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Bird Diversity in Different Land-use Types in the City Of Malolos, Bulacan, Central Luzon, Philippines

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Abstract

Birds are often considered as one of the most important environmental indicators since they are sensitive to habitat change and easy to record in any setting (Fa et al., 2017). The diversity of birds in different land-use types were investigated in the selected barangays of Malolos City, Bulacan. The result of this study may be used to assess the biodiversity value of urban areas, identify important habitats and corridors for birds, and develop conservation strategies to protect and enhance urban biodiversity.Point count method was carried out in four land-use types within the urban setting: (1) institutional; (2) residential; (3)agricultural; and (4) aquatic. A total of 1,278 individuals were recorded which included 20 species from 6 orders and 14 families. The order Passeriformes exhibited the highest prevalence, with 11 species recorded individuals. Notably, residential areas exhibited the highest species richness with 13 different bird species recorded. The Eurasian Tree Sparrow (*Passer montanus*) exhibited the highest abundance and was found in most land types, making it the most prevalent species in this study.Residential environments exhibit a greater avian species diversity compared to other land use types, owing to a confluence of factors that render residential areas particularly appealing. It offers a broad spectrum of food resources, nesting sites, water sources, and comparably undisturbed habitats. By creating and managing urban spaces that cater to the specific requirements of bird species, it is plausible to augment avian diversity and facilitate the sustenance of robust bird populations in urban settings.

Keywords: *bird diversity, point-count, abundance, birdwatching, land-use types*

INTRODUCTION

Birds are often considered as one of the most important environmental indicators since they are sensitive to habitat change and easy to record in any setting (Fa etal., 2017). Overall habitat quality is one of the most useful indicators that birds can provide, and their population patterns can indicate how effectively the ecosystem functions when birds rely on specific habitat conditions (Fraixedas et al., 2020). If the habitat fails to meet the ecological criteria, birds endowed with the ability to fly will leave the area. Moreover, the health of birds can be used to determine whether ecosystems are maintained for agricultural productivity, wildlife, water, or tourism. A decline in bird numbers indicates that humans are causing environmental damage through habitat fragmentation and destruction, pollution, pesticides, introduced species, and a variety of other factors (Manning & Sullivan, 2021).

The Philippines, a global biodiversity hotspot and one of the world's most biodiverse countries, has approximately more than 600 bird species representing 90 families found in the Philippines. There are 258 endemic species (43% of resident avifauna), and 141 species (24%) with high forest dependence (Kittelberger *et al,* 2021). In just the last decade, 86 new indigenous bird species have been discovered in the Philippines, and a new study reveals that even more species are endangered than previously assumed, with 84 species being shown to be at higher risk than their present International Union for Conservation of Nature Red List status (Cowan, 2021). There are many threats to birds, and the most common ones are human activities like mining, excessive extraction of natural resources, transformation of natural habitats for agricultural purposes, pollution resulting from industrial activities, and urban sprawl (Kondratevya et al., 2020). Also, urbanization is often blamed for the loss of biodiversity but for some species, urban areas, can represent suitable environment for life and even enable them to maintain stable and abundant populations (Tryjanowski et al., 2017) . Consequences of urbanization include changes in bird migration patterns, altered access to supplies, greater collisions with buildings, fewer woodland areas, and increased noise, air temperature, pollution, and domestic cats chasing them.

Bird surveys provide information on population status and trends of birds, which aid in the identification of species or populations in need of conservation. Changes in distribution and status can also act as an early warning system, exposing prospective environmental issues, guiding research objectives, and tracking the success of ongoing management initiatives. In the City of

Malolos, Bulacan there are ongoing construction of infrastructures as the city progress and becomes more urbanized which may displace bid species. Thus, it is imperative to identify status of birds in terms of species diversity, population size, range and trends. But trends are impossible to measure unless some baseline has previously been set. This is lacking in the City of Malolos. Most studies on biodiversity in the province of Bulacan were conducted in diptocarp secondary forest, karst forest and watersheds resulting to limited knowledge on urban biodiversity.

The goal of this study is to conduct an inventory of bird species in selected land-use types and determine their diversity, abundance and distribution. This information is crucial in assessing the biodiversity value of urban areas, identifying important habitats and corridors for birds, and developing conservation strategies to protect and enhance urban biodiversity.

MATERIALS AND METHODS

Bird Survey

Bird survey was carried out in five (5) land-use types within the urban setting classified as institutional (Bulacan State University, Main Campus & Malolos Provincial Capitol in Brgy Guinhawa), agricultural (Brgy. Sumapang Bata) , residential (Brgy. Mabolo), and aquatic (Brgy. Panasahan) from January-May 2023. The climate in the selected site has a tropical monsoon climate with an average annual precipitation of 142.38 mm mostly in the month of August and a temperature ranging from 23.48 °C - 36.36 ºC over the year.

The bird survey involved walking along a 50-meter transect line and allowing 5-10 minutes of waiting time at each spot to facilitate thorough observations (Gatesire et al., 2014). This waiting period was implemented to enhance the accuracy of bird observations and recording, as opposed to continuous walking along the transect line. Observation tools utilized included a phone camera for bird photography and an 18 x 14.8 x 5.5 cm binoculars with specifications of 80 x 80 magnification, 3.75 mm exit pupil diameter, and 5-meter close focus distance. Additionally, a telescope with 40 x 60 magnification, 160 mm length, 17 mm eyepiece, 50 mm objective, 1800 m / 9800 m line field of view, and a large wide angle of 60 was employed. All observations were documented on a field data sheet, noting the time of each observation using a 24-hour clock system. The point count method was employed as a standardized approach for bird counting across various locations and time intervals (Hostetler & Main, 2021).

Reappearance of certain species was also recorded in consideration for the calculation of

dominance. The number of individuals for each species encountered at different distances along the 50-meter radius plot, considering relevant environmental factors, was also listed using bird names and codes (Bibby et al., 2000). Unfavorable weather conditions such as wind, heavy rain, mist, fog, haze, and electrical storms were avoided during bird surveys. Any birds observed outside the 50-meter sample area but within the ten-minute recording period were documented on the opportunistic sightings field data sheet. The observation period spanned four days for each designated area, from 5 a.m. to 7 a.m. during sunrise, with a subsequent session from 5 p.m. to 7 p.m. to minimize disturbances and potential factors influencing bird species presence within the area.

Data Analysis

Bird data were analyzed with the use of Margalef species richness index, Shannon-Weiner species diversity index and Pielou species eveness index to assses bird's abundance, richness and diversity across land-use types. Birds were also categorized based on feeding guilds (Rohman et al., 2023).

RESULTS AND DISCUSSIONS

Bird Diversity

The survey resulted to 20 bird species observed from 14 families within the different land-use types in the Malolos City, Bulacan (Table 1). The highest number of species were observed in the residential area (13 species), followed by agricultural (10 species), institutional area (9 species) and aquatic area (8 species). Off all the species recorded, *Passer montanus*, is the most abundant species (631) found in all land-use types wherein more than 50% of total population is found institutional area. *P. montanus* benefits from the presence of structures with nooks and crannies that serve as suitable nesting sites. Also, the reduced presence of predators in institutional areas, as compared to natural habitats, contributes to the abundance of the Eurasian tree sparrow (Maciorowski et al., 2016).

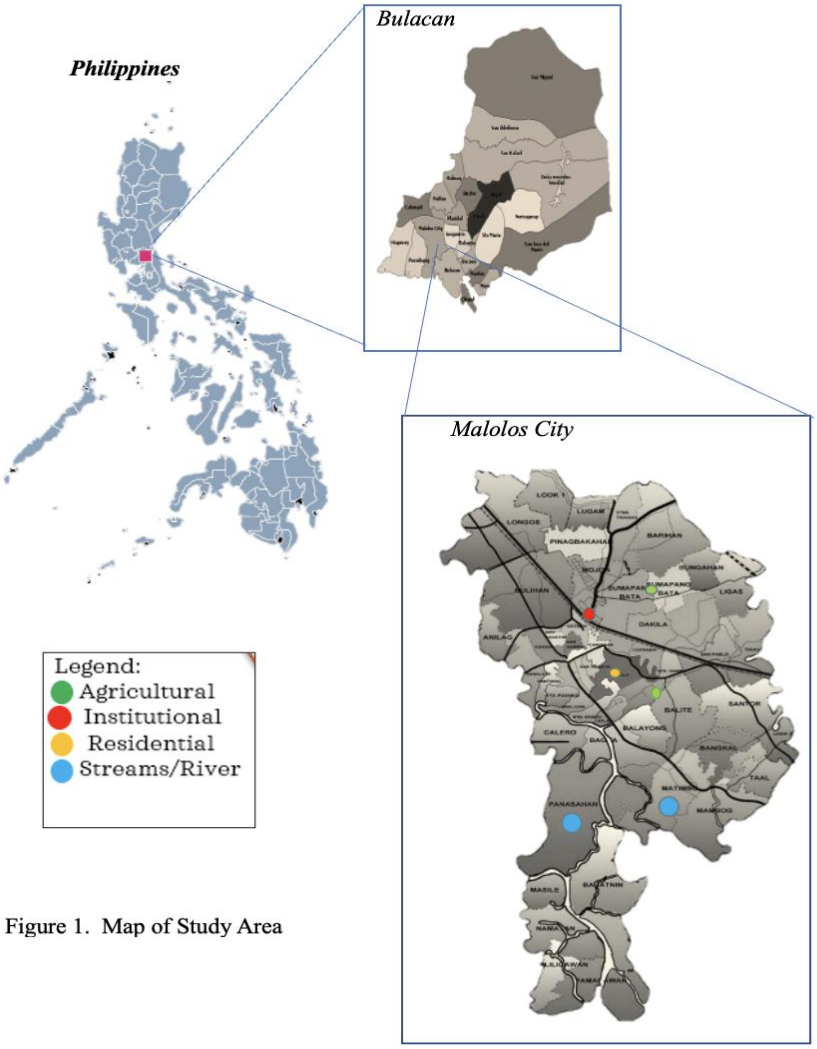

Figure 1. Map of Study Area

Table 1. List of birds (20 species) and their number in the four land-use types in Malolos City

SN	Common Name	Scientific Name	Family	Endemicity	Status	Land-use types					
						IA	RA	AG	AQ	Total	Feeding Guild
1	Eurasian Tree Sparrow	*Passer montanus*	Passeridae	Resident	LC	389	87	68	87	631	Granivore
2	Zebra Dove	*Geopelia striata*	Columbidae	Resident	LC	113	7	0	4	124	Granivore
3	Red-turtle dove	*Streptopelia tranquebarica*	Columbidae	Partial Migrant	LC	21	5	0	0	26	Granivore
4	Yellow-vented bulbul	*Pycnonotus goiavier*	Pycnonotidae	Resident	LC	14	15	3	1	33	Frugivore
5	Black-headed munia	*Lonchura atricapilla*	Estrildidae	Passage Migrant	LC	1	12	0	0	13	Granivore
6	Brown shrike	*Lanius cristatus*	Laniidae	Migrant	LC	10	5	0	0	15	Insectivore

7	Asian glossy starling	*Aplonis panayensis*	Sturnidae	Resident	LC	10	20	0	0	30	Frugivore
8	Philippine pied fantail	*Rhipidura nigritorquis*	Rhipiduridae	Resident	LC	16	16	0	0	32	Insectivore
9	Olive-backed sunbird	*Cinnyris jugularis*	Nectariniidae	Resident	LC	3	2	0	0	5	Nectarivore
10	Little egret	*Egretta garzetta*	Ardeidae	Migrant	LC	0	2	3	48	53	Carnivore
11	Rock dove	*Columba livia*	Columbidae	Resident	LC	0	15	0	0	15	Granivores
12	Barn Swallow	*Hirundo rustica*	Hirundinidae	Migrant	LC	0	2	0	0	2	Insectivore
13	Pacific swallow	*Hirundo tahitica*	Hirundinidae	Migrant	LC	0	20	20	10	50	Insectivore
14	Eastern cattle egret	*Bubulcus coromandus*	Ardeidae	Migrant	LC	0	0	92	0	92	Insectivore
15	White-winged tern	*Chlidonias leucopterus*	Laridae	Migrant	LC	0	0	3	123	126	Insectivore
16	White-throated kingfisher	*Halcyon smyrnensis*	Alcedinidae	Residentand partially migrant	LC	0	0	1	0	1	Carnivore
17	Tawny grassbird	*Cinclorhampus timoriensis*	Locustellidae	Resident	LC	0	0	5	0	5	Insectivore
18	Black-crowned night heron	*Nycticorax nycticorax*	Ardeidae	Migrant	LC	0	0	1	10	11	Carnivore
19	White-breasted waterhen	*Amauromis phoenicurus*	Rallidae	Resident	LC	0	0	10	0	10	Insectivore
20	Striated swallow	*Cecropis striolata*	Hirundinidae	Migrant	LC	0	0	0	4	4	Insectivore
Total						577	208	206	287	1278	
						9	13	10	8		

LC (least concerned); IG (Institutional Area); RG (Residential Area); AG (Agricultural Area); AQ (Aquatic Area

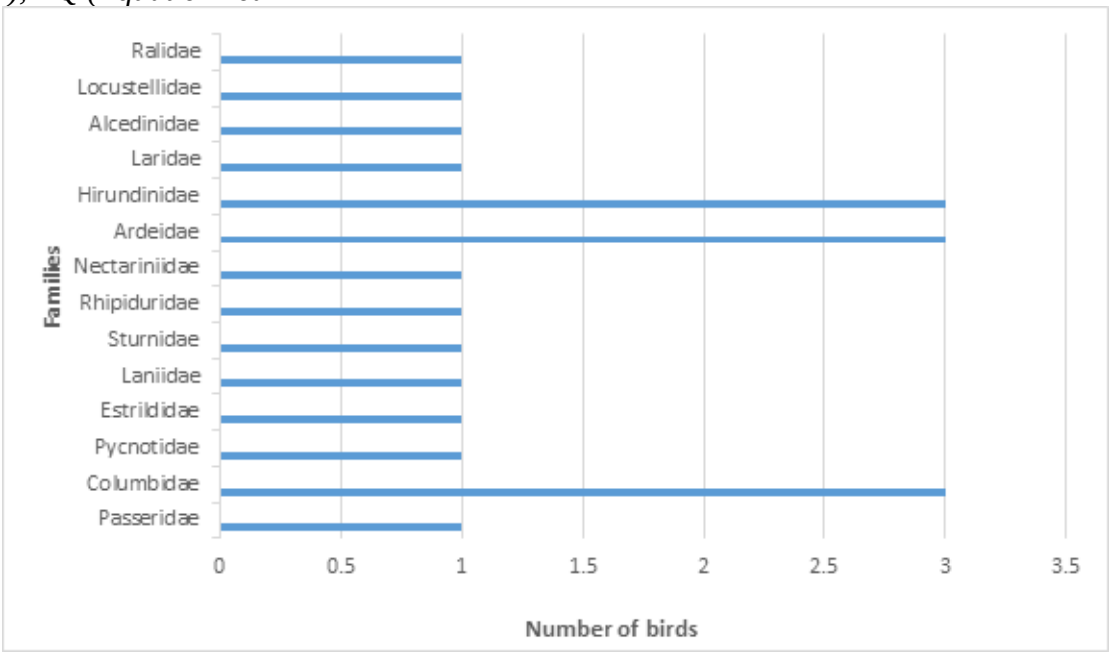

Figure 2. Distribution of bird species based on their respective families across various land-

use types in Malolos City, Bulacan.

Family Columbidae, Ardeidae and Hirundidae exhibited the highest frequency (15%) across the various land-use types in this study(Figure 2). These families were observed in institutional, residential, agricultural, and aquatic areas. They are abundant in urban areas due to specific characteristics and adaptations that allow them to thrive in city environments. Columbidae are known for their ability to adapt to urban landscapes because of their tolerance of disturbed habitats, exploit human resources such as food waste and artificial structures for nesting, and are highly adaptable to different types of urban environments (Croci et al., 2008).

Ardeidae, are often found near water bodies in cities, such as ponds, lakes, and rivers, where they can find abundant food sources and suitable nesting sites (Iwamura et al., 2013). They can tolerate human presence to some extent and have been observed nesting in urban parks and wetland areas (García-Moreno et al., 2014). Hirundinidae, are well-adapted to urban settings due to their aerial foraging habits and ability to build nests on man-made structures, such as buildings and bridges (Møller & Díaz, 2000). These birds have benefitted from the increased availability of insects in urban areas and have successfully utilized urban structures as nesting sites, leading to their abundance in cities (Lowry et al., 2013).

Table 2. Species Richness (DMg) index, Diversity (H') index and evenness index (J') of Avian species in the selected land-use types in Malolos City

Land - use	No. of Species	DMg	H'	J'
IA	9	0.9437	1.07	0.489
RA	13	2.2482	1.98	0.773
AG	10	1.6892	1.43	0.619
AQ	8	1.2369	1.4	0.672

Bird abundance is highest in residential area comprising of 65% of avian species observed in the study sites. Also, among the land-use type used, it is in the residential area that both species richness and diversity index are high (Table 2). Residential environments exhibit a greater avian species diversity compared to other urban landscapes, owing to a confluence of factors that render

residential areas particularly appealing to a variety of bird species.

One primary contributing factor is the abundant availability of food resources. Residential areas feature a heterogeneous composition of vegetation, encompassing lawns, gardens, and natural expenses such as parks and greenbelts, thereby offering a diverse array of food sources for avifauna (Matthies et al, 2017). An additional factor that contributes to the attractiveness of residential areas is the abundance of nesting sites and provides an assortment of microhabitats, such as dense foliage to cater to specific bird species and open spaces to suit others, thereby accommodating the distinct nesting preferences of diverse avian populations (Mardiastuti *et. al.*, 2018). Also, the relatively diminished level of disturbance encountered in residential areas, when compared with other urban landscapes, renders them a more desirable habitat for avian populations (Curzel, et. al., 2021). Because of diminished disruption like reduced noise pollution, infrequent disturbances originating from human activities, and a diminished presence of natural predators, collectively fosters an environment conducive to heighten avian species diversity within residential areas.

Feeding guild

Table 3. Number of species based on feeding guild in the land-use types.

Feeding Guild	Institutional		Residential		Agricultural		Aquatic	
	species	%	species	%	species	%	species	%
Insectivore	2	22.22	4	30.76	6	60.00	2	25.0
Carnivore	0	0	1	7.69	2	20.00	3	37.50
Granivore	4	44.44	5	38.46	1	10.00	2	25.00
Frugivore	2	22.22	2	15.38	1	10.00	1	12.50
Nectarivore	1	11.11	1	7.69	0	0.00	0	0
TOTAL	9	100	13	100	10	100	8	100

Granivores are dominant in both institutional and residential land use types (Table 3). Granivorous birds are widely distributed and are associated with humans through commensal relationship. This is considered as an adaptation for acquiring food sources because in both institutional and residential area, all year round supply is provided by sedentary human society through storage of grains or cereal, spilling and feeding domesticated animals in backyards or streets (Riyahi et al.,

2013), and of course, presence of vegetation such as grass, shrubs and trees due to landscaping activities. On the other hand, insectivorous birds are dominant aquatic area. This abundance is associated with mixed plant crop planting, the variety of plant crops provide insect food sources for nestlings and is a suitable nesting space, and the density of perching trees (Rajashekara & Venkatesha, 2014). Variety of agricultural plants supports higher diversity of insects supporting the needs of insectivorous birds. While carnivorous birds dominate in aquatic ecosystem, these aquatic birds are widespread in coastal areas, rivers and streams which feed on fish and insects. Their dominance is associated with the presence of aquaculture in the selected land-use type where in fish ponds are abundant. It has also been reported that these birds enhance wetland diversity, serve as pest control, bio-indicators and may act as indicators for disease outbreaks (Maznikova et al., 2024). Lastly, in all land use types, insectivorous, granivorous and frugivorous guilds are present.

Conclusion

Different land use types in urban areas are suitable habitats for birds as they demonstrate their adaptability and prevalence. Residential environments exhibit a greater avian species diversity compared to other urban landscapes, owing to a confluence of factors that render residential areas particularly appealing. It offers a broad spectrum of food resources, nesting sites, water sources, and comparably undisturbed habitats. By creating and managing urban spaces that cater to the specific requirements of bird species, it is plausible to augment avian diversity and facilitate the sustenance of robust bird populations in urban settings.

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