hirundinidae	Black Saw wing	*Psalidoprocne pristoptera*
Malaconotidae	Black-crowned Tchagra	*Tchagra seneegalus*
Estrilidae	Black-faced Firefinch	*Lagonosticta larvata*
Platysteiridae	Black-headed Batis	*Batis minor*
Estrilidae	Bronze Mannikin	*Spermestes cucullata*
Fringillidae	Brown-rumped Seedeater	*Serinus tristriatus*
Sylvidae	Brown-woodland Warbler	*Phylloscopus umbrovirens*
Sylvidae	Cinnamon-bracken Warbler	*Bradypterus cinnamomeus*
Pycnonotidae	Common Bulbul	*Pycnonotus barbatus*
Laniidae	Common Fiscal	*Lanius collaris*
Estrildidae	Common Waxbill	*Estrilda astrilda*
Cisticolidae	Craoking Cisticola	*Cisticola naatalensis*
Malaconotidae	Ethiopian Boubou	*Pogoniulus pusillus*
Corvidae	Fan-tailed Raven	*Corvus rhipidurus*

Ploceidae	Fan-tailed widowbird	*Euplectes axillaris*
Sylvidae	Gray-backed Camaroptera	*Camaroptera brachyura*
Sturnidae	Greater Blue-Eared Starling	*Lamprotornis chalybaeus*
Muscicapidae	Isabelline Wheatear	*Oenanthe isabellina*
Ploceidae	Lesser-musked Weaver	*Ploceus intemedius*
Alcedinidae	Malachite Kingfisher	*Alcedo cristata*
Zosteropidae	Montane White-eye	*Zosterops poliogastrus*
Hirundinidae	Mosque Swallow	*Cecropsis senegalensis*
Turdidae	Mountain Thrush	*Turdus abyssinicus*
Malaconotidae	Northern puffback	*Dryoscopus gambensis*
Turdidae	Northern Weatear	*Oenanthe oenanthe*
Cisticolidae	Northern-black Flycatcher	*Melaenornis edolioides*
Nectariniidae	Olive Sunbird	*Cyanomitra olivacea*
Cisticolidae	pectoral-patch cisticola	*Cisticola brunnescens*
Corvidae	Peid Crow	*Corvus albus*
Viduidae	Pin-tailed Whydah	*Vidua macroura*

Estrilidae	Red-billed Firefinch	*Lagonosticta senrgala*
Sturnidae	Red-billed oxpecker	*Buphagus erythrorhynchus*
Estrildidae	Red-cheeked Cordon-blue	*Uraeginthus bengalus*
Estrilidae	Red-collared Widowbird	*Euplectes ardens*
Campephagidae	Red-shouldered Cuckooshrike	*Campephaga phoenicea*
Sturnidae	Red-winged Starling	*Onychognathus morio*
Sturnidae	Ruppel's Robin chat[SE]	*Cossypha heuglini*
Nectariniidae	Scarlet-chested Sunbird	*Halcyon chelicuti*
Ploceidae	Spectacled Weaver	*Ploceus ocularis*
Cisticolidae	Stout Cisticola	*Cisticola robustus*
Fringillidae	Streaky Seadeater	*Serinus striolatus*
Alcedinidae	Striped kingfisher	*halcyon chelicuti*
Passeridae	Swainson Sparrow	*Passer swainsonii*
Nectariniidae	Tacaze Sunbird	*Nectarinia tacazze*
Cisticolidae	Tawny-lanked Prinia	*Prinia subflava*

	Corvidae	Thick-billed Raven[SE]	*Corvus crassirostris*
	Malaconotidae	Three-streaked Tchagra	*Tchagra jamesi*
	Nectariniidae	Variable Sunbird	*Cinnyris venustus*
	Ploceidae	Village Weaver	*Ploceus cucculatus*
	Ploceidae	Vitelline-musked Weaver	*Ploceus vitellinus*
	Estrilidae	White and Black Mannkin	*Spermestes bicolor*
	Sylvidae	White-rumped Babler	*Turdoides leucopygia*
	Sylvidae	willow Warbler	*Phylloscopus trochilus*
	Alcedinidae	Woodland Kingfisher	*Halcyon senegalensis*
	Motacillidae	Yellow Wagtail	*Motacilla flava*
	Estrildidae	Yellow-bellied Waxbill	*Coccopygia quartinia*
	Cisticolidae	Yellow-breasted Apalis	*Apalis flavida*
	Fringillidae	Yellow-crowned canary	*Serinus flavivertex*
Piciformes	Picidae	Abyssinian Woodpecker[SE]	*Dendropicos abyssinicus*
	Capitonidae	Banded Barbet[SE]	*Colius striatus*
	Picidae	Cardinal Woodpecker	*Dendropicos fuscescens*

	Capitonidae	Double-toothe Barbet	*Lybius bidentatus*
	Indicatoridae	Greater Honeyguide	*Indicator indicator*
	Picidae	Nubian-Woodpecker	*Camethera nubica*
	Capitonidae	Red and yellow Barbet	*Trachyphonus erythrocephalus*
	Capitonidae	Red-fronted tinker bird	*Pogoniulus chrysoconus*
	Capitonidae	yellow-fronted Tinker bird	*Pogoniulus chrysoconus*
Psittaciformes	Strigidae	African Wood Owl	*Tyto capensis*
	Psittacidae	Black-winged Lovebird^{SE}	*Agapornis taranta*
	Hirundinidae	Lesser-striped Swallow	*Cecropis abyssinica*
	Psittacidae	Yellow-fronted Parrot^{E}	*Poicephalus flavifrons*
Trogoniformes	Bucerotidae	Abyssinian-ground Hornbill^{SE}	*Bucorvus abyssinicus*
	Bucerotidae	Hemprich's Hornbill	*Tockus hemprichii*
	Trogonidae	Narina's Trogon	Apaloderma narina
	Bucerotidae	Silvery-cheecked Hornbill	*Bycanistes brevis*

Gruidae	Black-crowned Crane[R]	*Balearica pavonina*
Numididae	Helmeted Guineafowl[SE]	*Numida meleagris*
Caprimulgidae	Montane Nightjar	*Caprimulgus poliocephalus*
Gruidae	Wattled Crane[R]	*Bugeranus carunculatus*
Ciconiidae	Woolly-necked Stork	*ciconia episcopus*

E = endemic, **SE** = sub-endemic, **END** = endangered**,** **R** = rare

Table 3. Two-Way ANOVA analysis of mean species richness and population abundance of birds in each habitat during the dry season, wet season and pooled seasons (significance level, alpha = 0.05).

Season	Habitat	Richness mean ± S.E.	Abundance mean ± S.E.
Habitat*Season		*F(2,346= 0.217,p=0.805*	*(F2,346=0/079,P=0.924)*
DS	FOR	5.534±0.413	13.045 ± 1.312
	OPL	7.385±1.075	21.462 ± 3.412
	CUL	5.620±0.436	15.342±1.384
WS	FOR	7.363±0.433	13.513 ± 1.376
	OPL	8.188±0.969	20.500 ± 3.076
	CUL	7.237±0.444	16.329±1.411
		F(2,346=1.594, p= 0.205	*(F2,346=5.385,P=0.005)*
Season Combined	FOR	6.429±.311	20.981±2.297
	OPL	6.448±.299	13.279±.950
	CUL	7.786±.723	15.835±.988
		F(1,346=6.356, p= 0.012	*(F1,346=0.008,P=0.927)*
Habitat combined	DS	6.180±.410	16.616±1.303
	WS	7.596±.383	16.780±1.218

CUL = cultivated land, FOR = forest, OPL = open land, DS= dry season, WS = wet season

Results of Two-way ANOVA showed that habitat type had non-significant effect on mean number of species ($F_{2,\ 346}$ = 1.594, P =0.205), but season had significant effect on the mean number of species ($F_{1,\ 346}$ = 6.356, P = 0.012). Mean number of species was significantly greater during the wet season than dry season (Table 3). However, when the interactive effect of habitat type and season) on mean number of bird species was statistically non-significant ($F_{1,\ 346}$ = 0.217, *P* =0.805).

4.2. Bird population abundance

Results of EstimateS 9.1.0 showed that a total of 5,333 individuals recorded during the study time. During wet season, 2,702 individuals (1,090 in cultivated, 1,283 in forest and 329 in open land) and during dry season, 2,631 individuals (1,144 in cultivated, 1208 in forest and 279 in open land) were recorded. Two-way ANOVA (to compaire the mean abundance of the three habitat types and to show their significance difference) showed that mean bird abundance was significantly different among the three habitat types when seasons were combined ($F_{2,\ 346}$ = 5.385, *P* = 0.005). Forest habitat had significantly higher bird abundance than the other two habitat types. However, neither the effect of season ($F_{1,\ 346}$ = 0.008, *P* = 0.927) nor it interaction with habitat type had significant effect on mean number of bird abundance ($F_{2,346}$ = 0.079, *P* = 0.924; Table 3).

4.3. Bird species diversity

Shannon diversity index revealed that although cultivated land (disturbed habitat) had slightly greater bird species diversity than both the forest and open land habitats during both seasons, all habitats had comparable species diversity (Table 4).

Table 4. Avian Species Diversity Comparison across Habitat and Season (Shannon's Diversity Index (H')).

Season	**Habitats**	(H')
DS	CUL	3.86
	FOR	3.78
	OPL	3.68
WS	CUL	3.89
	FOR	3.77
	OPL	3.24
DS		4.09
WS		4.04

CUL=cultivated, FOR=forest, OPL=open land, DS=dry season, WS=wet season

4.4. Assemblage composition

The results of ANOSIM revealed that overall (based on combined season) bird species composition was significantly dissimilar between cultivated land and forest habitats ($R = 0.19$; $P < 0.05$) and between forest and open land ($R = 0.141$, $P < 0.05$) (Table 5). In contrast, regardless of habitat type (i.e., by combining data from all habitat types), bird species composition of the study area was similar between the dry and wet seasons ($R = 0.001$; $P = 0.322$). When each season was separately considered, similarities in wet season species composition between each pair of the three habitats followed similar pattern with that of pooled season, with the forest habitat containing significantly different species composition compared with the cultivated land and openland habitats (R, between forest vs cultivated land = 0.201; forest vs open land = 0.168; in both cases, P <0.05). However, significant difference in species composition during the dry season was revealed only between forest and cultivated land (R = 0.172; P <0.05). However, no significant seasonal difference in species composition was detected within each habitat type (Table 5).

Table 5. Bird assemblage similarity between the three habitat types within seasons and within habitat types between seasons, ANOSIM (PRIMER6) one way analysis (PAIRWISE TEST)

	R	Sign.
Season combined		
CUL vs. FOR	0.19	0.001
CUL vs. OPL	0.002	0.456
FOR vs. OPL	0.141	0.007
Within Habitat*between season		
FOR_WS vs FOR_DS	-0.005	0.714
OPL_WS vs OPL_DS	-0.032	0.752
CUL_DS vs CUL_WS	-0.005	0.677

CUL_WS=cultivated wet season, CUL_DS=cultivated dry season, FOR_WS=forest wet season, FOR_DS=forest dry season, OPL_WS=open land wet season, OPL_DS=open land dry season

4.5. Ornithological Significance

This study identified, a total of 122 birds species, of which 2 were endemic and 10 nearly-endemic (shared with Eritrea). Of the total species, 22 were Afro-tropical highland biome-restricted species, representing 46% of total number of species of this biome known to occur in Ethiopia. Similarly, 2 Somali-Massai biome species and 2 Cumbretam-Terminalia biome species were also recorded from the area during the study period. In addition, 7 species that are globally known to be critically endangered and endangered were recorded (Table 6). These results indicate that the area is of high ornithological importance, which make the area to retain its status of being one of the Important Bird Area (IBA) in the country.

Table 6. Biome-restricted species recorded in Hamuma Forest

Biome	English name	Scientific Name
Afro-tropical highland	Abyssinian Crimsonwing	*Cryptospiza salvadorii*
	Abyssinian Ground Trush	*Zoothera piaggiea*
	Abyssinian Longclaw	*Macronyx flavicollis*
	Abyssinian Oriole	*Oriolus monacha*
	Abyssinian Slaty Flycatcher	*Melaenornis chocolatinus*
	Abyssinian Woodpecker	*Melaenornis chocolatinus*
	African Citril	*Serinus citrinelloides*
	African Hill Babler	*Pseudoalcippe abyssinica*
	Baglafetch Weaver	*Ploceus baglafecht*
	Banded Barbet	*Lybius undatus*

	Black-winged love bird	*Agapornis taranta*
	Brown-rumped Seedeater	*Serinus tristriatus*
	Chestnut-naped Francolin	*Francolinus castaneicollis*
	Montane-Nihgtjar	*Caprimulgus poliocephalus*
	Montane White-eye	*Zosterops Poliogastrus*
	Rouget's Rail	*Rougetius rougetii*
	Ruppel's Robin Chat	*Cossypha heuglini*
	Streaky Seedeater	*Serinus striolatus*
	Swainson's Sparrow	*Passer swainsonii*
	Taccaze Sunbird	*Nectarinia tacazze*
	Thick-billed Raven	*Corvus crassirostris*
	White-cheeked Turacco	*Tauraco leucotis*
Somali-Massai	Three-streaky Tchagra	*Tchagra jamesi*
	White-rumped Babler	*Turdoides leucopygia*
Sudan-Guinea	Black-faced Firefinch	*Lagonosticta larvata*
	Hemprich's Hornbill	*Tockus hemprichii*

4.6. Habitat variables

Both tree abundance and cover were significantly higher in the forest habitat and in the open land than in the cultivated land (tree abundance: $F_{2,334}$ = 133.941; cover: $F_{2,334}$ = 111.211, in both cases, P <0.05; Table 7). Shrub cover was significantly greater in the forest habitat compared to the open land and cultivated land ($F_{2,334}$ = 49.378, P <0.05). However, bare ground cover was significantly greater in the cultivated land ($F_{2,334}$ =29.961, P <0.05) and grass cover significantly lower in the forest habitat ($F_{2,334}$ = 82.780, P <0.05). Herb cover varied among the three habitat types, being highest in the cultivated land, followed by forest habitat ($F_{2,334}$ = 5.878, P <0.05) (Table 7). None of the habitat variables showed significant relationship with species richness or bird abundance for all habitat types. Therefore, no need to present these results and discussed in the remaining sections of the thesis.

Table 7. Mean comparison habitat variables (tree abundance long10 transformed and the others arc-sin transformed) among the here habitat types.

Variable	Cultivated	Forest	Openland
Tree abundance	0.26 ± 0.05[a]	1.10 ± 0.05[b]	0.73 ± 0.12[c]
Tree cover	0.09 ± 0.02[a]	0.40 ± 0.02[b]	0.21 ± 0.05[c]
Shrub cover	0.04 ± 0.12[a]	0.19 ± 0.02[b]	0.17 ± 0.13[b]
Herb cover	0.20 ± 0.02[a]	0.13 ± 0.02[b]	0.10 ± 0.05[c]
Grass cover	0.26 ± 0.02[a]	0.05 ± 0.02[b]	0.23 ± 0.05[a]
Bareground	0.45 ± 0.02[a]	0.30 ± 0.02[b]	0.32 ± 0.04[b]

For each variable, significant mean differences are indicated by different superscript letters

5. Discussion

Despite considerable habitat disturbance in the modified land (cultivated and forest converted to farm land and settlements) patches, the overall avian species richness among the disturbed forest land (cultivated), open land and intact forest of the study area were similar. Avian diversity showed that the cultivated land is more diversified than intact forest habitat. These results contradict the general, and perhaps more expected, trend of lower bird species richness and diversity in farmland and/or disturbed forest compared to undisturbed forest habitats in both tropical and temprate regions (Thiollay, 1995; Daily *et al*., 2001; Naidoo, 2004; Heikkinen *et al*., 2004; Waltert *et al.*, 2004; Seavy, 2009 and Breitbach *et al*., 2010). For instance, Waltert *et al*. (2004) studied natural forests compared to maize fields with little or no remaining natural vegetation, and Seavy (2009) compared birds of continuous natural forest to adjacent banana plantations and their result support that disturbances or agro-forestries have no effect on bird species richness and abundance. In the present study, however, the cultivated land (forested land transformed to maize farm and settlement) areas encompass a mixture of agricultural-forested land cover where trees are retained in agricultural fields. The non-agricultural forested sites are impacted by selective logging and grazing, and have developed secondary growth (shrub layer) that also acts as an additional microhabitat (open land).

Similar to the present study, Gove *et al*. (2008) found equal species richness and higher diversity in overall bird species in adjacent agricultural forest and undisturbed forests in southeast Ethiopia. Furthermore, Girma Mengesha *et al*. (2011) Central Rift Valley, Ethiopia; Mulwa *et al*. (2012) Western Kenya and Addisu Asefa *et.al*. (2017) in the Bale Mountains, found higher bird species richness and over all avian abundance in disturbed forests than in relatively intact adjacent forests. For most of the species associated with the disturbed habitats in their studies, Gove *et al.* (2013) and Mulwa *et al*. (2012) hypothesized that there is connectivity both in time and space to other open areas, including those cultivated for long periods. There are thus many birds that have evolved in more open areas (savannas in lowlands, alpine areas in the highlands, or wetlands) and have since adapted to variegated agricultural areas that can colonize forest areas that have been disturbed and converted. Another explanation could be that African bird species, including sensitive guilds such as understory insectivores may not be as sensitive to forest conversion compared to species found elsewhere due to several thousand years of forest clearance and agrarian activity in Africa (Chapman and Chapman, 1996; Darbyshire *et al.*, 2003), resulting in African fauna to be more tolerant to disturbance (Karr, 1976; Gove *et al.*, 2008; Mulwa *et al*., 2012 and Gove *et al*., 2013).

In addition to these possibilities, more specific explanation can be made regarding the similar species richness in the disturbed forest (cultivated and open land) to comparatively intact forested area in the present study. Previous studies have pointed out that land-use intensity and thus the structural diversity in tropical farmlands strongly influence bird diversity (Harvey *et al*., 2006; Şekercioğlu *et al*., 2007 and Laube *et al*., 2008). Thus, the similar bird species richness reported in the present study for the three habitats (forest, cultivated and open land) may partly be attributable to their higher structural diversity, which comprises both primary and secondary forest patches, forest galleries, open land areas and crops with retained canopy trees (Haddis Tadele, 2014). These heterogeneous structural elements may constitute different micro-habitats and niches for a wider variety of bird species compared to the less disturbed forests that are typically dominated by primary growth with less understory growth (Tewksbury *et al*., 2002 and

Girma Mengesha *et al*., 2011). According to Mulwa *et al*. (2012) and Gove *et al*. (2013), it is also understood that crop fields attract many avian species (for instance, granivore guilds) and possible lack of farming inputs (such as insecticides) in the area can also be considered. Therefore little impact on insect abundance, could have contributed to the persistence of insectivore birds in the cultivated land. Lack of significant differences in species richness between the three land use types is consistent with previous studies (Waltert *et al*., 2004 and Gomes *et al*., 2008). These authors have suggested that some groups of species are less habitat-specific as long as food sources are available to them and thus are more tolerant to habitat alteration. For instance, generalist bird species, particularly, have a wide range of food sources making them more suited to modified (shrubland, openland and cultivated land) areas than forest specialist guilds (Addisu Asefa *et al*., 2017).

On the other hand the area fulfills the criterias of Important Bird Area (IBA). Mostly, the two criteria: 1) species of global conservation concern with 7 species and 2) biome-restricted species (afro-tropical highland biome 22 species, Somali-Massai biome 2 species and Combretam-Terminalia biome 2 species are found in the area. Therefore, the area should be one of the IBAs in the county (EWNHS, 2001).

6. Conclusion and Recommendations

6.1. Conclusion

The result of current disturbance levels found in the Hamuma Forests of southwest Ethiopia has no significant effect on the overall bird species richness compared to less disturbed forests (intact forest) should be interpreted with concern. This might be that the conversion of forest to agricultural land might be recent and did not use pesticide chemicals that have negative effect on biodiversity in general and on bird species in particular. Second, the avian species that inhabits the disturbed habitats (forest areas converted to cultivated land and open land) are not native species. They are generalist bird species those adapted to disturbed habitats. If detailed studies on habitat and feeding substrate guild were undertaken, forest-specialist guilds (native bird species) will be less abundant in disturbed and highly abundant in forested land. This suggests that forest-specialist species are negatively affected by habitat disturbance, favoring non-forest-specialist species (generalist species).

From a forest management perspective, the objective of protecting the Afromontane forest of Ethiopia from an avian perspective should remain that of maximizing all aspects of the overall bird diversity associated with forest (OBARD, 2007).

6.2.Recommendation

- Future work should focus on comparing several sites with varying levels of disturbances (e.g. none, low, medium, heavy, and very heavy) in order to better understand the impacts of disturbance on biodiversity, in general, and birds in particular.
- Forest management and decision making efforts should focus on how best to avoid or minimize forest degradation in order to maximize the overall diversity of bird species that are native and specialists to these biologically important forests with global significance.
- The area should recognize as an Important Bird Area (IBA) in the country.

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