International Journal of Ecology and Environmental Sciences 40 (2-3): 111-121, 2014
ISSN: 0377-015X (Print); 2320-5199 (Online)


# Species Composition, Distribution, Relative Abundance and Habitat Association of Bird Species from Aba Asrat Monastery, East Gojam Zone, Ethiopia

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ABSTRACT

Species composition, distribution, relative abundance and habitat association of birds of Aba Asrat Monastery were surveyed from July 2011 to March 2012. Sampling sites were stratified based on the vegetation types. Line transects and point counting techniques were applied. A total of 169 bird species of which four Intra- African migrants; six Palearctic migrants; four endemic and two globally endangered species were identified. Both forest and bushland habitats had the highest species diversity index and evenness, 0.97 and 0.89, respectively. The relative abundance score of each species in the different habitats was variable. The mean number of birds was highest in forest habitat during both wet and dry season, 38 and 35.75, respectively, whereas farmland had the least (14) during the dry season. Chi square test showed the presence of significant association ($F = 58.20$, $df = 3$, $P < 0.01$) of birds among the habitat types and between seasons ($F = 25.94$. $df = 1$, $P < 0.01$). The monastery supported varieties of species with a number of endemic, threatened and migrant birds but disturbed by intensive human encroachment.

Key Words: Aba Asrat Monastery; Abundance; Bird Diversity; Habitat Association; Species Richness

## INTRODUCTION

Ethiopia possesses broad latitudinal and altitudinal ranges that encompass a large number of ecological zones. It has diverse ecosystems, ranging from humid forests and extensive wetlands in the west and southwest to the desert of Afar depression in the northeast (Wood 1993). The altitudinal differences range from the lowest and hottest place on earth (Dallol depression), 116 m below sea level to the highest peak at Ras Dashen, 4620 m above sea level (Ethiopian Mapping Authority 1988).

Ethiopia is one of the mega-diversity countries consisting of various types of living organisms with variations in species composition. It is endowed with great ecological diversity (EWNHS 1996). There are 288 known terrestrial mammal species, of which 31 are endemic (Sewnet Mengistu 2012). There are 926 species of birds known to occur in Ethiopia, of which 29 are endemic to Ethiopia and neighbouring Eritrea and 19 are globally threatened species. The country is also one of Africa`s leading birding destinations. Its avifauna represents an interesting mixture of East and West African, Palearctic and endemic components (EWNHS 1996).

In Ethiopia, a total of 73 hotspots have been identified as Important Bird Areas (IBAs). Thirty of these sites (41%) comprise wetlands. The rest are representative of other types of ecosystems. Nationally, Ethiopian IBA sites have been grouped into three conservation categories: critical (19), urgent (23) and high (31) (Mengistu Wondafrash 2003). IBAs are internationally important for the conservation of bird biodiversity. Ethiopian Wildlife and Natural History Society (EWNHS) has identified three globally recognized Endemic Bird Areas (EBAs) (BirdLife International 2007).

The Amhara region, in the northwest of the country, has 11 Important Bird Areas (IBAs). The region also has

central Ethiopian Highland Endemic Bird Areas (EBAs). This accounts for over 75% of the region with eight endemic species and 12 highland biome species restricted to Ethiopia and Eritrea (EWNHS 1996). Although, many of these birds are known taxonomically, much of their ecology remains under investigation. Therefore, the aim of the present study is to evaluate the species diversity, distribution, relative abundance and habitat association of birds from Aba Asrat Monastery, East Gojam Zone, Ethiopia.

## STUDY AREA

Aba Asrat Monastery is a specific site where the present study was conducted. The area is located in the Amhara National Regional State, in East Gojam Zone. It is approximately 8 km far from Debre Markos town (the capital town of the zone) in the southeast direction and 292 km from Addis Ababa in the north direction, within the Chemoga River depression. This area has diverse habitats and agro-climatic zones. It is a sacred habitat with diversified natural floral and faunal species. The area possesses tree dominated natural forest, bushland, grassland and farmland habitats (Figure 1).

During the wet season, the forest and bushland habitats are covered with vegetation that produces nectar, flower and seed. The grassland habitat harbours a number of small streams and water logging patches with emerging grasses. Farmland habitat covers crops such as maize, tef, beans and pea. However, during the dry season, the forest and bushland habitats possess relatively similar vegetation cover. In the grassland and farmland habitats, the streams and water logging areas dry up and the crops are harvested, resulting in alteration of the vegetation structure. The altitude of the study area ranges from 2,479 m in the western part, to 2,206 m asl at the southern side in the farmland habitat. The 10 years (1999-2009) mean monthly temperature ranges from $15^0$C during the month of August up to $19^0$C during the month of April. The mean minimum rainfall is 11.7 mm during the month of February and the mean maximum was 312.8 mm during the month of August.

A preliminary survey was conducted during July, 2011. The physical features of different habitats in the study area were assessed using ground survey. The coordinates of each habitat were taken and their boundaries were delineated. The study was conducted from July 2011 to March 2012, covering both wet and dry seasons.

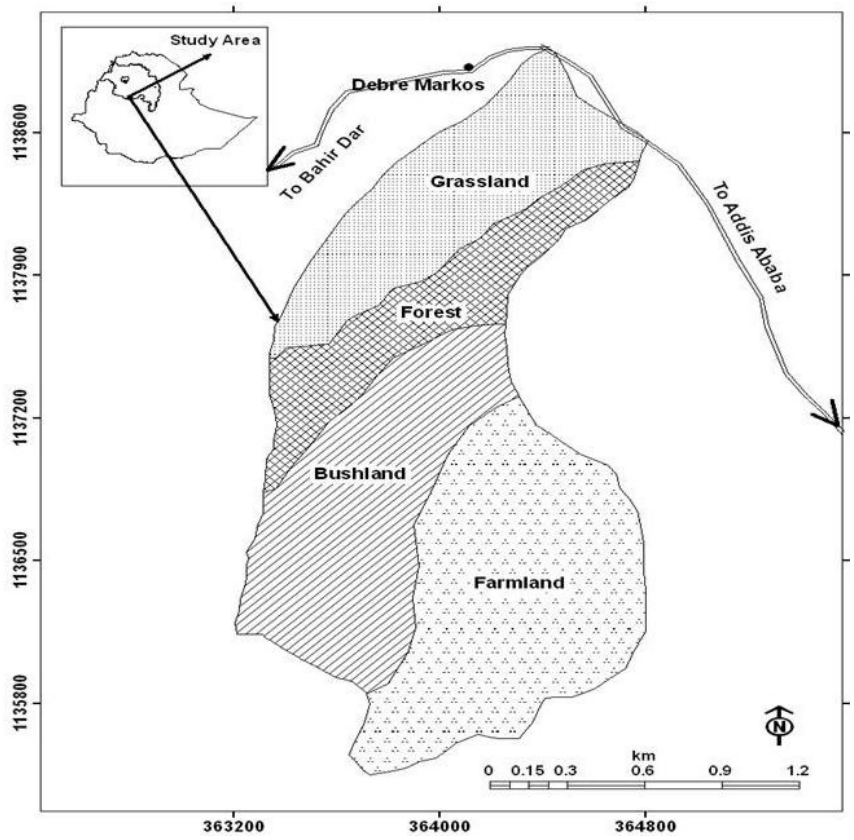


Figure. 1. Map of the study area

## METHODS

### Stratification of the Study Area and Sampling Design

The different habitat types were identified and stratified based on the vegetation cover. The sampling units within each habitat types were determined and assigned on the basis of area coverage. Stratification was made according to the methods of Krebs (1999). The total area of forest, bushland, grassland and farmland habitat was 38, 60, 75 and 90 ha, respectively. About 25% of forest and bushland habitats and 50% of grassland and farmland habitats were covered for sampling. A stratified random sampling technique was used to select the point count sampling sites in the forest and bushland habitats and to specify line transect routes in the grassland and farmland habitats (Bibby et al. 1998). To avoid double counting of birds, sampling sites were spaced out reasonably. There was 150-250 m gap between point count sampling sites and 250-500 m gap between transect routes based on the accessibility of sight in the habitats (Bibby et al. 1998). Birds were recorded for 10 minutes stay at the point count sampling sites. However, the speed of walking on the routes depended on the number of birds present and difficulties in recording them. To minimize disturbance during point count recording, a period of 3-5 minutes wait was applied (Sutherland 1996).

### Data Collection and Analysis

Collection of data was carried out based on the weather condition and the time of the day when most of the birds were active (Bibby et al. 1998). Data were collected early in the morning from 6:30 to 10:00 a.m. and late in the afternoon from 3:00 to 6:00 p.m. (Spencer 1963, Buskirk and McDonald 1995, Sutherland 1996, Bibby et al. 1998 and Centerbury et al. 2000). The type and number of bird species were recorded through direct watching supplemented with binoculars and indirectly using their calls (Bibby et al. 1998). Field guides were used to identify birds observed during the study period. Birds were identified to the species level and their taxonomic groups were properly categorized based on field guides (Sinclair and Ryan 2003).

Bird species diversity was evaluated using Simpson's Index (D) (Simpson 1949) and Shannon-Weaver Index (H') (Shannon-Weaver 1949). Species evenness (H'/H' max) was also calculated. The relative abundance of bird species was determined using encounter rates that give crude ordinal scales of abundance (rare, uncommon, frequent, common and abundant) (Bibby et al. 1998). The effort expended in bird survey results; field stay hours for each observer and the numbers of individuals of each species observed were incorporated in the encounter rates. This allowed an encounter rate to be calculated for each species by dividing the number of birds recorded by the number of hours spent searching to get a figure of birds per hour for each species. The abundance categories (the number of individuals per 100 field hours) were: <0.1, 0.1-2.0, 2.1-10.0, 10.1-40.0 and >40. For each category, the following abundance score was given: 1 (rare), 2 (uncommon), 3 (frequent), 4 (common) and 5 (abundant), respectively. Thus, the relative abundance of each species was determined on the ordinary scale of rare, uncommon, frequent, common and abundant.

Data obtained during the survey period were analyzed using SPSS-17.0 software. One way analysis of variance (ANOVA) was used for habitat comparison in terms of bird abundance in between seasons and among habitats. For mean abundance comparison, the least significant difference (LSD) was used. Chi-square test was used to evaluate season and habitat preference of birds in each vegetation types.

## RESULTS

A total of 169 species of bird were identified in the study area during both wet and dry seasons. The randomly selected sampling sites and line transects in the four habitats have different and common species composition during both seasons. Among the 169 species, 62 were exclusively recorded during the wet season and 40 species were recorded only during the dry season. However, there were 67 species observed during both seasons as residents (Table 1).

Among the recorded species, Order Passeriformes possessed the largest and the most abundant comprising 33 Families and 101 Species. The number of species within a Family ranged 1-16. Family Muscicapidae had highest number of species (16) whereas 17 Families had the lowest; each of them possessed a single species.

A total of 11 endemic species belonging to 7 Orders and 11 Families were observed in the area. Among these, seven species: White-Collared Pigeon (*Columba albitorques),* Rouget's Rail (*Rougetius rougetii*), Wattled Ibis (*Bostrychia carunculata*), Black Winged Lovebird (*Agapornis taranta*), Banded Barbet (*Lybius undatus*), White Backed Black Tit (*Parus leuconotus*) and Thick

Table 1. Bird species recorded during wet and dry seasons
([d] = birds observed only during the dry season [w] = birds observed only during the wet season)

| Family | Common name | Scientific name |
|---|---|---|
| Accipitridae | African White-Backed Vulture | *Gyps africanus,* Salvadori, 1865 |
| | Augur Buzzard | *Buteo rufofuscus,* Rüppell, 1836 |
| | Black Kit | *Milvus migrans,* Boddaert, 1783 |
| | Tawny (and Steppe) Eagle | *Aquila rapax,* Temminck, 1828 |
| | African Harrier-Hawk [D] | *Polyboroides typus,* Smith, 1829 |
| | Bateleur [D] | *Terathopius ecaudatus,* Lesson, 1830 |
| | Montagu's Harrier [D] | *Circus pygargus,* Linnaeus, 1758 |
| | Short-Toed Snake-Eagle | *Circaetus gallicus,* Gmelin, 1788 |
| Acrocephalidae | African Sedge Warbler [W] | *Acrocephalus schoenobaenus,* Linnaeus, 1758 |
| | Olivaceous Warbler [D] | *Hippolais pallid,* Ehrenberg, 1833 |
| Alaudidae | Crested Lark [D] | *Galerida cristata,* Linnaeus, 1758 |
| | Fischer's Sparrow Lark [D] | *Eremopterix leucopareia,* Fischer & Reichenow, 1884 |
| | Lesser Hoopoe-Lark [D] | *Alaemon hamertoni,* Witherby, 1905 |
| Anatidae | Egyptian Goose [W] | *Alopochen aegyptiacus,* Linnaeus, 1766 |
| Apodidae | Alpine Swift | *Tachymarptis melba,* Linnaeus, 1758 |
| | Nyanza Swift [W] | *Apus niansae,* Reichenow, 1887 |
| | Scarce Swift [W] | *Schoutedenapus myoptilus,* Salvadori, 1888 |
| | White-Rumped Swift | *Apus caffer,* Lichtenstein, 1823 |
| | African Palm Swift [D] | *Cypsiurus parvus,* Lichtenstein, 1823 |
| Ardeidae | Black Headed Heron [W] | *Ardea melanocephala,* Vigors & Children, 1826 |
| | Cattle Egret | *Bubulcus ibis,* Linnaeus, 1758 |
| | Grey Heron [W] | *Ardea cinerea,* Linnaeus, 1758 |
| Bucerotidae | African Pied Hornbill | *Tockus fasciatus,* Shaw, 1811 |
| | Black and White Casqued Hornbill | *Ceratogymna subcylindricus,* Sclater, 1870 |
| | Abyssinian Ground Hornbill [D] | *Bucorvus abyssinicus,* Boddaert, 1783 |
| | Crowned Hornbill | *Tockus alboterminatus,* Büttikofer, 1889 |
| Buphagidae | Red-Billed Oxpecker | *Buphagus erythrorhynchus,* Stanley, 1814 |
| Campephagidae | Black Cuckoo Shrike [W] | *Campephaga flava,* Vieillot, 1817 |
| Caprimulgidae | Swamp Nightjar [W] | *Caprimulgus natalensis,* Smith, 1845 |
| Ciconiidae | Black Stork | *Ciconia nigra,* Linnaeus, 1758 |
| | White Stork [W] | *Ciconia ciconia,* Linnaeus, 1758 |
| | Woolly-Necked Stork [W] | *Ciconia episcopus,* Boddaert, 1783 |
| | Yellow-Billed Stork [W] | *Mycteria ibis,* Linnaeus, 1766 |
| | Abdim's Stork [D] | *Ciconia abdimii,* Lichtenstein, 1823 |
| Cisticolidae | Graceful Warbler | *Prinia gracilis,* Lichtenstein, 1823 |
| | Tawny-Flanked Prinia [W] | *Prinia subflava,* Gmelin, 1789 |
| | Churring Cisticola [D] | *Cisticola njombe,* Lynes, 1933 |
| | Masked Apalis [D] | *Apalis binotata,* Reichenow, 1895 |
| | Rattling Cisticola [D] | *Cisticola chiniana,* Smith, 1843 |
| | Red-Faced Cisticola [D] | *Cisticola erythrops,* Hartlaub, 1857 |
| | Trilling Cisticola [D] | *Cisticola woosnami,* Ogilvie-Grant, 1908 |
| Coliidae | Speckled Mousebird | *Colius striatus,* Gmelin, 1789 |
| Columbidae | African Collared Dove [W] | *Streptopelia roseogrisea,* Sundevall, 1857 |
| | Dusky Turtle-Dove | *Streptopelia lugens,* Rüppell, 1837 |
| | Olive Pigeon | *Columba arquatrix,* Temminck, 1808 |
| | Red-Eyed Dove | *Strptopelia semitorquata,* Rüppell, 1837 |
| | Ring-Necked Dove | *Streptopelia capicola,* Sundevall, 1857 |
| | Speckled Pigeon | *Columba guinea,* Linnaeus, 1758 |

| Family | Common name | Scientific name |
|---|---|---|
| | White-Collared Pigeon [EE] | *Columba albitorques,* Rüppell, 1837 |
| | African Mourning Dove [D] | *Streptopelia decipiens,* Hartlaub & Finsch, 1870 |
| Coraciidae | Lilac-Breasted Roller [D] | *Coracias caudate,* Linnaeus, 1766 |
| Corvidae | African Rook | *Corvus capensis,* Lichtenstein, 1823 |
| | Pied Crow | *Corvus albus,* Statius Muller, 1776 |
| | Thick-Billed Raven [EE] | *Corvus crassirostris,* Rüppell, 1836 |
| | White-Necked Raven | *Corvus albicollis,* Latham, 1790 |
| Cuculidae | Great Spotted Cuckoo | *Clamator glandarius,* Linnaeus, 1758 |
| | Klaas's Cuckoo | *Chrysococcyx klaas,* Stephens, 1815 |
| | Red-Chested Cuckoo | *Cuculus solitaries,* Stephens, 1815 |
| | Senegal Coucal [W] | *Centropus senegalensis,* Linnaeus, 1766 |
| | Yellow billed Cuckoo | *Coccyzus americanus,* Linnaeus, 1758 |
| | African Emerald Cuckoo [D] | *Chrysococcyx cupreus,* Shaw, 1792 |
| | Black &White Cuckoo [D] | *Oxylophus jacobinus,* Boddaert, 1783 |
| | White-Browed Coucal [D] | *Centropus superciliosus,* Hemprich & Ehrenberg, 1833 |
| Emberizidae | Southern Rock Bunting [W] | *Emberiza capensis,* Linnaeus, 1766 |
| | Cinnamon-Breasted Rock Bunting [D] | *Emberiza tahapisi,* Smith, 1836 |
| Estrildidae | Dusky Crimsonwing [W] | *Cryptospiza jacksoni,* Sharpe, 1902 |
| | Fawn-Breasted Waxbill [W] | *Estrilda paludicola,* Heuglin, 1863 |
| | Red-Billed Firefinch | *Lagonosticta senegala,* Linnaeus, 1766 |
| Fringillidae | African Citril | *Serinus citrinelloides,* Rüppell, 1840 |
| | Brown-Rumped Seedeater | *Serinus tristriatus,* Rüppell, 1840 |
| | Yellow-Fronted Serin [W] | *Serinus mozambicus,* Müller, 1776 |
| | Black Headed Siskin [D E] | *Serinus nigriceps,* Du Bus de Gisignies, 1847 |
| | Streaky Serin [D] | *Serinus striolatus,* Rüppell, 1840 |
| | Yellow-Crowned Canary [D] | *Serinus flavivertex,* Blanford, 1869 |
| | Yellow Rumped Serin [D] | *Serinus xanthopygius,* Rüppell, 1840 |
| Gruidae | Black Crowned-Crane | *Balearica pavonina,* Linnaeus, 1758 |
| | Grey Crowned-Crane | *Balearica regulorum,* Bennett, 1834 |
| Hirundinidae | Barn Swallow | *Hirundo rustica,* Linnaeus, 1758 |
| | Red-Chested Swallow | *Hirundo lucida,* Hartlaub, 1858 |
| | Western House-Martin [D] | *Delichon urbica,* Linnaeus, 1758 |
| Indicatoridae | Brown-Backed (wahlberg's) Honeybird [D] | *Prodotiscus regulus,* Sundevall, 1850 |
| Laniidae | Common Fiscal | *Lanius collaris,* Linnaeus, 1766 |
| | Long-Tailed Fiscal | *Lanius cabanisi,* Hartert, 1906 |
| | Red-Backed Shrike [W] | *Lanius collurio,* Linnaeus, 1758 |
| Lybiidae | Banded Barbet [W EE] | *Lybius undatus,* Rüppell, 1837 |
| | Yellow-Rumped Tinkerbird [W] | *Pogoniulus bilineatus,* Sundevall, 1850 |
| Malaconotidae | Grey-Green Bush-Shrike [W] | *Malaconotus bocagei,* Reichenow, 1894 |
| | Pink-Footed Puffback [W] | *Dryoscopus angolensis,* Hartlaub, 1860 |
| | Tropical Boubou | *Laniarius ferrugineus,* Gmelin, 1788 |
| | White Helmet Shrike [W] | *Prionops plumata,* Shaw, 1809 |
| Meropidae | Cinnamon-Chested Bee-eater | *Merops oreobates,* Sharpe, 1892 |
| | Little Green Bee-Eater [D] | *Merops orientalis,* Latham, 1802 |
| Monarchidae | African Paradise Monarch | *Terpsiphone viridis,* Müller, 1776 |
| Motacillidae | Red-Throated Pipit [W] | *Anthus cervinus,* Pallas, 1811 |

| Family | Common name | Scientific name |
|---|---|---|
| | Yellow Wagtail [W] | *Motacilla flava,* Linnaeus, 1758 |
| | African Pied Wagtail [D] | *Motacilla aguimp,* Dumont, 1821 |
| Muscicapidae | Abyssinian Slaty Flycatcher [W] | *Melaenornis chocolatinus,* Rüppell, 1840 |
| | Archer's Robin-Chat [W] | *Cossypha archeri,* Sharpe, 1902 |
| | Brown-Tailed Chat [W] | *Cercomela scotocerca,* Heuglin, 1869 |
| | Collared Flycatcher | *Ficedula albicollis,* Temminck, 1815 |
| | Common Stonechat | *Saxicola torquata,* Linnaeus, 1766 |
| | Grey-Winged Robin-chat [W] | *Cossypha polioptera,* Reichenow, 1892 |
| | Mourning Wheatear [W] | *Oenanthe lugens,* Lichtenstein, 1823 |
| | Northern Black Flycatcher [W] | *Melaenornis edolioides,* Swainson, 1837 |
| | Pied Flycatcher [W] | *Ficedula hypoleuca,* Pallas, 1764 |
| | Rueppell's Robin Chat | *Cossypha semirufa,* Rüppell, 1840 |
| | White-Eyed Slaty Flycatcher [W] | *Melaenornis fischeri,* Reichenow, 1884 |
| | Alpine Chat [D] | *Ceromela sordid,* Ruppell, 1837 |
| | Heuglin's Robin-Chat | *Cossypha heuglini,* Hartlaub, 1866 |
| | Isabelline Wheatear [D] | *Oenanthe isabellina,* Temminck, 1829 |
| | Little Rock-Thrush [D] | *Monticola rufocinerea,* Rüppell, 1837 |
| | Pallid Flycatcher [D] | *Bradornis pallidus,* von Müller, 1851 |
| Musophagidae | White-Bellied Go-Away Bird [W] | *Corythaixoides leucogaster,* Ruppell, 1842 |
| Nectariniidae | Amani Sunbird [W] | *Anthreptes pallidigaster,* Sclater & Moreau, 1935 |
| | Bronze Sunbird | *Nectarinia kilimensis,* Shelley, 1884 |
| | Green-Throated Sunbird [W] | *Nectarinia rubescens,* Vieillot, 1819 |
| | Little Olive Sunbird [W] | *Nectarinia seimundi,* Ogilvie-Grant, 1908 |
| | Scarlet-Chested Sunbird | *Nectarinia Senegalensis,* Linnaeus, 1766 |
| | Stuhlmann Double-Collared Sunbird [W] | *Nectarinia stuhlmanni,* Reichenow, 1893 |
| | Tacazze Sunbird [W] | *Nectarinia tacazze,* Stanley, 1814 |
| | Variable Sunbird | *Nectarinia venusta,* Shaw, 1799 |
| Oriolidae | African Black Headed Oriole | *Oriolus larvatus,* Lichtenstein, 1823 |
| | Black headed Forest Oriole [E] | *Oriolus monacha,* Lichtenstein, 1823 |
| Paridae | Stripe-Breasted Tit [W] | *Parus fasciiventer,* Reichenow, 1893 |
| | White-Backed Black Tit [EE] | *Parus leuconotus,* Guérin-Méneville, 1843 |
| Passeridae | Yellow-Spotted Petronia [D] | *Petronia pyrgita,* Heuglin, 1862 |
| Phasianidae | Clapperton's Francolin | *Francolinus clappertoni,* Children, 1826 |
| | Crested Francolin | *Francolinus sephaena,* Smith, 1836 |
| | Harwood's Francolin [E] | *Francolinus harwoodi,* Blundell & Lovat, 1899 |
| | Heuglin's Francolin | *Francolinus icterorhynchus,* Heuglin, 1863 |
| Phoeniculidae | Abyssinian Scimitar Bill [D] | *Rhinopomastus minor*, Rüppell, 1845 |
| Picidae | Cardinal Woodpecker | *Dendropicos fuscescens,* Vieillot, 1818 |
| | Oliver Woodpecker [W] | *Dendropicos griseocephalus,* Boddaert, 1783 |
| | Tullberg's Woodpecker [W] | *Campethera tullbergi,* Sjöstedt, 1892 |
| Platysteiridae | Crested Shrike- Flycatcher | *Bias musicus,* Vieillot, 1818 |
| | Grey-Headed Batis [W] | *Batis orientalis,* Heuglin, 1871 |
| | Banded Wattle-Eye [D] | *Platysteira cyanea,* Bates, 1926 |
| | Chin-Spot Batis [D] | *Batis molitor,* Küster, 1850 |
| Ploceidae | Baglafecht Weaver | *Ploceus baglafecht,* Daudin, 1802 |
| | Mountain Marsh widowbird [W] | *Euplectes psammocromius,* Reichenow, 1900 |

| Family | Common name | Scientific name |
|---|---|---|
| | Red-Billed Quelea [W] | *Quelea quelea,* Linnaeus, 1758 |
| | Red-Collared Widowbird [W] | *Euplectes ardens,* Boddaert, 1783 |
| | Spectacled Weaver [W] | *Ploceus ocularis,* Smith, 1839 |
| | Speke's Weaver [W] | *Ploceus spekei,* Heuglin, 1861 |
| | Yellow-Crowned Bishop [W] | *Euplectes afer,* Gmelin, 1789 |
| | Yellow-Mantled Widowbird [W] | *Euplectes macrourus,* Gmelin, 1789 |
| Psittacidae | Black Winged lovebird [EE] | *Agapornis taranta,* Stanley, 1814 |
| Pycnonotidae | Common Bulbul | *Pycnonotus barbatus,* Desfontaines, 1789 |
| | Sombre Greenbul [D] | *Andropadus importunes,* Vieillot, 1818 |
| Rallidae | Rouget's Rail [W EE] | *Rougetius rougetii,* Guérin-Méneville, 1843 |
| Scopidae | Hammerkop [W] | *Scopus umbretta,* Gmelin, 1789 |
| Stenostiridae | White-Tailed Crested-Monarch [D] | *Elminia albonotata,* Sharpe, 1891 |
| Strigidae | Pearl- Spotted Owlet | *Glaucidium perlatum,* Vieillot, 1817 |
| Sturnidae | Fischer's Starling [W] | *Spreo fischeri,* Reichenow, 1884 |
| | Greater Blue-Eared Glossy Starling | *Lamprotornis chalybeus,* Hemprich & Ehrenberg, 1828 |
| | Magpie Starling [W] | *Speculipastor bicolor,* Reichenow, 1879 |
| | Superb Starling [W] | *Spreo superbus,* Rüppell, 1845 |
| Sylviidae | Blackcap [W] | *Sylvia atricapilla,* Linnaeus, 1758 |
| | Brown Parisoma [W] | *Parisoma lugens,* Rüppell, 1840 |
| | Lesser Whitethroat [W] | *Sylvia curruca,* Linnaeus, 1758 |
| | Menetries's Warbler [W] | *Sylvia mystacea,* Ménétries, 1832 |
| | Red Sea Warbler [W] | *Sylvia leucomelaena,* Hemprich & Ehrenberg, 1833 |
| Threskiornithidae | Hadada Ibis | *Bostrychia hagedash,* Latham, 1790 |
| | Sacred Ibis | *Threskiornis aethiopica,* Latham, 1790 |
| | Wattled Ibis [EE] | *Bostrychia carunculata,* Rüppell, 1837 |
| Timaliidae | Abyssinian Catbird [D E] | *Parophasma galinieri,*Guérin-Méneville, 1843 |
| Turdidae | Groundscraper Thrush | *Psophocichla litsitsirupa,* Smith, 1836 |
| Upupidae | Hoopoe | *Upupa epops,* Linnaeus, 1758 |
| Viduidae | *Acacia* Paradise Whydah [W] | *Vidua paradisaea,* Linnaeus, 1758 |
| | Pin tailed Whydah | *Vidua macroura,* Pallas, 1764 |

Billed Raven (*Corvus crassirostris*) were shared with Eritrea and four species: Harwood's Francolin (*Francolinus harwoodi*), Abyssinian Catbird (*Parophasma galinieri*), Black Headed Siskin (*Serinus nigriceps*) and Black Headed Forest Oriole (*Oriolus monacha)* occurred only in Ethiopia.

Among the recorded species, Banded Wattle-eye (*Platysteira cyanea*) and Amani Sunbird (*Anthreptes pallidigaster*) are endangered species. Black Crowned Crane (*Balearica pavonina*), Harwood's Francolin (*Francolinus harwoodi*) and Grey-Crowned Crane (*Balearica regulorum*) are vulnerable. Bateleur (*Terathopius ecaudatus*), African White Backed Vulture (*Gyps africanus*) and Rouget's Rail (*Rougetius rougetii*) are under the Near Threatened categories. However, the others were Least Concern (IUCN 2008). There were four Intra-African migrants: Abdim's Stork *(Ciconia abdimii);* Great Spotted Cuckoo *(Clamator glandarius);* Red-Chested Cuckoo *(Cuculus solitaries)* and White-Rumped Swift *(Apus caffer)* and six Palaearctic migrants: Barn Swallow *(Hirundo rustica);* Black Kite (*Milvus migrans);* Montagu's Harrier *(Circus pygargus);* Red-Backed Shrike *(Lanius collurio);* White Stork *(Ciconia ciconia) and* Yellow Wagtail *(Motacilla flava)* (BirdLife International 2007).

During the wet season, the highest species diversity was observed in forest habitat (3.73), followed by bushland habitats, 3.54. The grassland habitat had the

lowest species diversity (2.80). During the dry season, the species diversity in the bushland habitat was the highest (3.48). However, the least was observed in the grassland habitat (2.01). The highest species evenness was recorded in the forest habitat (0.93), during the wet season and in the bushland habitat during the dry season (0.91) (Table 2).

Table 2. Bird species diversity during the wet and dry season

| Habitat | Season | No. of species | Abundance | H' | D | H'/H' max |
|---|---|---|---|---|---|---|
| | Wet | 55 | 1268 | 3.73 | 0.97 | 0.93 |
| Forest | Dry | 49 | 1468 | 3.45 | 0.96 | 0.89 |
| | Both | 85 | 2736 | 3.95 | 0.97 | 0.89 |
| | Wet | 54 | 1484 | 3.54 | 0.96 | 0.89 |
| Bushland | Dry | 46 | 1488 | 3.48 | 0.95 | 0.91 |
| | Both | 88 | 2972 | 3.95 | 0.97 | 0.89 |
| | Wet | 33 | 1081 | 2.80 | 0.91 | 0.80 |
| Grassland | Dry | 29 | 1026 | 2.01 | 0.77 | 0.60 |
| | Both | 52 | 2107 | 2.75 | 0.87 | 0.70 |
| | Wet | 35 | 1378 | 2.83 | 0.91 | 0.80 |
| Farmland | Dry | 21 | 336 | 2.08 | 0.79 | 0.68 |
| | Both | 48 | 1714 | 3.09 | 0.93 | 0.80 |

H'= Shannon-Weaver Index; H'/H' max=Evenness; D= Diversity Index; H'max=ln(S)

The abundance of birds in each habitat during the wet and dry seasons varied significantly ($F(3, 8 = 15.2$, $P < 0.01$) and ($F(3, 8 = 53.86$, $P < 0.01$), respectively. During the wet season, the mean number of bird species observed in the forest habitat had significant variation compared to the grassland and farmland habitats ($P < 0.05$), but had no significant variation with the bushland habitat ($P > 0.05$). Bushland habitat had also significant variation with the grassland and farmland habitats ($P < 0.05$). However, the grassland habitat did not show significant variation with the farmland habitat ($P > 0.05$). During the dry season, there were significant differences among the forest, grassland and farmland habitats. The bushland habitat had significant association with grassland and farmland habitats ($P < 0.05$). However, there was no statistically significant difference between forest and bushland habitats ($P > 0.05$).

The relative abundance scores of species during the wet season showed variation. Seven and four species were uncommon in the grassland and farmland habitats, respectively. There were 31, 21, 11 and 16 frequent species in the forest, bushland, grassland and farmland habitats, respectively. In the forest, bushland, grassland and farmland habitats, there were 22, 28, 11 and 11 common species, respectively. There were 1, 5, 4 and 5 abundant species in the forest, bushland, grassland and farmland habitats, respectively. During the dry season, 9 and 10 species were uncommon in the grassland and farmland habitats, respectively. There were 28, 16, 12 and 8 frequent species in the forest, bushland, grassland and farmland habitats, respectively. The forest, bushland, grassland and farmland habitats had 17, 26, 4 and 1 common species, respectively and 5, 3, 4 and 2 species were abundant in these habitats, respectively (Table 3).

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

| Habitat | Season | Uncommon | Frequent | Common | Abundant |
|---|---|---|---|---|---|
| Forest | Wet | - | 31 | 22 | 1 |
| | Dry | - | 28 | 17 | 5 |
| Bushland | Wet | - | 21 | 28 | 5 |
| | Dry | - | 16 | 26 | 3 |
| Grassland | Wet | 7 | 11 | 11 | 4 |
| | Dry | 9 | 12 | 4 | 4 |
| Farmland | Wet | 4 | 16 | 11 | 5 |
| | Dry | 10 | 8 | 1 | 2 |

The number of bird species, during the wet season, the highest mean number of birds was recorded from forest (38) followed by bushland habitat (37). Grassland and farmland habitats supported the least, relatively, and almost equal number of species (26). During the dry season, highest number of species was observed from forest (35) followed by bushland habitat (33). The least number of bird species was recorded from farmland habitats (14) (Table 4).

The distribution and abundance of birds were highly associated both to habitat types and seasons (Figure 2). High significant differences were observed among the habitat types ($F = 58.20$, $df = 3$, $P < 0.01$) and among seasons ($F = 25.94$. $df = 1$, $P < 0.01$). The interaction between habitats and seasons also showed significant difference on the abundance and distribution of birds ($F = 3.82$, $df = 3$, $P < 0.05$).

Table 4. Number of species in different habitats (mean ± SE)

| Season | Habitat | Sampling units | M ± SE |
|---|---|---|---|
| | Forest | 4 | 38.0 ± 1.5 |
| Wet | Bushland | 4 | 37.5 ± 1.2 |
| | Grassland | 2 | 26.5 ± 1.5 |
| | Farmland | 2 | 26.5 ± 2.5 |
| | Forest | 4 | 35.8 ± 1.1 |
| Dry | Bushland | 4 | 33.3 ± 1.1 |
| | Grassland | 2 | 20.5 ± 1.5 |
| | Farmland | 2 | 14.0 ± 2.0 |

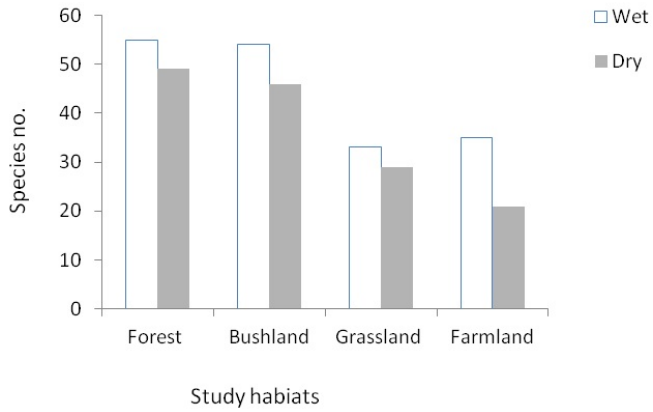


Figure 2. Distribution of bird species during wet and dry seasons.

## DISCUSSION

The Monastery possesses high number of birds including endemic and threatened species. This was probably due to the favourable environment of the habitat. For example, trees in the forest habitat like *P. africana* and S. abyssinica were used for nesting, breeding, feeding and sheltering sites for bird species (Shimelis Aynalem *et al.,* 2008*)*. The heterogeneous vegetation cover of the habitats and large canopy sizes probably were the ideal environment for the species to survive.

Species composition varied depending upon habitat types. The highest number of species was observed in the bushland and forest habitats during the study period. This might be due to the presence of diverse vegetation that provided heterogeneous land cover for various bird species and availability of food items to support birds (Jansen *et al.* 2001). This was associated with the complexity of the vegetation as a result of vertical, horizontal and temporal heterogeneity of the habitats (MacArthur and MacArthur 1961, MacArthur 1964).

Species diversity fluctuated at different seasons within the same habitat. This was probably due to the availability of resources like food, nesting site and vegetation strata for cover (Stephen *et al*. 2003). During the wet season, the highest diversity was obtained in the forest and the least in the grassland habitat. However, during the dry season, the least bird diversity was recorded in the farmland habitat. This might be due to the limitation of resources for birds (Stephen *et al*. 2003) as a result of harvesting of crops from the farmland. Species richness of the study site increased with land cover diversity in both forest and bushland habitats which might create conducive situations for feeding, nesting and protection (Oindo De By and Skidmore 2001).

Abundance of bird species within the study area varied in different habitats and between seasons. This might be highly dependent on the weather conditions and the land cover diversities (Vivikery et al. 2001). Forest and bushland habitats had high number of birds, perhaps due to the presence of high amount of nectar, seed and fruit producing plants (MacArthur and MacArthur 1961). During the wet season, farmland and grassland habitats had high avian abundance, probably, due to the presence of sufficient amount of vegetation cover with grasses, flowers and seeds. However, during the dry season, the abundance of birds that occur in such habitats decline as a result of changes in the nature and density of vegetation structure through grazing and harvesting of crops. Floristic composition and vegetation structures are habitat variables that determine the abundance of birds in different vegetation types (Sisay Hailu 2008). The abundance of birds in the forest habitat during the dry season was highest. This might probably be due to the local migration of birds in search of food and cover. MacPherson and Jetz (2007) stated that the abundance of species in the habitat increases as a result of immigration of birds from niche limited areas.

The distribution patterns of birds showed higher evenness in both forest and bushland habitats during both seasons. This might be due to the similarity in vegetation cover of the habitats providing suitable conditions for birds during both seasons (Waterhouse *et al.* 2002). This study has also revealed that bird species associations were dissimilar with different vegetation types. This was probably, due to the variability of vegetation cover in each habitat (Sodhi 2002). The highest habitat association pattern was found in areas containing fruit

and flower producing plants in the forest and bushland habitats, but relatively less association was observed at the edge and conifer tree covered areas during both wet and dry seasons. This might be due to the presence of trees and shrubs that produce nectar, fruits and seeds that were highly favoured and visited by many species of birds as their survival is highly dependent upon such type of food sources (Davies *et al*. 2007).

During the fruiting and flowering season, the number of frugivores, seed eaters and nectar sucking birds like Black-Headed Forest Oriole (*Oriolus monacha*), Black-Winged Lovebird (*Agapornis taranta*) and Variable Sunbird (*Nectarinia venusta*) was higher. These were highly associated with fruit, flower and seed producing trees in the forest and bushland habitats. Sisay Hailu (2008) also found that insectivorous birds like Great Spotted Cuckoo (*Clamator glandarius*) and Hadada Ibis (*Bostrychia hagedash*) were dominant in habitats that had insects during the wet season but their number was reduced during the dry season.

Red-Billed Oxpeckers (*Buphagus erythrorhynchus*) were mostly found in the grassland habitat sucking blood on the back of cattle, horses and donkeys. Other bird species like Cattle Egrets (*Bubulcus ibis*) and Pied Crows (*Corvus albus*) occurred in areas where livestock graze. These habitats were preferred by such birds due to the presence of external parasites such as ticks on the animals and invertebrates that occur on the dung of cattle. Pearl-Spotted Owlet (*Glaucidium perlatum*) was strongly associated with the forest habitat. This might be due to the use of holes on tree branches as nests.

Though the Monastery is highly threatened by the pressure of the surrounding local people, the species richness, diversity and evenness of bird species were high in both forest and bushland habitats. This reflects the significance of those habitats to birds for providing necessary requirements. The Monastery also possesses a number of migrant, threatened and endemic bird species.

## ACKNOWLEDGEMENT

We are grateful for the fund provided by Addis Ababa University.

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*Received 25 April 2013;*
*Accepted 8 June 2013*