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Biodiversity Assessment of Avifauna in the Forest Reservation of Aurora State College of Technology (ASCOT), Philippines

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Abstract

The research study was conducted to assess and quantify the current status of avifauna biodiversity assets of Aurora State College of Technology's Forest Reservation in Baler, Aurora, Philippines. Assessment of avifaunal diversity was undertaken by traversing the four established circular plots having a radius of 125 meters or 250 meters diameters each as permanent monitoring stations. Study revealed a total number of 151 Individual species, classified into 23 genera and 21 families. Eighteen of these species are endemic while the remaining five were fully migrated birds. All birds observed were classified as Least Concern (LC) species according to the International Union for Conservation of Nature's Red List of Threatened Species and the updated list of the Birds of the World online. Its abundance, richness and diversity index were calculated using Shannon Diversity Index (H') while Pielou's evenness (J') for distribution of species. Forest reservation of ASCOT has more even (0.756 J') and moderate diversity (2.812 H') observation on avifauna in general. However, this avian population evaluation was threatened into a verge of extinction due to natural and anthropological threats that causes forest deforestation. Such deforestation of habitat causes dwindling of wildlife territory leading to the scarcity of bird's population. Thus, the assessment was conducted to aid ASCOT administration find significant plans to ensure sustainable conservation and protection of the remaining avifauna species in the reservation area.

Keywords

Biodiversity, Avifauna, Abundance, Species Richness, Species Diversity

1. Introduction

Birds fascinate us more than any other group of fauna as new information surfaces every year [1]. Biodiversity assessment of Avifauna is considered necessary because the population around the world is getting endangered today, yet the existence of avians manifests the quality of environment—whether is it in good or bad condition [2] [3].

Though various biodiversity studies were conducted elsewhere, nobody led a study regarding the diversity of avifauna in central Aurora, particularly in Baler—a place where ASCOT Forest Reservation was found. Thus, the study was conducted on July 2022 to June 2023 to enrich and document the current diversity status of avifauna within the reservation area of ASCOT.

The results will be a great tool to determine which part of the reservation area should be considered a hotspot, which needs full protection, and which areas are intended for project development. Likewise, the data derived might also be utilized to evaluate the potential capacity of ASCOT reservation as ecotourism destination [4] due to the presence of abundant wildlife that provides people with a depth sense of emotions and excitements upon encountered a bird flying in the wild [5]. Further, the results are also significant in seeking efficient strategies to ensure the long-term protection, conservation and preservation of the remaining biodiversity necessary for planning, researches and educational purposes.

The research study's general objective is to assess the current biodiversity status of Avifauna in the Forest Reservation of Aurora State College of Technology. Specifically, the study aims to: 1) Conduct assessment on biodiversity of avifauna in Dibudalan Mountain Forest Reservation of Aurora State College of Technology; 2) Determine the conservation and endemism status of avifauna; 3) Determine the abundance, species richness and diversity index of avifauna; 4) Determine the threats in ASCOT forest reservation.

Although complex and costly, assessment remains the most feasible and effective way to assess the overall status of biodiversity in a specific region. In effect, many biodiversity studies have relied on avian species as indicators to reflect the general environmental condition of a region. Thus, assessment applies in this study to help ASCOT decide on the planning and proper utilization of the reservation area.

2. Methodology and Materials

2.1. Location of the Study Site

Research study site was located in the school site forest reservation of Aurora State College of Technology in Baler, Aurora province (**Figure 1**), known as Dibudalan Mountain Forest Reserve (DMFR). DMFR was declared School Site Civil Reservation of ASCOT through Proclamation No. 559 on April 7, 1995.

Dibudalan Mountain Forest was under the geo-political boundary of Barangay Zabali in the municipality of Baler. Baler is the smallest municipality of Aurora province yet the capital town and is considered as the economic and tourism hub

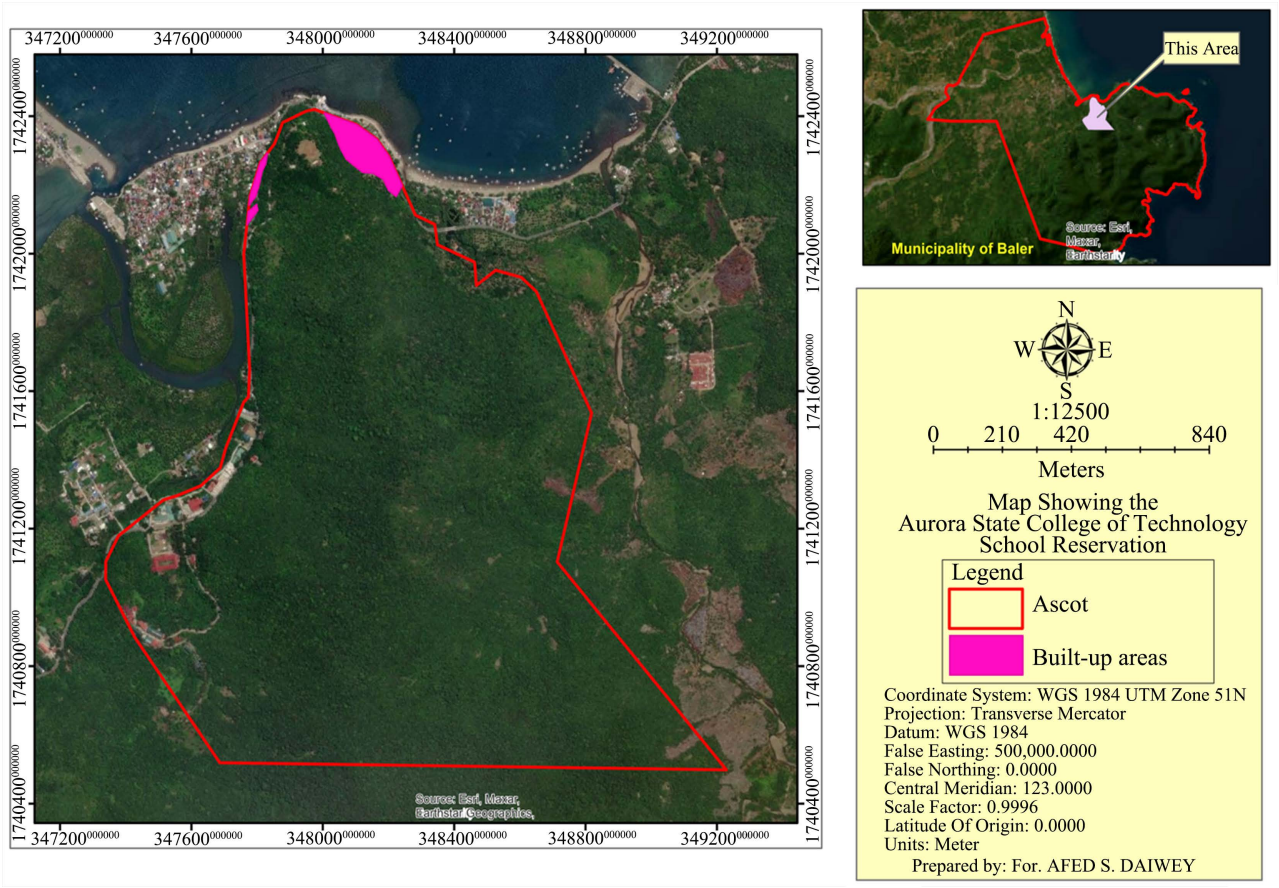

Figure 1. Map showing the research study site.

of the province. Dibudalan forest is adjacent to Sierra Madre Mountain Range that nestles at the eastern coastline of Central Luzon. The formation of Dibudalan Mountain Forest Reserve is undulating to rolling with level to gently sloping plateau at the northeastern portion.

2.2. Avifaunal Inventory

Birds were practically identified through the use of a high-end Digital Single-Lens Reflex (DSLR) Camera, installed with high-end adjustable lens known as Celestron Ultima with 65 mm 18 - 55× Straight spotting scopes (**Figure 2**), and a digital audio recorder for recording bird calls. The unidentified captured images onsite were identified by comparison with the database's photos online, such as Internet Bird Collection (https://www.macaulaylibrary.org/the-internet-bird-collection-the-macaulay-library/), Wild Bird Club of the Philippines (http://www.birdwatch.ph/), and through consultation with someone expert in Bird's identification.

The survey method is simply counting of species seen in the four Modified Circular Plots (MCP) having a radius of 125 meters or 250 meters diameters each (**Figure 3**). Traversed the trail with the data sheet samples to record the species seen or heard within the MCP [6].

Figure 2. High-end DSLR Camera with adjustable lens.

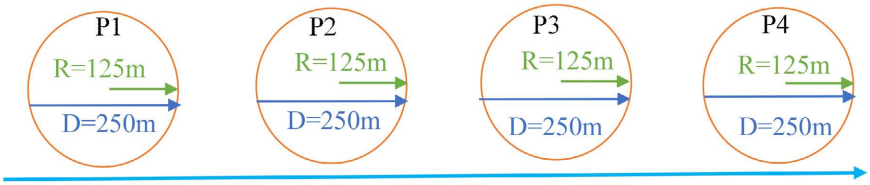

Figure 3. Modified circular monitoring plots of the study site.

Walk continuously towards the next site until the end of the transect line. Brief stops are necessary to ensure appropriate counts and to estimate the flushing distance and angle of the subject. A walk on transect line is a systematic walk along the transect line across the study area [7].

Monitoring Plot 2 has the highest elevation of about 150 - 200 above sea level (ASL), Plot 1 of around 50 - 100 ASL, Plot 3 is about 100 - 150 ASL, and Plot 4 has an elevation of about 30 - 100 ASL. To minimize the bias on counting, birds in constant flight during the observation period are not recorded due to lack of fixed flushing distance.

More observation time was applied to mixed feeding flocks to ascertain the identities of individuals, estimating counts in getting the diversity of many flock's flights was applied. Visitation of the monitoring sites was conducted early in the morning and late afternoon, usually coinciding with the foraging activity of birds.

3. Data Analysis

The statistical tools employed in the study are combination of qualitative and quantitative research approach. The qualitative method involved descriptive probability assessment as a result of purposive interviews. Whereas, the quantitative approach is the assessment results of monitoring and evaluation of species being observed in the study site.

The statistical data analysis on the Abundance, Species richness and Diversity of fauna was determined using Shannon Diversity Index (H') (a.k.a. the Shannon-Wiener diversity index) [8]. The Shannon-Weiner index (H') is a measure of diversity that combines species richness and their relative abundances [9].

$$H = -\sum_{i=1}^{S} p_i * \ln p_i$$

where:

i = species coming from the community.

s = total number of species in the community.

p_i = Proportion of the specie.

ln = Natural log of the proportion.

Modified Model scale in determining diversity of fauna species:

0 - 1.5 = Very low diversity.

>1.5 - 2.5 = Low diversity.

>2.5 - 3.5 = Moderate diversity.

>3.5 - 5.0 = High diversity.

>5.0 = extreme diversity.

In addition, the empirical relationship between species richness and evenness is determined by calculating Pielou's evenness (J'), which was expressed in the Shannon information scale to measure the species evenness for each community.

$$J' = \frac{H'}{\ln(S)}$$

where H' represents the observed value of Shannon index, ln is the natural log, and S is the total number of species observed. Two reasons why choosing Pielou's formula in calculating the evenness index. First, it is the most widely used in ecology, and Second, it has been demonstrated in a study on a tropical forest that species richness was predicted through species-abundance models as evaluated by J'. The value of J' ranges from 0 to 1, values closer to 1 or higher results are indications of a more evenly distribution of species, while values closer to zero are less even [10].

Furthermore, the conservation and endemism status of avifauna species is determined by referring to the IUCN Red List of Threatened Species [11], and the updated list of the Birds of the World online [12]. The threats were determined by collating the data gathered after a series of interviews with the community resided inside reservation area and the key officials of ASCOT.

4. Results and Discussion

4.1. Biodiversity Assessment of Avifauna

From a total of 9702 avifauna species globally [13], 1327 birds identified in southeast Asia [14], and more than 700 known species of birds in the Philippines [15]; a total of 151 bird species are frequently sighted in the forest reservation of ASCOT. Out of the 151 total Avians observed are 21 families, 23 individuals and 23 distinct genera of which the most dominant and frequently observed avian was Luzon hornbill (*Penelopides manillae*) with a total of 26 head counts (**Table 1**).

Table 1. The abundance and scientific classification of Avifauna species in DMFR.

	Common Name	Family Name	Genera	Abundance
1.	Northern Brown Shrike	Laniidae	Lanius	2
2.	White-browed shama	Muscicapidae	Copsychus	7
3.	Red keeled flowerpecker	Dicaeidae	Dicaeum	8
4.	Yellow-wattled Bulbul	Pycnonotidae	Poliolophus	6
5.	Plain swift	Apodidae	Apus	4
6.	Eurasian barn swallow	Hirundinidae	Hirundo	4
7.	Luzon hornbill	Bucerotidae	Penelopides	26
8.	Spotted wood kingfisher	Alcedinidae	Actenoides	15
9.	Philippine frogmouth	Podargidae	Batrachostomus	1
10.	Northern rufous paradise flycatcher	Monarchidae	Terpsiphone	3
11.	Blue-headed fantail	Rhipiduridae	Rhipidura	4
12.	Gray wagtail	Motacillidae	Motacilla	15
13.	Philippine bulbul	Sturnidae	Hypsipetes	10
14.	Stripe-headed rhabdornis	"	Rhabdornis	1
15.	Chestnut cheeked starling	"	Agropsar	5
16.	Ashy minivet	Campephagidae	Pericrocotus	3
17.	Lowland white eye	Zosteropidae	Zosterops	6
18.	Plain throated sunbird	Nectariniidae	Anthreptes	1
19.	Chestnut Munia	Estrildidae	Lonchura	1
20.	Philippine Serpent Eagle	Accipitridae	Spilornis	7
21.	Eurasian Tree Sparrow	Passeridae	Passer	12
22.	Common raven	Corvidae	Corvus	5
23.	Red Junglefowl	Phasianidae	Gallus	5
	Total			151

The probability of *Penelopides manillae* dominance was due to the massive Information Education Campaign (IEC) on wildlife protection and conservation by the Department of Environment and Natural Resources (DENR) in collaboration of Aurora State College of Technology (ASCOT) that increases people's level of awareness on wildlife conservation.

Likewise, the vendors inside reservation area are also helping in the protection and conservation by feeding these species that keep them coming back which eventually becoming tame. In return, vendors are benefiting from these birds because more tourists are visiting the area hoping to see more distinct birds that increases customers. In effect, the vendors earnings are increasing too. Therefore, avians were not just a contributor in the re-engineering of our ecosystem but rather a survival resource that human beings had leaned on.

Moreover, the predominance of *Penelopides manillae* and abundance of avi-

ans are good indicator to determine which parts of the reservation area should be considered hotspots, area needs full protection, areas suitable for commercial, ecotourism, and construction of project development.

Above all, the abundance of avians in DMFR may also be used as a baseline in developing a policy to convert ASCOT reservation area into wildlife sanctuary to ensure the continuous biodiversity conservation and protection as environmental policy implementation in the sanctuary was strictly executed [16].

4.2. Conservation and Endemism Status of Avifauna

Using the International Union for Conservation of Nature and Wildlife Sanctuary database of the Department of Environment and Natural Resources, the scientific classification and comprehensive facts regarding conservation and endemism status of avifauna observed inside DMFR were discovered as Least-Concerned (LC), 18 were endemic, and 5 are fully migrants (**Table 2**).

Table 2. Conservation and endemism status of avifauna inside DMFR.

Scientific Name	Conservation	Endemism
Lanius cristatus	Least Concern	Endemic
Copsychus luzoniensis	Least Concern	Endemic
Dicaeum australe	Least Concern	Endemic
Poliolophus urostictus	Least Concern	Endemic
Apus unicolor	Least Concern	Full Migrant
Hirundo rustica	Least Concern	Full Migrant
Penelopides manillae	Least Concern	Endemic
Actenoides lindsayi	Least Concern	Endemic
Batrachostomus septimus	Least Concern	Endemic
Terpsiphone cinnamomea	Least Concern	Endemic
Rhipidura cyaniceps	Least Concern	Endemic
Motacilla cinerea	Least Concern	Full Migrant
Hypsipetes philippinus	Least Concern	Endemic
Rhabdornis inornatus	Least Concern	Endemic
Agropsar philippensis	Least Concern	Full Migrant
Pericrocotus divaricatus	Least Concern	Full Migrant
Zosterops meyeni	Least Concern	Endemic
Anthreptes malacensis	Least Concern	Endemic
Lonchura atricapilla	Least Concern	Endemic
Spilornis holospilus	Least Concern	Endemic
Passer montanus	Least Concern	Endemic
Corvus corax	Least Concern	Endemic
Gallus gallus	Least Concern	Endemic

The least-concern species is one that has been classified by the IUCN as not being a priority for conservation since still abundant in a given area. Whereas, endemism of birds means stability of fair climate or temperature conditions due to abundance of trees and other biodiversity. The stable climatic temperature in DMFR, although slightly disturbed due to project development in some parts, is one of the main drivers to have abundant endemic species that end up to permanent migration of *Apus unicolor*, *Hirundo rustica*, *Motacilla cinerea*, *Agropsar philippensis*, and *Pericrocotus divaricatus* (Table 2).

4.3. Overall Diversity Index of Avians

The diversity index of avifauna was calculated using the formula developed by Shannon (*H*) "a.k.a. Shannon-Wiener diversity index". The 151 Avians assessed has a corresponding Shannon diversity index of 2.81 (Table 3) which shows that

Table 3. The overall diversity index of avifauna observed in ASCOT reservation.

Common Name	Pi	LnPi	Pi * LnPi	*H*
Northern Brown Shrike	0.013	−4.3241	−0.0573	0.0573
White-browed shama	0.046	−3.0714	−0.1424	0.1424
Red keeled flowerpecker	0.053	−2.9378	−0.1556	0.1556
Yellow wattled Bulbul	0.040	−3.2255	−0.1282	0.1282
Plain swift	0.026	−3.6310	−0.0962	0.0962
Eurasian barn swallow	0.026	−3.6310	−0.0962	0.0962
Luzon hornbill (tarictic)	0.172	−1.7592	−0.3029	0.3029
Spotted wood kingfisher	0.099	−2.3092	−0.2294	0.2294
Philippine frogmouth	0.007	−5.0173	−0.0332	0.0332
Northern rufous paradise flycatcher	0.020	−3.9187	−0.0779	0.0779
Blue-headed fantail	0.026	−3.6310	−0.0962	0.0962
Gray wagtail	0.099	−2.3092	−0.2294	0.2294
Philippine bulbul	0.066	−2.7147	−0.1798	0.1798
Stripe headed rhabdornis	0.007	−5.0173	−0.0332	0.0332
Chestnut cheeked starling	0.033	−3.4078	−0.1128	0.1128
Ashy minivet	0.020	−3.9187	−0.0779	0.0779
Lowland white eye	0.040	−3.2255	−0.1282	0.1282
Plain throated sunbird	0.007	−5.0173	−0.0332	0.0332
Chestnut Munia or Red Maya	0.007	−5.0173	−0.0332	0.0332
Philippine Serpent Eagle	0.046	−3.0714	−0.1424	0.1424
Eurasian Tree Sparrow	0.079	−2.5324	−0.2012	0.2012
Crow or Common Raven	0.033	−3.4078	−0.1128	0.1128
Red Junglefowl	0.033	−3.4078	−0.1128	0.1128
Total	**1.000**	**−80.5033**	**−2.8124**	**2.8124**

DMFR has a moderate avifaunal diversity in general, based on the modified scale model (p. 8) of the study. The index results further revealed that the most dominant birds seen in the area is Luzon hornbill, locally known as "Taractic", which obtained the highest diversity index of 0.3029. This finding confirms the theory that Luzon hornbill is endemic in the forests of Luzon and nearby islands in the northern Philippines [11].

Unfortunately, the gradual dwindling population of these species cannot be denied due to unceasing illegal hunting and slaughtering by predators. These incidents pursued this research as the results could be utilized to see what preventive measures are applicable to ensure the long-term protection and sustainable conservation since abundancy of biodiversity is essential in maintaining better ecosystem. As the late ecologist Dr. Thomas Lovejoy emphasized during his speech in the United Nations Foundation in 2018 as quoted by Altman (2023) "Without biological diversity, there is no other life on Earth—including our own. Even though we are often oblivious to it, this diversity of life is what provides clean water, oxygen, and all other things that end up being part of our diet, as well as clothing and shelter. It provides a lot of psychological benefits too, which are not much appreciated" [17]. Considering the findings of this study, the problems on wildlife protection and conservation in DMFR may address and resolve.

4.4. Species Richness, Abundance and Diversity Index of Avifauna Per Plot

Species richness refers to the number of species in a community [17] [18], it does not matter how abundant they are. The differences in species richness of avifauna per plot was revealed in **Table 4**, wherein Plot 1 (P1) and P4 have the richest avifauna observed with 20 populations each (86.96%), followed by P3 with 15 avian (65.22%), and then P2 with the lowest accumulated population of 3 (13.04%).

With regards to the measurement of abundancy or frequency of individuals that answers questions regarding the increasing or decreasing number of individuals as defined by Booth *et al.* (2003) and cited by Travlos (2018) [19] [20]; study revealed that Modified Circular Plot 1 obtained the highest population with an abundance of 61 and diversity index (H) of 2.76; followed by P4 with an abundance of 59 and H of 2.76), P3 with 27 abundancy and H of 2.59, and lastly is P2 with abundancy of 4 and H of 1.04 (**Table 5**).

The probability of maintaining the highest diversity index of Avifauna in P1 and P4, particularly *Penelopides manillae*, was due to several factors such as; elevation, spacious disturbed forest, abundance of fruiting trees, and closer distance to the bodies of water. This probability of observations was proven in the study of Ana Katrina Mamangun and Juan Carlos Tecson Gonzalez (2024) in their research on "Density and Feeding Preference of the Polillo Tarictic Hornbill (*Penelopides manillae subnigra*) in Fragmented Forests of Polillo Island"

[21] demonstrated that there is a higher density of avians in the areas of abundant fruiting trees and spacious disturbed forest compared to the densely residual forest site. Anni Charis T. Salinas (2010) also stated in her research on "Biodiversity Assessment of Avifauna in the Pine Forests of Camp John Hay Forest Reservation, Baguio City, Philippines" demonstrated that there is a significant number and diversity of bird species in the disturbed habitat despite of various development activities [18].

Table 4. Presents the richness of birds per plot.

	Common Name	Species Richness			
		Plot 1	Plot 2	Plot 3	Plot 4
1.	Northern Brown Shrike	1	x	x	1
2.	White-browed shama	1	x	1	1
3.	Red keeled flowerpecker	1	x	x	1
4.	Yellow wattled Bulbul	1	x	1	1
5.	Plain swift	1	1	x	1
6.	Eurasian barn swallow	1	x	1	1
7.	Luzon hornbill (tarictic)	1	1	1	1
8.	Spotted wood kingfisher	1	x	1	1
9.	Philippine frogmouth	x	x	x	1
10.	Northern rufous paradise flycatcher	1	x	1	1
11.	Blue-headed fantail	1	x	1	1
12.	Gray wagtail	1	x	1	1
13.	Philippine bulbul	1	x	x	1
14.	Stripe headed rhabdornis	x	1	x	x
15.	Chestnut cheeked starling	1	x	1	1
16.	Ashy minivet	1	x	1	1
17.	Lowland white eye	1	x	1	1
18.	Plain throated sunbird	1	x	x	x
19.	Chestnut Munia	x	x	x	1
20.	Philippine Serpent Eagle	1	x	1	1
21.	Eurasian Tree Sparrow	1	x	1	1
22.	Crow (Common Raven)	1	x	1	1
23.	Red Junglefowl	1	x	1	x
	Total	20	3	15	20
	Percentage	86.96	13.04	65.22	86.96

*1 = Presence of birds in plot. x = Absence of birds in plot.

Table 5. The abundancy and diversity of avifauna per plot.

Common Name	Abundance				Plot 1				Plot 2				Plot 3				Plot 4			
	P1	P2	P3	P4	Pi	LnPi	Pi * LnPi	*H'*	Pi	LnPi	Pi * LnPi	*H'*	Pi	LnPi	Pi * LnPi	H'	Pi	LnPi	Pi * LnPi	*H'*
Northern Brown Shrike	1	0	0	1	0.017	−4.078	−0.069	0.069	0	0.000	0	0	0.000	0.000	0.000	0.000	0.017	−4.078	−0.07	0.069
White-browed shama	2	0	2	3	0.051	−2.979	−0.151	0.151	0	0.000	0	0	0.074	−2.603	−0.193	0.193	0.051	−2.979	−0.15	0.151
Red keeled flowerpecker	3	0	0	5	0.085	−2.468	−0.209	0.209	0	0.000	0	0	0.000	0.000	0.000	0.000	0.085	−2.468	−0.21	0.209
Yellow wattled Bulbul	1	0	1	4	0.068	−2.691	−0.182	0.182	0	0.000	0	0	0.037	−3.296	−0.122	0.122	0.068	−2.691	−0.18	0.182
Plain swift	1	1	0	2	0.034	−3.384	−0.115	0.115	0.25	−1.386	−0.35	0.347	0.000	0.000	0.000	0.000	0.034	−3.384	−0.11	0.115
Eurasian barn swallow	1	0	1	2	0.034	−3.384	−0.115	0.115	0	0.000	0	0	0.037	−3.296	−0.122	0.122	0.034	−3.384	−0.11	0.115
Luzon hornbill	10	2	4	10	0.169	−1.775	−0.301	0.301	0.5	−0.693	−0.35	0.347	0.148	−1.910	−0.283	0.283	0.169	−1.775	−0.3	0.301
Spotted wood kingfisher	7	0	3	5	0.085	−2.468	−0.209	0.209	0	0.000	0	0	0.111	−2.197	−0.244	0.244	0.085	−2.468	−0.21	0.209
Philippine frogmouth	0	0	0	1	0.017	−4.078	−0.069	0.069	0	0.000	0	0	0.000	0.000	0.000	0.000	0.017	−4.078	−0.07	0.069
Northern rufous paradise flycatcher	1	0	1	1	0.017	−4.078	−0.069	0.069	0	0.000	0	0	0.037	−3.296	−0.122	0.122	0.017	−4.078	−0.07	0.069
Blue-headed fantail	2	0	1	1	0.017	−4.078	−0.069	0.069	0	0.000	0	0	0.037	−3.296	−0.122	0.122	0.017	−4.078	−0.07	0.069
Gray wagtail	7	0	3	5	0.085	−2.468	−0.209	0.209	0	0.000	0	0	0.111	−2.197	−0.244	0.244	0.085	−2.468	−0.21	0.209
Philippine bulbul	7	0	0	3	0.051	−2.979	−0.151	0.151	0	0.000	0	0	0.000	0.000	0.000	0.000	0.051	−2.979	−0.15	0.151
Stripe headed rhabdornis	0	1	0	0	0.000	0.000	0.000	0.000	0.25	−1.386	−0.35	0.347	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Chestnut cheeked starling	2	0	1	2	0.034	−3.384	−0.115	0.115	0	0.000	0	0	0.037	−3.296	−0.122	0.122	0.034	−3.384	−0.11	0.115
Ashy minivet	1	0	1	1	0.017	−4.078	−0.069	0.069	0	0.000	0	0	0.037	−3.296	−0.122	0.122	0.017	−4.078	−0.07	0.069
Lowland white eye	2	0	2	2	0.034	−3.384	−0.115	0.115	0	0.000	0	0	0.074	−2.603	−0.193	0.193	0.034	−3.384	−0.11	0.115
Plain throated sunbird	1	0	0	0	0.000	0.000	0.000	0.000	0	0.000	0	0	0.000	0.000	0.000	0.000	0.000	0.00	0.000	0.000
Chestnut Munia	0	0	0	1	0.017	−4.078	−0.069	0.069	0	0.000	0	0	0.000	0.000	0.000	0.000	0.017	−4.078	−0.07	0.069
Philippine Serpent Eagle	2	0	2	3	0.051	−2.979	−0.151	0.151	0	0.000	0	0	0.074	−2.603	−0.193	0.193	0.051	−2.979	−0.15	0.151
Eurasian Tree Sparrow	5	0	2	5	0.085	−2.468	−0.209	0.209	0	0.000	0	0	0.074	−2.603	−0.193	0.193	0.085	−2.468	−0.21	0.209
Crow (Common Raven)	2	0	1	2	0.034	−3.384	−0.115	0.115	0	0.000	0	0	0.037	−3.296	−0.122	0.122	0.034	−3.384	−0.11	0.115
Red Junglefowl	3	0	2	0	0.000	0.000	0.000	0.000	0	0.000	0	0	0.074	−2.603	−0.193	0.193	0.000	0.000	0.000	0.000
Total	61	4	27	59	1	−64.663	−2.763	2.763	1	−3.466	−1.040	1.040	1	−42.388	−2.590	2.590	1	−64.66	−2.763	2.763

Further, the empirical relationship between diversity index, species richness and evenness distribution of the avifauna was calculated using Pielou's evenness (J) formula. The species diversity index is a measure of the number of species present (richness) and their relative abundances (evenness) in the area [19]. The study's findings illustrate that avifauna's evenness distribution was less even in P2 and P3 (**Table 6**). This may be owing to the fact that these plots were totally disturbed in various ways such as; land conversion, kaingin and traditional charcoal making, illegal cutting, and poaching of animals that caused dwindling of wildlife habitat, particularly those portions closer to the road. According to Gamalo and Baril (2018) as cited by Ordonio *et al.* (2020), the species richness and abundance of avifauna were lesser in the area near to the road [2] [22]. Ford *et al.* (2000) also stated that absence of suitable habitat could actually contribute to the low species diversity of birds in the area [23].

Furthermore, the noise from automobiles and various human activities in the surrounding was additional contributing factor for species evenness. According to Kociolek *et al.* (2015) and Jack *et al.* (2015), birds exposed to loud noise exhibited raised stress levels, such as increased heart rate, which may translate into an increased risk of acquiring physiological stress over time [24] [25].

In contrast, the distribution of avian species was more even in P1 and P4 as both of them have recorded an evenness value of 0.756 (**Table 6**). These results might be attributed to the following observation: 1) vegetation in these plots is not so much densely populated that gives spacious range for avifauna to move freely, 2) there are presence of fruit bearing trees around that birds can eat, and 3) there are bodies of waters in the surroundings where avians can consume and drink. Although P1 and P2 are slightly disrupted as a result of the infrastructures and buildings constructed, these developments helped a lot as they serve as a shelter and protection for birds. According to Calimpong and Nuñeza (2015) as cited by Ordinario *et al.* (2020), minor disturbances due to structural diversity can provide different niches and micro-habitats for a variety of birds, resulting in a large number of individuals and species richness [2] [26]. In short, the ASCOT forest reservation, despite of slight disturbances, is a potential safe dwelling place and shelter for animal reproduction.

Table 6. Empirical test of the relationship between species richness and evenness.

Observation plots	Species Richness	Diversity Index (H')	Pielou's evenness (J')	Relative Value
P1	20	2.265	0.756	More even
P2	3	0.019	0.017	Less even
P3	15	1.152	0.425	Less even
P4	20	2.265	0.756	More even

4.5. Threats

There were natural and anthropogenic threats identified after a series of interviews with respondents. The two most devastating natural threats identified are typhoon and El-Niño (Figure 4).

The majority (81%) of the respondents perceived typhoon as the most dangerous natural threat as typhoons inflicted damages on people's property, environment, and natural resources found inside DMFR. November of 2020 when the havoc wreaked by typhoon Ulysses hits the province of aurora that causes devastation of crops, damages of buildings, uprooting and cutting of trees in the DMFR. On the El-Niño phenomenon, respondents bluntly manifested how the mountain was once burnt due to a long phase of warm. The strikes of a long drought phenomenon also hits the farmer's crops and nothing remains due to high heat index.

On the other hand, the 3 most nasty anthropogenic threats experienced by the respondents are illegal logging, traditional charcoal making, and land conversion (Figure 5). Most of the respondents (47%) perceived that illegal logging/cutting of trees is the most serious human threat. One respondent emotionally narrated that there are unlawful loggers that were caught in the act by the authorities but freed immediately after a short dialogue and intervention by unknown officers. In effect, the intruders continued to engage in the illegal activities that destroys Dibudalan forest and oppressed people who are relying on the natural and intrinsic benefits provided by nature.

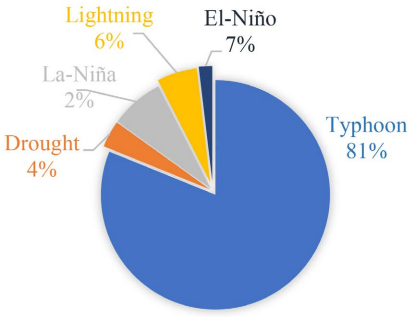

Figure 4. Natural threats.

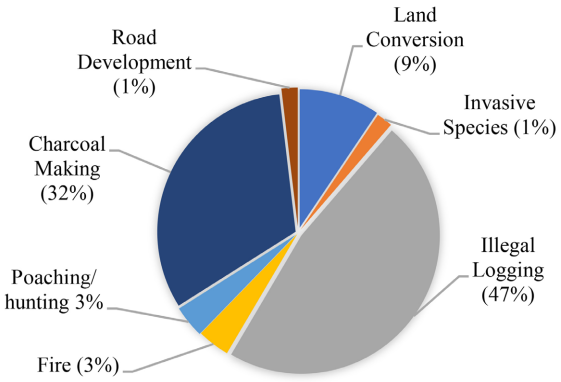

Figure 5. Anthropogenic threats.

The traditional charcoal-making production was also viewed as serious human threats, 32% of the respondents stated unequivocally that some residents inside and outside Dibudalan forest were engaged in that way of living. Such kind of activities pushes other people to illegally tilled the land, extracted natural resources, and occupied portion of the mountain; all these things happened due to the lack of rigorous law enforcement.

Land conversion (9%) is also considered as major human threat that threatens the population of avifauna in the reservation area of ASCOT. As I have personally witnessed recently, the lower portions of the ASCOT reservation area were converted into private farms by few people that causes deforestation in the eastern part of the reservation which is indeed alarming as forests is the safe haven place of biodiversity. The Biodiversity Management Bureau (BMB), as the National Focal Point of the Philippine Clearing House Mechanism, stated further that due to massive deforestation, about 50 to 100 species of animals are being lost each day [6]. This leads to the eradication of plant and animals on a massive scale. The animals were not only losing territorial habitats and shelters but pushes them into extinction as well [27].

The same is true with poaching/hunting (3%), the usual target of poachers are Red Junglefowl, Luzon hornbill (tarictic) and Eagles that causes their population waning. What saddened much is that some of these animals are being used as decorations after being tied up or detained in a small cage inside their backyard. These species were being punished that way without knowing the fact that conservation, preservation, and protection of these wildlife helps human beings rebuild the environment that provides food to eat, water to drink, and even the clean air we breathe.

5. Conclusions

Research study results revealed that ASCOT forest reservation has a more even distribution of avifauna and is moderately diversified in general. This implies that the reservation area is moderately suitable for reproduction venue and a safe shelter for avifauna.

Notably, Luzon hornbill (*Penelopides manillae*) was frequently seen in the reservation area, but like any other bird, they were seemingly going to the verge of extinction soon or later if DMFR was not strictly protected. The relentless intrusions of invaders, project developments, and land use conversions destroy wildlife's habitat. Disturbances of the study area due to human activities cannot stop, if the authorities concern remains deaf and numb to solve the problem.

Thus, the results of this study are appealing to all concerned institutions to work together in order to address the issue and ensure the long-term sustainability conservation and protection of the remaining biodiversity of avifauna and the forest reservation of ASCOT as a whole.

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Conflicts of Interest

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

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