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Behavioural Activities of Two Sympatric Bird Species and Implications for Conservation and Birding Tourism in an Urban Landscape

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ABSTRACT

The behaviours of most Afro-tropical birds inhabiting urban landscapes are still poorly understood making species conservation and utilization challenging particularly in increasingly changing cityscapes. This study investigated activity patterns of two sympatric bird species, the Zanzibar red bishop (*Euplectes nigroventris*) and Black-headed weaver (*Ploceus cucullatus*) inhabiting urban forest remnants to provide information to improve species conservation and potential plans for avitourism in urban Morogoro, Tanzania. A total of 60 individual Zanzibar red bishop and 28 individual weaver birds were observed, for three weeks to understand their diel activity patterns. Eleven activities were displayed by the birds with the mean time budgets for some activities varying significantly between species, bird sex and habitat types. Further, birds spent significantly longer time during morning than afternoon or evening on most activities probably to offset the energy demands for the survival and reproduction. Variation in activity budgets between the two species was probably due to the species intrinsic strategies such as group foraging by the weaver that enhance easy detection and access to the food resources. These data will be useful for planning bird conservation and utilization programs especially in cities where birds are increasing threatened by human persecution.

Key words: Daily activity pattern - Afro-tropical birds - City tourism – Passerines - Time budget - Urban ecology.

INTRODUCTION

Urban landscapes are constantly changing owning to increasing expansion of built-up areas accelerated by human population growth and development (Reynolds *et al.* 2019). Such changes impact on the bird species and their functional activities, e.g., reduced ability to forage and reproduce (Liker *et al.* 2008). Also, body mass, size, and condition of the house sparrow (an urban commoner species) on average, are lower in highly urbanized than natural rural habitats (Liker *et al.* 2008). These changes in species traits may directly influence on the behavior of individual species living in cities consistent with the credit card hypothesis (Shochat 2004) which suggests that bird behavior, reproduction and survival may change along a gradient of urbanization. Further, behavioral adaptations among the urban birds play an important role in defining their potential interaction with humans in the cities. Most urban birds for example, are highly tolerant to disturbance and are tame to intruders (Stankowich and Blumstein 2005), a situation that may expose them to increased predation risks (Møller and Ibáñez-Álamo 2012, Stankowich and Coss 2005). However, such a trait can potentially be beneficial to the urban human population when tapped to be economically or environmentally useful (Sekercioglu 2002). Elsewhere, documented bird behaviors have been used in promoting birding and avitourism, thereby improving local incomes and species conservation in the cities (Nicolaides 2013, Sekercioglu 2002).

However, the possibility for such opportunities to unleash in most African cities is still uncertain due to scarce information on the biology of most urban birds.

Birding or birdwatching- an act of observing or studying birds for recreation (Nicolaides 2013, Sekercioglu 2002), is a growing ecotourism niche that is increasingly becoming popular in nature-based conservation realms in many urban landscapes globally (Cordell and Herbert 2002, Ma *et al.* 2012, Steven *et al.* 2015). Despite this, birdwatching and avitourism research efforts is currently strongly geographically biased towards the northern hemisphere and north America and thus far remain embryonic in most tropical developing countries particularly in Africa (Steven *et al.* 2015). Such geographic disparity may partly be explained by the awareness of birdwatching and avitourism importance to the human and environmental health, and conservation, and the economic status of avitourists among these regions. For example, studies have reported that most avitourists and bird watchers are well educated, wealthiest and travel long distances to destinations with high diversity and endemic species and are usually of older age (Connell 2009, Nicolaides 2013, Sali *et al.* 2008). There is thus, a great potential for the threatened species and economically poor societies to benefits from avitourism when destinations are well equipped with some necessary tools for improving the industry.

The economic potential and thus, development of the avitourism industry is, however, supported with strong knowledge about the birds including the species identification and behavior. Such knowledge is well known to enhance avitourist experience and potentially influence increased visitor stays and return to the destination (Kumar *et al.* 2019, Steven *et al.* 2021), consequently increase in income earnings at the destination. Further, there remain little efforts in developing the knowledge base needed to build the industry in urban areas, thus preclude the possibility for planning effective bird utilization and conservation programs in cities. However, most existing studies on the behaviours of some bird species were mostly conducted in wild places (Friedl 2004, Klump *et al.* 2009) but scarce information exists on birds inhabiting urban landscapes (Mgelwa *et al.* 2018). Building species-specific knowledge among local experts would help unleash the vast opportunities associated with tourism in cities (Cobar *et al.* 2017, Murawiec *et al.* 2021), and enhance bird ecosystem functions and services provision to humanity (Sekercioglu 2006). This study aimed at documenting the biology of two passerine bird species inhabiting urbanized landscapes in Morogoro, Tanzania. Specifically, the study aimed to quantify activity budgets of various behaviours displayed by the species and examine how the time budgets for the activities vary between habitat types, bird sex and time of day. The study hypothesized that:

(a) The mean time budget for the feeding activity overall, would be higher than for other activities due to high energy demand for the body physiological and reproductive activities.

(b) The mean feeding time would be higher in morning than other times of day and would be similar between two bird species.

(c) The time budget for all activities combined for a particular bird species overall would be higher in a habitat with potentially high abundant food resources.

This study provides insights into the potential direct benefits that birds could provide to people through engaging in birdwatching and avitourism by tapping the species behavioural repertoires as emerging business ventures in the developing countries.

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MATERIALS AND METHOD

Study site

This study was conducted in two sites within Morogoro urban located at latitudes 5º 00' and 7º 40' S and longitudes 37º 10' and 38º 33' E, in Eastern Tanzania about 200 Km from the Indian ocean (Figure 1). Morogoro urban receives mean annual rainfall ranges of between 750 mm and 1050 mm per annum with mean monthly temperature varying between 21 ℃ and 27 ℃ (Msanya *et al.* 2003). The rainfall is bimodal, falling as short and long rains separated by a short and dry season from October to December and from March and ends in May respectively (Msanya *et al.* 2003). Morogoro urban is characteristic of disturbed landscapes, with most remnant vegetation cover showing complex mix of both native and non-native plant species (Rija *et al.* 2014a). Further, the urban Morogoro is rich in animal life including diverse birds (Rija *et al.* 2014b) and spiders (Rija *et al.* 2014c). The two study sites harbor spectacular birdlife and are thus potential sites for birders and avitourists visiting the city.

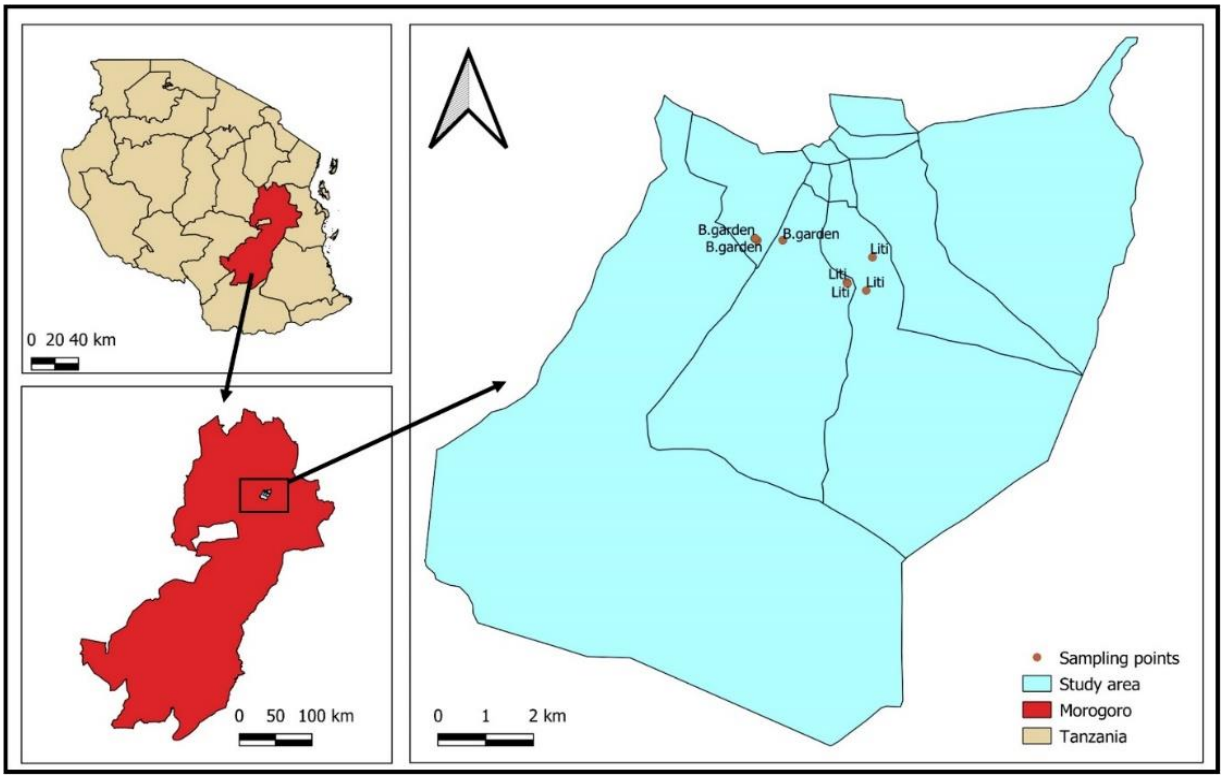

Figure 1. Map of study area in Morogoro urban showing location of Sokoine University of Agriculture (SUA)' Botanical Garden and Livestock Training Institute (LITI) forest patch remnants.

Bird species and Sampling procedure

Two passerine bird species, the Zanzibar red bishop (*Euplectes nigroventris*) and Black-headed weaver (*Ploceus cucullatus*) were selected for this study due to their high abundance and easy of sighting in the study area. Also, the plumage colour of these birds are beautiful (Figure 2) thus are likely to attract the attention of birdwatchers and avitourists who may visit the city for bird tourism. The Zanzibar red bishop bird lives mostly in pair of male and female and during breeding season the male bishop develops red plumage which adds to its easy sex identification to observers, similar to other bishop species across Sub-Saharan Africa (Friedl 2004, Klump *et al.* 2009). Further, the black headed weaver on the other hand is social and nests in large colony with each nest used to one pair of male and female birds (Collias and Victoria 1978, Craig 2004). Both species feed on

grains but sometimes they forage on invertebrates (Craig 2004).

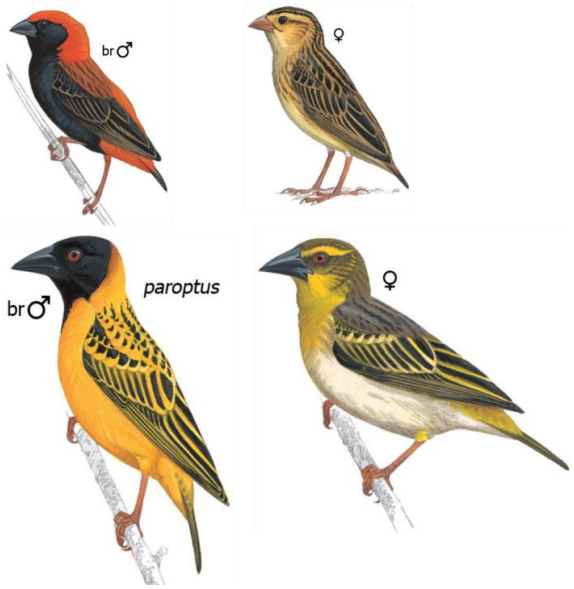

Figure 2. Images of the Zanzibar red bishop (upper) and Black-headed weaver (lower). *Adapted from the field guide to the birds of East Africa (Stevenson and Fanshawe 2020).*

Bird assessment was conducted between March-April, 2021 for three weeks during breeding season for these birds by observing individual focal birds that were sampled based on the focal sampling method (Altmann 1974). At each location, upon arrival, the researcher allowed 5 minutes for the target bird species to settle to avoid sampling bias (Bibby *et al.* 2000) and to be able to randomly choose one individual (i.e., focal bird) for data collection. The focal individual was monitored for 10 minutes and recorded all activities (Table 1) that the bird was doing. Previous behavioural studies of birds recorded activities on ringed individuals and for longer time i.e., at least 6 months birds (Collias and Victoria 1978; Klump *et al.* 2009). To ensure individuals were correctly monitored in the absence of bird rings, the current study monitored individual birds only once for 30 minutes each, thus recoding data from 60 individual Zanzibar red bishops and 28 individual Black-headed weavers. Pooling individual data from such a sampling protocol was appropriate and enabled analysis for the sampled population. Further, when sampling on the bird was completed a maximum of five minutes was spent resting and to allow proper data recording before resuming further observations on the same individual until each individual focal bird was observed for 30 minutes. When the bird moved from its original site, it was kept in sight (using a binocular) until 30 minutes of observations was completed before switching to another focal bird. When the bird took flight away before the maximum observation time was completed, recording of the data on that individual bird was halted, such data discarded and another individual focal bird was identified. This sampling procedure was conducted at three times of the day during early morning (7.0-10 am), afternoon (12.0-3.0 pm) and evening 4.0-12.30 pm). Further, the focal Zanzibar red bishops were observed across different habitat types around the Botanical Garden including fallow land, riparian area, farmland and grassland. The black headed weaver was mostly observed at LITI and SUA Botanical Garden. All observations were made with the aid of binoculars (80x40 magnification) and were conducted within a 60-meter range on average from the observer. Furthermore, birds were observed and recorded their sex and identified breeding sites (based on repeated flights to the same patch by the bird). Breeding birds were also observed to record their activity budget during nesting.

Data analysis

Because most variables describing the activity budgets by the bird species required simple analysis, we computed mean of the variables and tested their differences between the study sites, sampling period and species using Kruskal Wallis and Man-Whitney test as most variables were not normally distributed (Shapiro Wilk test $p < 0.05$). Such analyses were performed on cleaned data conducted using various functions in the packages “dplyr” and “tidyverse” built in the R-program ver 4.1.0 (R core Team 2021).

Table 1. Definition of bird activities recorded during field data collection.

Behaviour	Definition used
Roosting	An act of a bird escaping from different stressful conditions such as rainfall or temperature into the nest.
Resting	When a bird was stationary
Scanning	When birds were seen on trees wandering, with the head up or looking side by side.
Searching	A bird seen finding for food or materials for weaving nests
Mating	When male was seen mounting female i.e., copulating
Material Carrying	Birds seen carrying material in beaks for such as grasses, feather or food item.
Nest Weaving	Bird seen constructing a nest by weaving grass fibres.
Mate calling	Male bird seen calling a female to a constructed nest
Feeding	When bird was seen sizing and swallowing a food item
Drinking	Birds seen drinking water, also associated with water bath
Territory defence	Male birds seen chasing other males that were getting near his territory

RESULTS

Both bird species exhibited variability in time spent performing different activities (Table 2). There was a significant difference in the time spent scanning the environment (χ^2 = 10.943, DF = 2, p = 0.004, with more time being spent during morning (mean = 6.20 ± 5.40 sec than afternoon (mean = 4.57 ± 3.37 sec) and evening time (mean = 4.42 ± 3.36 sec). Also, the birds spent significantly different times performing scanning activity between the habitats (χ^2= 11.755, DF = 3, p = 0.008) with the fallow land showing highest scan time (mean = 6.52 ± 5.35 sec) and grassland habitat lowest (mean = 4.16 ± 2.49 sec). Further, the birds showed significantly more time in searching for food in the morning (mean = 4.96 ± 3.93 sec) than other times of the day (χ^2= 13.021, DF = 2, p = 0.001, Evening, mean = 3.60 ± 2.76 sec). Further, we found the red bishop spending significantly more time in feeding particularly in morning (mean = 15.12 ± 9.33 sec than during other times of the day (χ^2= 9.3439, DF = 2, p= 0.009). The feeding times were variable between the two species, sites, habitat types but not between the sex of individual bird species (Figure 3). The Black headed weaver, on average spent significantly more time in feeding that the red bishop (Figure 3).

Table 2 shows the mean time and Standard deviation spent by the bird species performing various activities during the sampling period. Apart from resting and roosting, Feeding was the most time-consuming activities by all the bird species.

Table 2: Mean times of various activities of the bird.

Bird behaviour activity	Mean time (s) + SD	ZrB	BhW
Scanning	5.479 ± 4.722	√	-
Searching	4.384 ± 3.508	√	-
Roosting	130.841 ± 84.227	-	√
Resting	91.708 ± 71.508	-	√
Weaving	9.567 ± 7.272	√	-
Feeding		18.21 ± 12.32	63.818 ± 63.414
Territory defending	5.318 ± 2.514	√	-
Drinking	38.039 ± 31.431	-	√
Mate calling	6.214 ± 2.991	√	-
Mating	6.375 ± 3.372	√	-
Nest material carrying	4.702 ± 2.961	√	-

Key:

ZrB = Zanzibar red bishop,

BhW = Black-headed Weaver,

tick and minus signs show recorded or not recorded activity for the bird species.

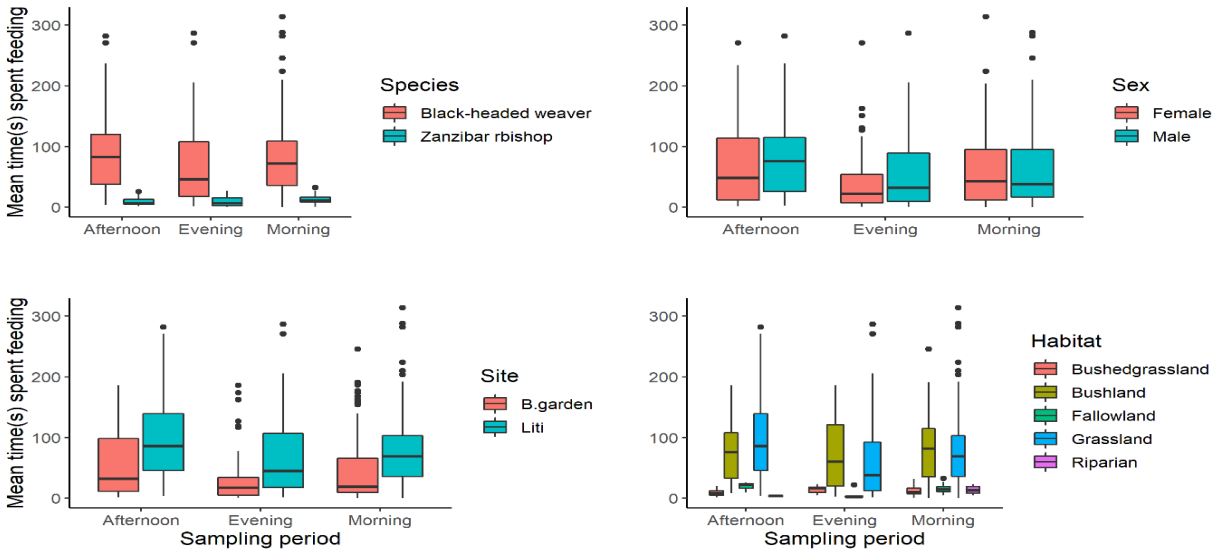

Figure 3: The time budgets of the two bird species spent in feeding across the habitat types, species and time of day based on the field observations in the study area.

Territory defense, calling mates and mating also characterized the bird's activity during breeding season. There was significantly more time spent in defending territory in the red bishop (χ^2= 0.408, DF = 1, p = 0.052) in morning that other time (morning, mean = 5.318 ± 2.514sec). Female red bishop spent more time caring for the chicks than the male while the male on another hand, heavily defended the territory in the morning than other times of the day (χ^2= 8.9737, DF = 2, p = 0.011, Figure 4). Mating was also mostly observed in the morning (mean = 8.27± 2.79 sec) than afternoon (mean = 4.0± 1.41 sec) or evening

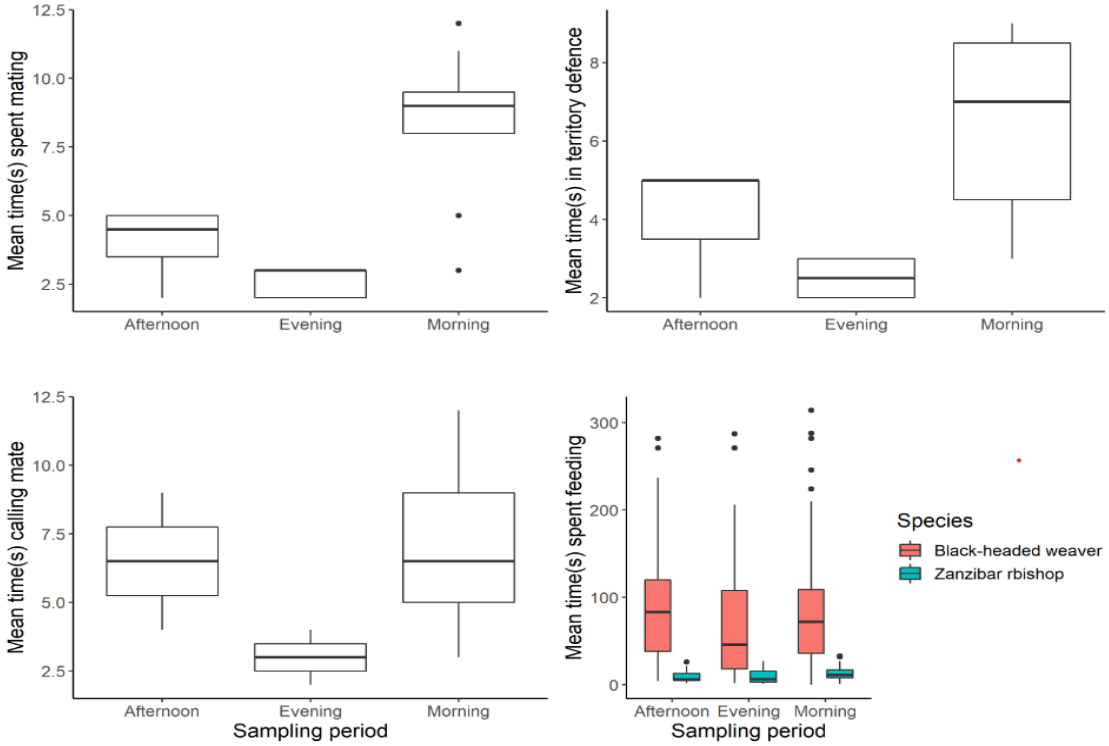

Figure 4: Activity time budgeting in mate calling, mating and defending territory in the red bishop recorded in the study area. All the activities varied significantly across the day.

(mean = 2.6± 0.54 sec) (χ^2= 12.685, DF = 2, P = 0.001) and was initiated by the male. Examining nest construction in the Zanzibar red bishop, the analysis showed no significant difference in the time spent in nest weaving between times of day nor between the different habitats assessed. Nest construction defined the carrying of materials for constructing nests where there was a significant chunk of time used by the birds. The time budget for carrying the nesting materials was not different across the times of day.

DISCUSSION

Studies of bird behaviours in urban landscapes are rare, making utilization of the birds inhabiting cities in developing countries less developed. In this study, the time budgets for the various activities displayed by the two bird species were quantified. We found time budgets for scanning, searching and feeding variable across the day time, habitat and studied sites. There was also contrasting pattern in the time budgeting of territory defense, nest construction and mating between the species, habitats and sampled sites. Most of the bird activities were mostly conducted in morning.

The observation of difference in time spent feeding between the two species could be related to the territorial nature of the red bishop and the group foraging nature of the black-headed weaver. Territory defense is an energy costing activity which necessitates the birds to take several chases against any potential territory intruder. To overcome it, the birds have to spend more time feeding to enable them to effectively defend the territory to ensure successful mating and breeding (Craig 2004). Collias and Victoria (1978) studying the Black-headed weaver in a zoo reported significantly longer time spent by the birds feeding to conduct reproductive activities such as nest weaving to attract female to the nests. Such finding agrees with the current study. An alternative explanation for group foragers such as the black- headed weaver is that facilitation during food searching and foraging may result in some individual bird spending more time feeding. Further, group facilitation has been observed to be advantageous on the birds because reduced time that could be spent searching and scanning for potential intruders and enemy, is spent more in feeding (Friedl 2004; Klump *et al.* 2009). Furthermore, we found activity budget varying across the habitats and that the fallow land was more important than others. This could be related to the rich resources such as abundant food resources, nesting materials, roosting and escape cover this habitat type provide the birds with plenty foraging opportunities. The searching in this habitat was relatively easier than other habitat due to openness which perhaps increased bird visibility and easier spotting of the food resources.

The result that high scanning time was spent in fallow land than other habitats could be due to presence of cultivated farms and a road crossing near that area that was being used by people, and cars. The frequent human activities probably caused disturbance to the birds thereby increasing overall scanning time to detect any approaching danger. This indeed constitutes the bird's survival tactics in the face of potential predator (Lima 2009). Studies have shown that longer scan bout duration facilitates the monitoring of the environment for any potential danger (Fernández-Juricic and Schroeder 2003). Thus, birds make a tradeoff between avoidance of disturbance by humans against activities that may increase fitness, such as scanning, mating and territory defense (Frid and Dill 2002).

Further, birds are known to nest on trees along the riparian area growing on the bunks of the dams and lakes. However, in this study, birds were not nesting because of the disturbance available in the area that was caused by generators which run most of the time producing noise. We speculate that

the negative influence of the generator could have affected some activities performed by the birds.

CONCLUSION AND RECOMMENDATION

Birds play critical roles in urban landscapes as seed dispersers, pollinators, and suppressors of rodent and arthropod populations. The knowledge on the biology or behaviours of these birds provides useful information that could inform conservation particularly in urban areas where birds are increasingly being threatened by human persecution. Further, this particular study highlights some useful information that could be used for planning bird utilization programs particularly through birdwatching and avitourism. This in turn would cascade into improved conservation of the urban forest remnants and the bird biodiversity in cities. Furthermore, there is a great potential for such knowledge to improve the functional importance of the urban forests thereby improve ecosystem service provision that support the human health in increasingly expanding cities across tropical Africa. Further, the results strongly supported the hypotheses stated earlier in the introduction. The resulted are useful as baseline and provide opportunities for broader assessment of other bird species in order to build strong knowledge on many species. Future studies should look into the how the bird behaviours are related to bird persecution in urbanized landscapes. Such information will be useful for addressing bird-human conflicts in increasing sprawling cities.

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