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Avian Diversity and Abundance in Ololunga town, Narok County, Kenya

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Abstract

This study sought to determine bird abundance and diversity within Ololunga town, Narok County, Kenya. Using point counts and line transects, a rapid assessment of three habitats, based on levels of human disturbance was conducted. A total of 394 (n=394) birds belonging to 25 families and 34 species were recorded, with bushland recording the highest abundance and species richness (43.15%; and 26), followed by farmlands at 31.47% and 15; and human settlement recording the least (25.38% and 10). The Tukey HSD test established a significant difference in bird abundance between bushlands and human settlement areas (p = 0.014), with no significance between bushlands and farmlands (p = 0.082); nor between farmlands and human settlements (p = 0.356). Jaccard index / similarity coefficient across habitat scores noted a reducing similarity across avian sighted habitats at 0.316, 0.281 and 0.2 for human settlements-farmland; farmland-bushlands; and human settlement-bushland, respectively. Study results demonstrate that human influence has an impact on avian species composition, distribution, and abundance, especially within peri-urban areas of Narok, Kenya. Our study proposes creation of avian sensitive buffer zones within the habitats and ecotones; targeted community education on impacts of anthropogenic activities on avian diversity; and a deeper appraisal on seasonal and functional diversity in habitat types and overlapping ecotones on avian species, with a lens on resource availability.

Keywords: Biodiversity, Birds, Land Fragmentation, Relative Abundance, Ololunga, Narok, Urban Ecology

Introduction

There are approximately 9,990 bird species recorded on earth (Mynott, 2018). Birds contribute to the achievement of a myriad of ecological functions in their habitats ranging from seed dispersal, pollination, pest control and nutrient recycling (Sekercioglu, 2006). The Republic of Kenya has recorded over 1,080 bird species (Bennun and Njoroge, 2000). Habitat destruction, degradation and modification are great conservation concerns in the country (Fanshawe and Bennun, 1991). Over time, Ololunga and the greater Narok ecosystem has continued to face increased human induced degradation that alters landscapes (Gicheru *et al*., 2012). These perturbations range from land sub-division and fragmentation for human settlement, industrial development, livestock rearing, subsistence and plantation farming, and wildlife conservation, in a bid to meet socio-economic needs. Unabated charcoal burning, pole cutting, and fuel-wood collection have exacerbated degradation of natural avian habitats, which consequently may affect and alter their variety and variability (Fahrig, 2003). Local and regional extinctions of birds as witnessed by Sekercioglu (2006) can significantly impair resilience and ecosystem service delivery, as well as disturb ecosystem function in systems that are both naturally occurring, and human dominated.

Avian studies and conservation initiatives continue to be promoted globally since vertebrate taxa contribute to human understanding of the natural setting in which they occur (as bio-indicators) (Gibbons *et al*., 1996). Additionally, the bird taxon is sensitive, noticeable, and mobile, thus a great bioindicator for determining how people are affecting biodiversity (Chazdon *et al*., 2009), especially in urban areas (Miller, 2001).

It is prudent to monitor avian geospatial and temporal diversity and trends. Using birds as bio-indicators of ecosystem health, this study sought to create a baseline on their diversity and abundance in Ololunga *vis-a-vie* mushrooming anthropogenic development on urban avian ecology, especially in peri-urban areas. According to OECD (1979), a peri-urban area is "*a grey area which is neither entirely urban nor purely rural in the traditional sense; it is at most the partly urbanised rural area*". The findings can underscore role of citizen science in national and global biodiversity monitoring and community awareness (Greenwood, 2007; Kobori *et al*., 2016; Ministry of Tourism and Wildlife, 2018; Pocock *et al*., 2018; Callaghan *et al*., 2022); attainment of the Aichi Sustainability targets and UN Sustainable Development Goals (SDGs) (Chandler *et al*., 2017; Fraisl *et al*., 2020); and champion promotion of green jobs through sustainable avian tourism (Sekercioglu, 2002; Waswala and Mboweni, 2019).

Materials and Methods

Study Area

The study was conducted within Ololunga town, Narok County, located in the southern part of the Kenyan Rift Valley (fig. 1) in June 2021. Ololunga town lies on the fringes of the Masai Mara Important Bird Area (IBA), within the Somali-Masai biome (Bennun and Njoroge, 2000; BirdLife International, 2023). The town has an elevation of 1,952 meters above sea level in the longitude 35.664 East and latitude -1.003 South.

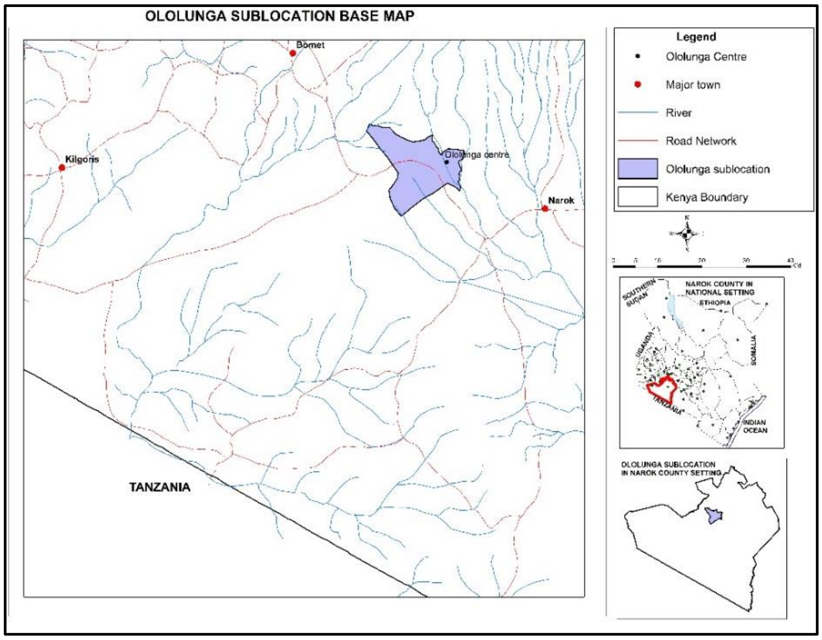

Figure 1: Geo-location of Ololunga Town

The annual temperature averages 18°C, with extremes of 32°C (January–March) to lows of 15°C (June–September). Ololunga town experiences a bimodal rainfall pattern, ranging from 1,000 mm to 1,500 mm per annum (Bartzke *et al*., 2018). The brief rains occur between August and November, while the lengthy rains occur between February and June. The county's altitude and physical features strongly influence its climatic conditions (Campbell and Hofer, 1995). The vegetation structure is characterized by bushlands, grasslands and shrubs, as in most semi-arid lands (Opiyo *et al*., 2015; Korir, 2019) within the Somali – Masai biome. Ololunga town is dominated by the Maasai Tribe (Kereto *et al*., 2022) who engage in pastoralism, wildlife tourism and conservation, and crop farming. The area is currently facing increased land degradation, fragmentation, and natural resource use conflicts, which are attributed to changing land tenure (Campbell and Hofer, 1995; Li *et al*., 2020).

Data Collection and Analysis

Field data was obtained using point counts and line transects. For point counts, the investigators stood at a fixed location for 5 minutes where they recorded highly visible and vocally active bird species within the habitats within a radius of 100 meters (Gibbons *et al*., 1996). Double observer line transects are also employed to complement the point counts, in open space areas (Chen, 2000). Seven point counts per habitat were done (21-point counts in total). This involved walking at a slow pace (approximately 1 km/hour with occasional pauses) along pre-planned path while recording the perpendicular distance of each bird to the point of observation (transect) on their side of the line transect, as well as any birds heard or seen within a 100-meter radius (using a Digital 7X Range Handheld, Rangefinder Range Finder). To evenly distribute visiting time across all transects, sites were chosen at random. Depending on the terrain, each foot transects took 25 to 30 minutes to complete. A total of 21 transects were conducted (7 per habitat). The bird counts were conducted early in the morning, from 6:00 am to 8:00 am (East African Time), and in the evening, from 4:00 pm to 6:00 pm (East African Time), to achieve consistency. In both study methods, visual identification was done using bird field guidebooks (Zimmerman *et al*., 2020; Stevenson and Fanshawe, 2004).

Birds' species diversity was calculated using Shannon-Weiner Diversity Index. Relative abundance was calculated using the formula: $ni/N * 100$; where, ni = the number of individuals in the ith species, and N= total number of individuals of species recorded during the survey. A Tukey HSD test was also conducted to establish relationship in species abundance between the three habitats: namely bushlands, human settlement, and farmlands. Finally, a Jaccard Index / Similarity Coefficient (Jaccard, 1912; Barbercheck, 2009) was also calculated to evaluate species' overlap similarities between the habitats. It is calculated using the formula: $J(A,B) = |A \cap B|/|A \cup B|$; where Jaccard Index = (the number in both sets) / (the number in either set) * 100.

Results and Discussion

The study recorded a total of 394 individual birds belonging to 25 families and 34 species (Table 1).

Table 1: Avian Species Encountered Across Multiple Habitats in Ololunga Town, Narok County

No.	Common name	Family	Scientific name	Human settlement	Farmland	Bushland
1	Crowned Lapwing	Charadriidae	Vanellus coronatus		Present	
2	Rattling Cisticola	Cisticolidae	Cisticola chiniana		Present	Present
3	Speckled Mousebird	Coliidae	Colius striatus		Present	Present
4	Red-eyed Dove	Columbidae	Streptopelia semitorquata			Present
5	Ring-necked Dove	Columbidae	Streptopelia capicola	Present	Present	Present
6	Tambourine Dove	Columbidae	Turtur tympanistria			Present
7	Pied Crow	Corvidae	Corvus albus	Present		
8	Common Drongo	Dicruridae	Dicrurus adsimilis			Present
9	African Firefinch	Estrildidae	Lagonosticta rubricata	Present		
10	Grey-headed Silverbill	Estrildidae	Spermestes griseicapilla		Present	
11	Purple Grenadier	Estrildidae	Granatina ianthinogaster	Present		Present
12	African Citril	Fringillidae	Crithagra citrinelloides		Present	
13	Streaky seedeater	Fringillidae	Crithagra striolata			Present

14	White-throated Swallow	Hirundinidae	Hirundo albigularis	Present	Present	
15	Fiscal Shrike	Laniidae	Lanius collaris		Present	Present
16	Arrow-marked Babbler	Leiothrichidae	Turdoides jardineii		Present	Present
17	D`Arnaud`s Barbet	Lybiidae	Trachyphonus darnaudii		Present	Present
18	Tropical Boubou	Malaconotidae	Laniarius aethiopicus			Present
19	Eurasian Bee-eater	Meropidae	Merops apiaster			Present
20	African Pied Wagtail	Motacillidae	Motacilla aguimp			Present
21	Cape Robin-Chat	Muscicapidae	Cossypha caffra			Present
22	White-browed Robin-Chat	Muscicapidae	Cossypha heuglini			Present
23	Grey go-away bird	Musophagidae	Corythaixoides concolor			Present
24	Scarlet-chested Sunbird	Nectariniidae	Chalcomitra senegalensis			Present
25	House Sparrow	Passeridae	Passer domesticus	Present	Present	
26	Grey-headed Woodpecker	Picidae	Picus canus			Present
27	Chin-spot Batis	Platysteiridae	Batis molitor			Present
28	Black-headed Weaver	Ploceidae	Ploceus melanocephalus	Present	Present	Present
29	Chestnut Weaver	Ploceidae	Ploceus rubiginosus	Present		Present
30	Speckled-fronted Weaver	Ploceidae	Sporopipes frontalis		Present	
31	Common Bulbul	Pycnonotidae	Pycnonotus barbatu			Present
32	Hildebrandt’s Starling	Sturnidae	Lamprotornis hildebrandti	Present	Present	Present
33	Superb Starling	Sturnidae	Lamprotornis superbus	Present	Present	Present
34	African Hoopoe	Upupidae	Upupa africana			Present

The bushland (BL) had the highest abundance with 170 individual birds sighted (43.15%), followed by farmland (FL) with 124 individuals (31.47%) and human settlement (HS) having the relative abundance with 100 individuals (25.28%) of the entire bird sampled (figure 2) during the study period.

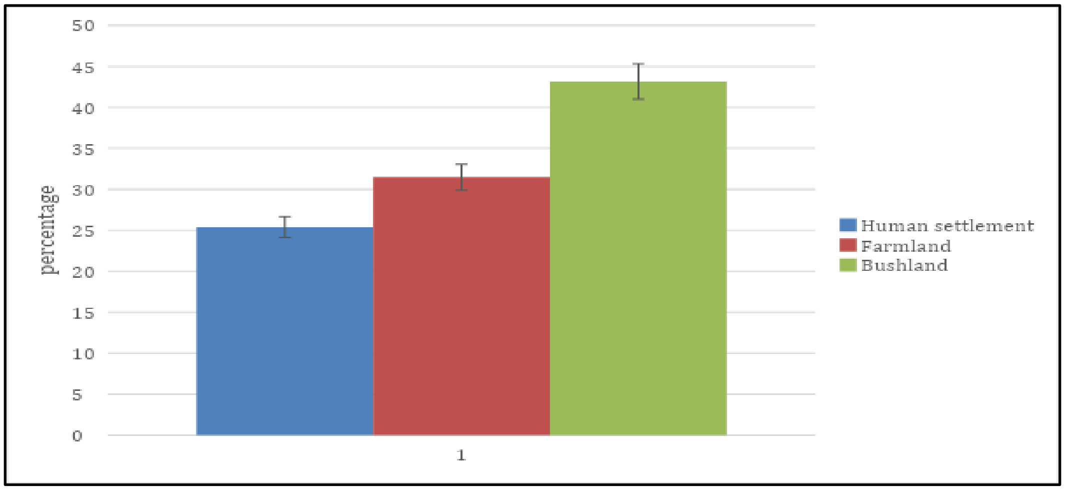

Figure 2: Relative Abundance of Aves Encountered in Different Habitats Within Ololunga Town.

The study revealed that Ololunga bushlands exhibited the highest Shannon Weiner diversity index at 3.09, followed by farmlands at 2.59, and human settlement at the lowest at 1.94 (HS<FL<BL). Bushlands exhibited the highest relative abundance at 15.29, followed by farmlands and human settlement at 12.09 and 9.375 respectively (BL>FL>HS).

Table 2: Avian Density and Diversity Indices at Ololunga Town

Habitat	Species richness	Individual birds encountered	Relative abundance	Species Evenness	Shannon Weiner
Human settlement (HS)	10	100	9.37	0.882	1.94
Farmland (FL)	15	124	12.09	0.956	2.59
Bushland (BL)	26	170	15.29	0.947	3.09

Ten (10) bird species were noted in human settlements areas; with farmlands and bushlands hosting 15 and 26 avian species respectively during the time of the study. The study revealed that avian species evenness was lowest at human settlements (0.881), with farmlands and bushlands at 0.956 and 0.947, respectively. These findings support earlier research by Savard *et al*. (2000), which found that altered urban environments had an adverse effect on bird and species diversity, which is inversely correlated with vegetative complexity and plant species-richness.

During the study, four (4) species were encountered in all the sampled habitats. These were Hildebrandt's Starling, Superb Starling, Black-headed Weaver, and Ring-necked Dove. The study revealed two species overlapped human settlements and farmlands, namely White-throated Swallows and House Sparrows; with Chestnut Weavers and Purple Grenadiers overlapping in humans' settlements and bushlands. Five (5) species were encountered in both farmlands and bushlands namely, Common Fiscal, Arrow-marked Babbler; D'Arnaud`s Barbet; Speckled Mousebird and Rattling Cisticola. In relation to habitat exclusivity, the study revealed that two (2) species were encountered exclusively in human settlement areas; four (4) species in farmlands; and fifteen (15) species in bushlands.

The study also revealed that farmland-bushland habitats shared nine (9) species while human settlement-bushland and human settlement-farmlands shared six (6) species each. However, the Jaccard Index / Similarity Coefficient revealed a reducing similarity across avian sighted habitats at 0.316, 0.281 and 0.2 for human settlements-farmland; farmland-bushlands; and human settlement-bushland, respectively.

The cumulative abundance of individual birds and species diversity that was lowest in human settlements and highest in bushlands could be attributed to human induced perturbations, resulting in fragmentation and loss of ecosystem integrity. This has a negative impact on nesting, breeding and foraging areas as supported by Rurangwa *et al*. (2021). The four species of birds encountered in all habitats, namely, Hildebrandt's starling, Superb starling, Black headed weaver and House Sparrow. This can be attributed to their feeding guilds; they are easily habituated to humans and are gap-tolerant species; and their ability to tolerate the intermediate ecotones found within the habitats. It is postulated that the human settlements were unique as they provide nesting / roosting refuge for the White-throated Swallows and House Sparrows who foraged in the farmlands.

A high diversity (26 species) and individual birds encountered (170) in bushlands, which were primarily undisturbed, indicate the importance of natural niches and eco-systems to avian conservation, as opposed to human settlements that hosted ten (10) species and 100 individual birds. The bushlands had a myriad of vegetation characteristics and diversity, resulting in increased resource partitioning or niche differentiation, and thus more bird diversity and numbers. There may be fewer resources offered by the various vegetation types in the highly disturbed site compared to the other locations, which would explain the comparatively low bird numbers there. The study reveals that vegetation changes attributed to anthropogenic activities along complex geographical and environmental gradients, can indeed impact the structure, composition, and diversity of avian communities, as postulated by Lee and Rotenberry (2015) and Sulemana *et al*. (2022).

The Tukey HSD test revealed that there was a significance in species abundance between bushlands and human settlement areas ($p = 0.014$). However, there was no significance in relation to abundance between bushlands and farmlands ($p = 0.082$); nor between farmlands and human settlements ($p = 0.356$). We attribute this to relative homogeneity along the ecotones.

Bushland sites due to variety of vegetation, hosted the highest bird species abundance and diversity as compared to human settlement site. Human settlement being moderately disturbed had moderate bird diversity and abundance as well as species richness. There was a prediction of habitat overlap between most species and their occurrence in bushland and human settlement areas. Niche overlaps occur when varied species of birds co-exist in the same habitat and utilize the same resources. Therefore, the study shows there was habitat overlap in all habitats that is, bushland, farmland, and human settlement. Certain species are limited to specific habitats while others can spread widely due to variations in the availability of resources such as food, water, nesting materials, and breeding grounds.

The study also reveals that alteration and modification of ecosystems primarily by urbanization can have a negative direct impact on native birds' species community dynamics, as confirmed by Pickett *et al*. (1997) and John and Kagembe (2022). This can result in biotic homogeneity, population isolations of native species and local extinction as opined by Ricketts (2001). The study also disclosed the occurrence of pied crows in human settlement areas. This affirmed precious studies by Leedy (1979), which stated that birds such as crows can maximize human disposed waste and increase in abundance within human areas.

Conclusion

The study revealed that habitats with fewer human activities had higher bird diversity and populations diversity and numbers within Ololunga town. The higher diversity suggests higher ecological stability compared to human disturbed areas. However, the human settlement areas are important because they also support large numbers of bird communities. Increased human development and land use change happening in Ololunga town, can therefore have a negative impact on bird diversity, distribution, and abundance within the Maasai Mara IBA. The study recommends the creation of avian sensitive buffer zones within the habitats and eco-tones, which can contribute to ecosystem integrity and connectivity within the heterogeneous ecosystem. There is need for targeted community education through citizen science on impacts of anthropogenic activities on avian diversity, especially on local extinction and proliferation of pied crows attributed to poor human waste disposal. The study finally proposes a deeper appraisal on seasonal and functional diversity in habitat types and overlapping ecotones on avian species, with a lens on resource availability (feeding guilds).

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Conflict of Interest

The authors declare no conflict of interest regarding the publication of this paper.

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