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Seasonal Variation in Bird Diversity in the Campus of Forest Research Institute

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သဘာဝပတ်ဝန်းကျင်တွင် ငှက်မျိုးစိတ်ကြွယ်ဝမှုသည် အဓိကကျသော အခန်းကဏ္ဍမှ ပါဝင်သည့် အပြင် နေရင်းဒေသများရှိ ဇီဝမျိုးစုံမျိုးကွဲတို့ကို အကဲဖြတ်ရာတွင်လည်း အညွှန်းကိန်း တစ်ခုအဖြစ် အသုံးပြုပါသည်။ ဇီဝဆိုင်ရာအချက်အလက်များ (အပင်နှင့် သတ္တဝါ) နှင့် ဇီဝမဟုတ်သော အချက်အလက်များ (အပူချိန်နှင့် မိုးရေချိန်)သည် ငှက်မျိုးစိတ် ပေါကြွယ်ဝမှု အပေါ်တွင် လွှမ်းမိုး လျက်ရှိ ပါသည်။ ဤသုတေသနသည် ၁) ဌာနေငှက်များနှင့် ရာသီလိုက် နေထိုင်သော ငှက်မျိုးစိတ်များကို ဖော်ထုတ်နိုင်ရန်၊ ၂) ငှက်မျိုးစိတ်ကြွယ်ဝမှုနှင့် ပေါများမှုများကို လေ့လာရန်နှင့် ၃) ငှက်မျိုးစိတ် ကြွယ်ဝမှုနှင့် ရာသီဥတုဆိုင်ရာ အချက်အလက်များ အကြားဆက်စပ်မှုများကို တင်ပြရန် ရည်ရွယ်ပါ သည်။ Line Transect အသုံးပြု၍ ရေဆင်းဆည် အပါအဝင် သစ်တောသုတေသနဝန်းအတွင်း ၂၀၁၆ ခုနှစ် နိုဝင်ဘာလမှ ၂၀၁၇ ခုနှစ် အောက်တိုဘာလအထိ နွေမိုးဆောင်းဥတုသုံးပါးစလုံးတွင် ငှက်မျိုးစိတ်များအား လေ့လာခြင်းမှ ငှက်အကောင်ရေ ၁၅၃၀ နှင့်အတူ မျိုးစိတ် ၈၇ မျိုးတွေ့ရှိရပြီး ဒေသရင်းငှက်မျိုး ၂ မျိုး၊ မျိုးသုန်းရန် ချိန်းခြောက်မှုအဆင့်သို့ နီးကပ်နေသော ငှက်မျိုးစိတ် ၂ မျိုး ကိုလည်း တွေ့ရပါသည်။ ငှင်းငှက်မျိုး စိတ် ၈၇ မျိုးတွင် ဌာနေငှက် ၃၅ မျိုး၊ ဌာနေငှက်သို့မဟုတ် ရွှေ့ပြောင်းနေထိုင်တတ်သောငှက် ၁၉ မျိုး၊ ဆောင်းခိုငှက် ၂၂ မျိုး၊ နွေပျော်ငှက် ၂ မျိုးနှင့် မိုးပျော် ငှက် ၇ မျိုးတို့ ပါဝင်ပါသည်။ Shannon-Wiener and Simpson's (D) diversity index ကို အသုံးပြု၍ ဆန်းစစ်ခြင်းအရ သစ်တောသုတေသနဝန်းသည် ငှက်မျိုးစိတ် ပေါကြွယ်ဝမှုရှိကြောင်း တွေ့ရှိရပါသည် (၃.၄၃၉၂နှင့် ၀.၉၄၆၃ အသီးသီးဖြစ်ကြပါသည်)။ ရာသီအလိုက် လေ့လာမှုမှ ဆောင်းရာသီတွင် ငှက်မျိုးစိတ် ၇၂ မျိုး၊ နွေရာသီတွင် ၄၉ မျိုးနှင့် မိုးရာသီတွင် ၅၉ မျိုး တွေ့ရှိရပါသည်။ Diversity index တွက်ချက်မှုမှ ဆောင်းရာသီတွင် ငှက်မျိုးစိတ်ကြွယ်ဝမှု အများဆုံးဖြစ်ကြောင်းတွေ့ရှိရပါသည်။ Nonparametric Kruskal–Wallis tests တွက်ချက်မှုမှ ရာသီအလိုက် ငှက်မျိုးစိတ်ကြွယ်ဝမှုတွင် ကွဲပြားမှုမရှိကြောင်း တွေ့ရှိရပြီး Linear Regression အရ အပူချိန်သည် ငှက်မျိုးစိတ်များအပေါ် ပြောင်းပြန်အချိုး သက်ရောက်မှုရှိပြီး မိုးရေချိန်သည် လွှမ်းမိုးမှု မရှိကြောင်း တွေ့ရပါသည်။ ထို့အပြင် အပူချိန်နှင့် မိုးရေချိန်သည် ငှက်မျိုးစိတ်ပေါများမှု အပေါ်တွင် သက်ရောက်မှု မရှိကြောင်း တွေ့ရှိရပြန်ပါသည်။

Seasonal Variation in Bird Diversity in the Campus of Forest Research Institute

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Abstract

Bird species diversity takes an critically important role in the natural environment. It is an indicator for evaluating biodiversity in all habitats. Composition and species richness of bird community are influenced by abiotic factors such as temperature and precipitation and biotic factors such as plants and animals. This study aimed at 1) characterizing bird species which were resident in FRI campus, and which used the area only seasonally, 2) assessing the species abundance, richness, evenness and diversity of FRI campus's avifauna and 3) observing basic information on how climatic factors relate with bird species diversity. This study was conducted in the Forest Research Institute (FRI) campus including Yezin Dam for different three seasons (November 2016 to October 2017) by using line transect. As a result, 87 species and 1530 birds were observed in total including 2 endemic species and 2 near threatened species. Moreover, 35 residents, 19 both resident or partially migratory birds, 22 winter visitors, 2 summer visitors and 7 rainy season visitors were also found. The analysis of the Shannon-Wiener and Simpson's (D) diversity index revealed that FRI campus occupied high species diversity (3.4392 and 0.9463 respectively). In the winter season, there were 72 bird species; in the summer season, 49 species and in the rainy season, 59 species. The analysis of the diversity index described that species richness and diversity were highest in winter. The analysis of Nonparametric Kruskal–Wallis tests showed that there was no significant difference in bird species diversity among three seasons. According to linear regression, average temperature negatively affected species richness ($p=0.004$) whereas there was no significant correlation between species and rainfall. Moreover, average temperature and rainfall did not influence species abundance.

Key Words: Bird Species, Diversity, Richness, Abundance, Seasonality,

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1. Introduction

Birds are highly diverse which have twice as many taxa or ten times more than other flying species. They are very important for the dynamics of natural and human dominated ecosystems by providing such ecological services as provisioning, regulating, cultural and supporting services (Sekercioglu et al., 2002; Sekercioglu et al., 2004). They also perform most of the ecological functions such as seed dispersers, pollinators, nutrient depositors, insectivores, raptors, scavengers, and ecosystem engineers. (Sekercioglu et al., 2002; Sekercioglu et al., 2004; Van Bael et al., 2008; Karp et al., 2013). They consume vegetative parts of plants such as fruits, seeds, roots, shoots and leaves (Karasov, 1990; López-Calleja and Bozinovic, 1999), nectar, insects, small mammals, lizards, snakes, amphibians, dead animals, other organic material, aquatic food resources and so on. Depending on their main food habits, they were classified into eight categories: insectivore, nectarivore, granivore, frugivore, herbivore, carnivore, omnivore and avian scavengers (Kissling et al., 2011).

Birds may shift to feeding on other food resources or migrate to other areas where their original resources are available when there is seasonal irregularity in the availability of food resources and breeding habitats (Wagner, 1981; Carrascal et al., 1987; Newton, 2007; Suarez-Seoane et al., 2008). Changes in the availability of food resource and climate factors can affect bird species richness and composition along with time and space (Blake and Loiselle, 1991; Koen, 1992; Poulin et al., 1994; Honkanen et al., 2010). However, this study has mainly focused on climatic factors such as temperature and rainfall.

Birds respond to changes in habitats because of their mobility and habitat selection (Hostetler, 1999; Kwon et al., 2007; Wenny et.al, 2011), and are used as an effective indicator for assessing biodiversity in all habitats: natural and artificial habitats (Bibby et al., 1992; Chace and Walsh, 2006; Yang et al., 2015). Nowadays, the conservation of species diversity has become an important environmental issue (Turner et al., 1990; Ehrlich and Wilson, 1991). Bird diversity also takes place in preserving a healthy and sustainable forest. It is known to evaluate habitat protection and green corridors in urban areas (Niemela, 1999; Matsuba et al., 2016).

Myanmar is at the transition zone between three biogeographic regions (Sino-Himalayan region in the north, Indochinese region in the east and Malayan peninsular in the south) where unique and diverse species communities are found (NBSAP, 2015-2020). It is a room to a wide variety of bird species varying from residents to migratory birds including winter visitors and summer visitors (World Institute for Conservation & Environment). Forest Department has been conducting biodiversity surveys including bird survey throughout the country by itself and also with the collaboration of many international organizations. According to NBSAP (2015-2020), regional or localized studies on biodiversity are under development. This study was aimed at providing basic information of bird species diversity of Forest Research Institute (hereinafter FRI) as a specific case study. Previous studies on bird species in Myanmar usually focus on specific taxa or migratory bird species residing in

or migrating to wetland regions, and conservation of rare or endangered bird species. However, there are little fine-grained studies assessing whether seasonality influences the bird species diversity in a specific area.

2. Objectives

The objectives of this study are:

(1) To characterize bird species which were resident in FRI campus, and which used the area only seasonally

(2) To assess the species richness, evenness and diversity of FRI campus's avifauna among seasons

(3) To observe how climatic factors influence on bird species diversity

3. Materials and Methods

3.1. Study Area

This study was performed in FRI located in Yezin, Nay Pyi Taw (19°50'35.39"N, 96°16'43.94"E) covering an area of 107.80 hectares and in Yezin Dam (19°51'54"N, 96°16'59"E) accounting for 1031.95 hectares (not describe the whole area of Yezin Dam in the figure-1). Yezin receives annual rainfall of 1925 mm and experiences average minimum and maximum temperatures of 23°C to 34°C respectively (DAR, 2016-2017). In FRI, there are 103 tree species under 71 genera and 31 families especially planted and grown in the arboretum, accounting for 3.674 diversity index, and 79.116% evenness. Nabe (*Lannea coromandelica* (Houtt.) Merr.) , Lunbo (*Buchanania lanzan* Spreng.), Bawzagaing (*Leucaena leucocephala* (Lam.) De Wit), Padauk (*Pterocarpus macrocarpus* Kurz), and Taukkyan (*Terminalia crenulata* (Heyne) Roth) are the most commonly found tree species in FRI, and also it can be found that the highest number of individuals are in family Anacardiaceae followed by Mimosaceae, Verbenaceae, Dipterocarpaceae, Fabaceae and Combretaceae (AKECOP, 2016).

3.2. Bird Surveys

Bird survey was conducted by walking along the left and right road sides in offices and in the residential sites while following routes in secondary forests, lakes, dam and golf course in FRI; ranging from 560m to 2140 m (0.35 mile to 1.33 miles). The survey was carried out for 104 days (10 days per month except July, October and November accounting for 5, 4 and 5 days respectively) in three seasons: from November to February in winter season, March to mid-May in summer and mid-May to October in rainy season. The data collection was taken from 6:00 to 9:00 and 16:30 to 18:30 per day during November, 2016 - October, 2017. All birds found were recorded through the unaided eye and Swift (Aerolite) binoculars (7×35), and using a Nikon ESO 50 D SLR digital camera to take photos and sometimes through the sounds of birds.

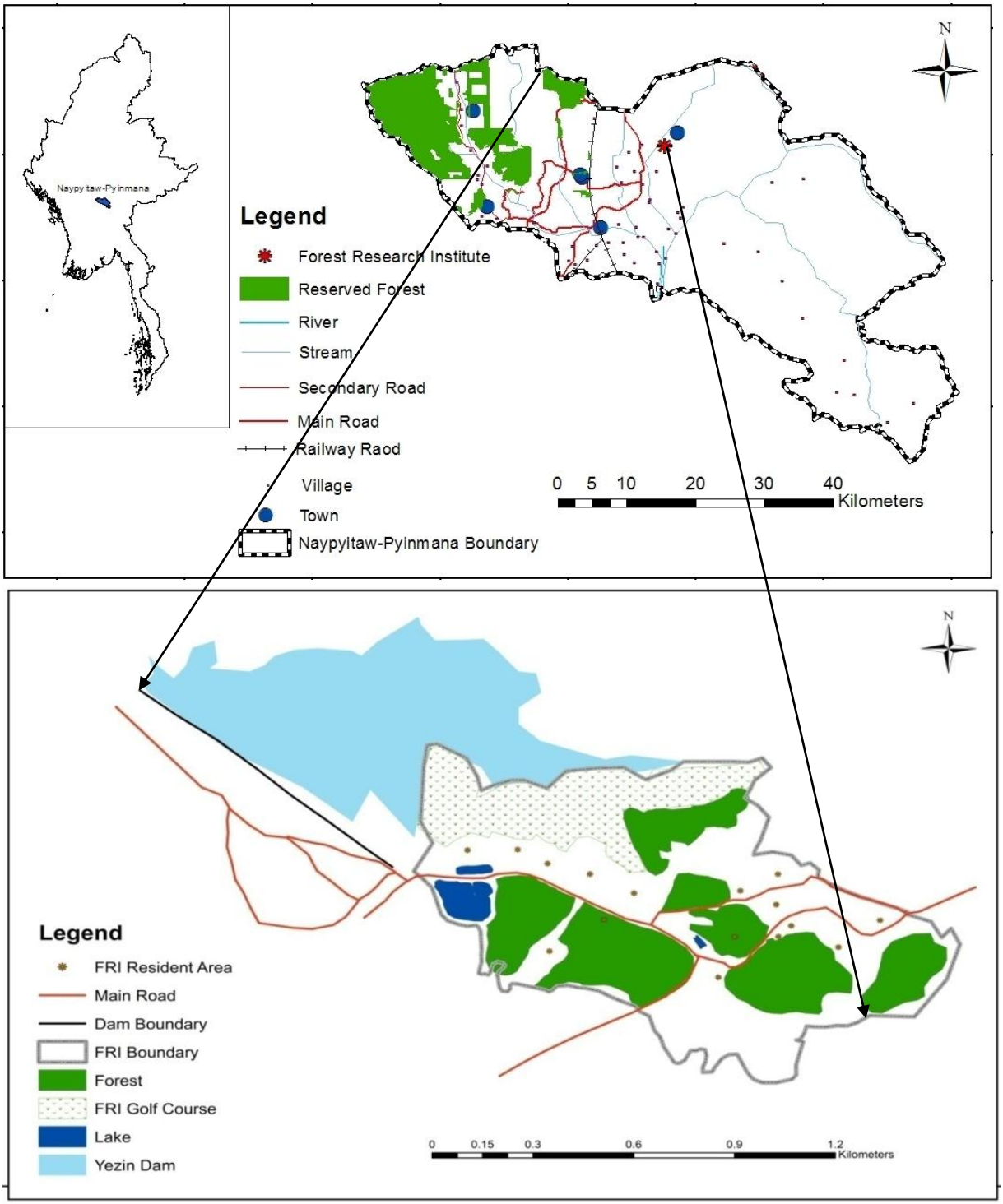

Figure-1: Location Map of Forest Research Institute, Yezin, Nay Pyi Taw, Myanmar

3.3. Climate Data Collection

Maximum and minimum temperatures, rainfall and number of rainy days between November 2016 and October 2017 were collected from the Department of Agricultural Research which is about 2000 m (1.2 miles) away from FRI (Figure-2).

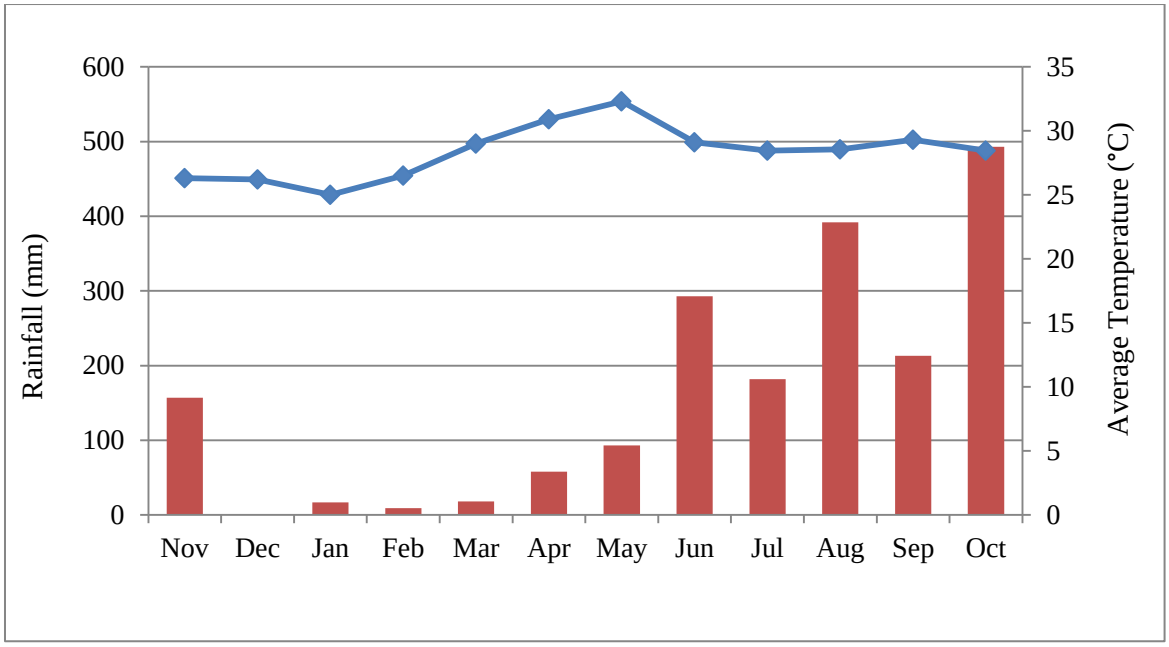

Figure-2: Average Temperature and Rainfall from November, 2016 to October, 2017

3.4. Data Analysis

Data were analyzed by using MS Excel 2007 and SPSS version 16. To calculate bird species diversity, evenness, and richness, the following formulas were used:

Species Diversity Index (Shannon and Weaver, 1949): *H'*

$$H' = -\sum \left(\frac{ni}{N}\right) \ln\left(\frac{ni}{N}\right)$$

Where,

ni= the number of birds in each species

N= total number of birds

ln= natural logarithms

Evenness Index (Pielou, 1975): *J '*

$J' = H' / \ln(S)$

Where,

S= total number of observed species

H'= Species diversity

Richness Index (Margalef, 1958): $^{e}H'$

$^{e}H' = (S-1)/\ln(N)$

Simpson's Diversity Index (Magurran, 1988): *D*

$$D = \sum_{i=1}^{s} \frac{(n_i (n_i - 1))}{(N (N - 1))} = 1\text{-}D$$

Where,
n_i = number of individuals of species "i" in the sample
s= number of species in the sample
N= total number of individuals of all species in the sample

In this study, the Sørensen–Dice similarity was used to assess the compositional similarity among different seasons.

Sørensen–Dice similarity (Dice, 1945): *S*

$$S = \frac{2n_t}{n_x + n_y}$$

Where,
n_t = number of species found in both sites
n_x = number of species found in one season
n_y = number of species found in another season

Nonparametric Kruskal–Wallis tests were used to test if the means of diversity indices are significantly different among three seasons and liner regression analysis was applied to estimate the influences of climatic factors on bird diversity. In this study, only the maximum number of a single species during each season was analyzed. Bird species richness was also determined by the total number of families, genera, and species for different three seasons. In addition, bird species are categorized into different groups depending on the period of their visit to FRI campus (residents, residents/migrants which are residents but have locally movement, winter visitors, summer visitors and rainy season visitors) and feeding habits of the bird species (insectivore, nectarivore, granivore, carnivore, frugivore, omnivores and scavengers). In this study, the category of herbivore was not considered because herbivorous birds which feed only on leaves are rare (Sekercioglu, et al., 2004) and also birds which eat other plant resources such as seeds, fruits and nectar are already described as granivore, frugivore, and nectarivore.

Taxonomic classification of bird species followed field guide to the birds of Korea (Lee et al., 2000), Birds of Myanmar (Lwin and Thwin, 2003), New Holland field guide to the birds of South-East Asia (Robson, 2008), Water birds from the Gulf of Mottama (BANCA, 2014), Biodiversity of Mt.Popa, Myanmar (Lee et al., 2014), and Wildlife of Southeast Asia (Myers, 2016). The migratory (winter or summer visitors), endemic or residential status was accorded with Lwin and Thwin (2003), and Robson (2008) and also feeding habits of bird species with Lwin and Thwin (2003) and (Wikipedia).

4. Results and Discussion

4.1. Avifauna in Forest Research Institute Campus

From this survey, we found a total of 1530 bird individuals belonging to 87 species, 68 genera, 44 families, and 17 orders in FRI campus (Appendix-1). Twenty-two families were represented only by one species each while other families include 2 to 7 species. There are 44 species in order Passeriformes while other orders have 2 to 7 species except Bucerotiformes, Caprimulgiformes, Ciconiiformes, Falconiformes, Gruiformes, Podicipediformes and Suliformes with one species each (Table-1). In consecutive 2 years bird survey of Chandoli National Park in Western Ghats of Maharashtra State, India, and 7 years of Maduruoya National Park in Sri Lanka, 151 and 196 species were recorded with 45 and 66 families, and 15 and 20 orders respectively (Ramchandra, 2013, Gabadage et al., 2015). In these studies, it was also found that order Passeriformes has highest species numbers amounting for 63 species and 71 species.

In Myanmar, there are 1096 avifauna species including 6 endemic species, and 46 Red List species (NBSAP, 2015-2020). Nearly one twelfth of total bird species of Myanmar was found in the FRI campus. About 20% of total bird species of Mandalay Region accounting for 433 species was also covered (eBird, 2017). Without considering their agroecological zones and survey methods, when compared to the other specific areas in Myanmar especially protected areas, it was within the range of 18% to 77% of total species recorded in each of them except Shwe-U-Daung Wildlife Sanctuary and Minsontaung Wildlife Sanctuary (Figure-3) (Pamphlets of Nature and Wildlife Conservation Division, Forest Department, 2017).

Two endemic species (burmese bushlark and white-throated babbler) (2.3% of total bird community) were recorded in FRI campus accounting for 21 and 18 individuals respectively. There was an observation of grey-headed parakeet found in the winter season with 30 individuals (2% of total individuals of bird species in FRI) and blossom-headed parakeet noted in the summer and rainy seasons with 138 and 42 birds (9% and 3%) respectively which are recorded as nearly threatened species (Birdlife International, 2016). All other recorded species are listed as “least concern” (IUCN, 2017). In eBird, red-billed blue magpie is recognized as a sensitive species of Myanmar which means that this bird species faces risks including capture, targeted killing or significant disturbance. In FRI, only 8 individuals of this species were found.

Four species dominating bird population are little green bee-eater with 200 birds accounting for 13% of the relative abundance, 138 blossom-headed parakeets with 9%, 130 crested treeswifts and 124 lesser whistling-ducks amounting for 8% in each. In one study of bird distribution and diversity in the 493 ha University of Philippines Diliman campus including residential areas, academic use areas, parks and commercial areas, 70 bird species were recorded including 10.3 % endemic, 1.5% resident/migrant, 17.6% migratory birds and 50% breeding residents (Vallejo Jr et al., 2009). Concerning the status of bird species in FRI campus, the majority of species are residents (about 42 % of the total bird community)

followed by winter visitors accounting for 25%, and the resident species with local movement (resident/migrant) with 22% (Table-2). In the comparison of the status of FRI bird species with literature reviews in Myanmar, there is a big difference in numbers of resident birds. It can be assumed that some residents may come to FRI as winter or summer or rainy visitors while living as resident/migrants (Table-2).

A lot of studies described that there were nearly 600 nectarivores, 36 scanvengers, over 1000 granivores (Sekercioglu, et al., 2004), 5128 insectivores, 300 carnivores, 500 omnivores (Kissling, et al., 2012) while nearly one in seven bird species are frugivores (Sekercioglu, et al., 2004). In the FRI campus, 8 nectarivores, 4 scavengers, 12 granivores, 52 insectivores, 27 carnivores, 10 omnivores, and 15 frugivores were recorded (Table-3). At all seasons, the majority of birds were insectivores while carnivore bird species placed at the second largest group followed by frugivores and granivores. Omnivores, nectarivores and scavengers were the smallest groups. In the Taninthayi Nature Reserve, half of the total 244 species are insectivorous (TNRP, 2008). In Anaikatti Hill, Western Ghats, the avifauna was largely dominated by insectivore guild followed by omnivore and frugivore (Nirmala, 2016)

In the statistics analysis of this research, Shannon and Weaver diversity was 3.4392, evenness was 0.77, and species richness index was 11.7278. Numbers of individuals per hectare are 14.19. Simpson's diversity index also showed high level of species diversity of the campus (0.9463). Many studies reported that the more complex vegetation composition, the more diversity of birds and vice versa (Wang, 1995; Wang and Carpenter, 1997; Macarthur and Macarthur, 1961; Leito et al., 2006). The previous plant inventory (AKECO, 2016) described that FRI campus occupied high level of tree species diversity (0.961 Simpson's Diversity Index). This study also showed that bird diversity placed at the high level.

Table-2. Characterization of endemic, residency and migrants at the species level

Status	**Number of Species [a] (%) [b] according to their status in FRI campus**	**Number of Species [a] (%) [b] according to the literature in Myanmar**
Resident	35 (40%)	62 (71%)
Resident/Endemic	2 (2%)	2 (2%)
Resident/Migrant	19 (22%)	11 (13%)
Resident/Winter Visitor	0	7 (8%)
Winter Visitor	22 (25%)	5 (6%)
Summer Visitor	2 (2%)	0
Rainy Season Visitor	7 (8%)	0
	87	**87**

[a] Total number of resident, or migratory birds

[b] Percentage of resident, or migratory birds of the total number of bird species

Table-1.Relative diversity (RDi) of various avifaunal orders in Forest Research Institute Campus

Sr.no	Order	No. of Species	No. of Individuals	Relative Diversity
1	Accipitriformes	4	5	0.3268
2	Anseriformes	2	154	10.0654
3	Bucerotiformes	1	8	0.5229
4	Caprimulgiformes	1	130	8.4967
5	Charadriiformes	3	11	0.7190
6	Ciconiiformes	1	36	2.3529
7	Columbiformes	4	101	6.6013
8	Coraciiformes	5	215	14.0523
9	Cuculiformes	4	7	0.4575
10	Falconiformes	1	1	0.0654
11	Gruiformes	1	1	0.0654
12	Passeriformes	44	568	37.1242
13	Pelecaniformes	7	92	6.0131
14	Piciformes	5	7	0.4575
15	Podicipediformes	1	6	0.3922
16	Psittaciformes	2	168	10.9804
17	Suliformes	1	20	1.3072
	Total	**87**	**1530**	**100%**

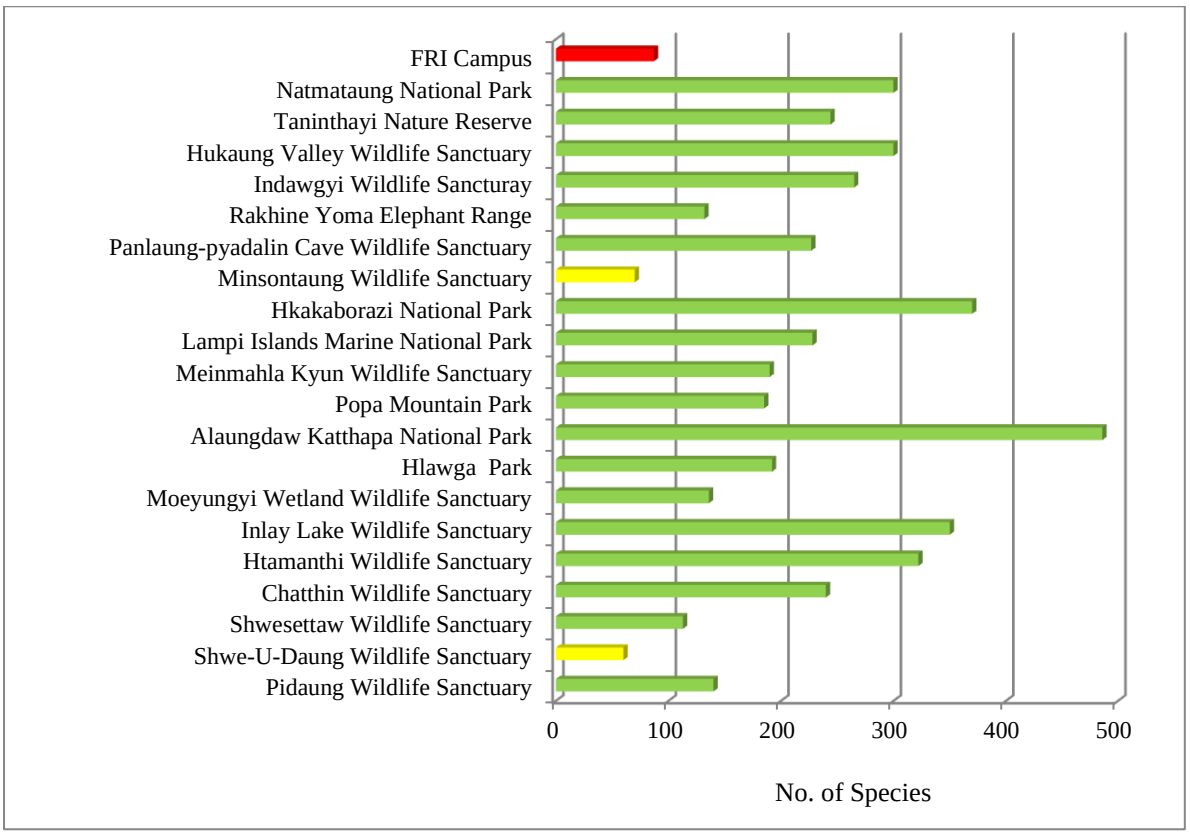

Figure-3. Number of Species Found in the Specific Areas of Myanmar

Table-3. Characterization of feeding habits at the species level

Status	No. of Species Found in FRI	No. of Species in Winter Season	No. of Species in Summer Season	No. of Species in Rainy Season
Insectivore	52	47	27	36
Carnivore	27	24	16	18
Frugivore	15	12	8	8
Granivore	12	8	9	9
Nectarivore	8	7	6	7
Omnivore	10	7	7	7
Scavenger	4	4	4	2

4.2. Bird species with Different Seasons

In the study area, 72 bird species with 1071 individuals were found in the winter season, 49 with 558 in the summer season and 59 with 657 in the rainy season. It was clearly found that the number of bird species was highest in the winter season with the largest species abundance. In the winter season, little green bee-eater, **lesser whistling-duck**, striated swallow and **common myna** were the most abundant species. **Lesser whistling-duck** occurred in highest proportion in the summer season followed by spotted dove, asian openbill, and **common myna**. In the rainy season, the highest number of blossom-headed parakeet was observed followed by crested treeswift, scaly-breasted munia, and eastern cattle egret (Figure-4).

According to the Sørensen–Dice index, there was more similarity between summer and rainy seasons (77.78%) than other comparisons (70.23% between winter and rainy seasons and 67.77% between winter and summer seasons). All of the families found in summer and rainy seasons were also found in the winter season except Turdidae and Turnicidae whereas 5 families (Coraciidae, Falconidae, Monarchidae, Oriolidae, and Phylloscopidae) were recorded only in the winter season.

Among three seasons, the winter season occupied the highest species diversity measured by Shannon-Wiener index and Simpson's diversity index, evenness and richness (Table-5) together with the highest species, genera, and families (Table-4) even though there was no significant difference in bird species richness and abundance among three seasons ($p=0.15$ and $p=0.08$ respectively) according to Nonparametric Kruskal–Wallis tests. Gaston (1978) also revealed that bird species diversity was highly found during winter but was low in summer in New Delhi. The reason for such clear differences in diversity and richness seems to be related to many winter visitors (25% of total species) and resident/winter migrants (22%) with 26% of total individuals. One study described that the presence of locally moving birds and winter visitors are one of the major factors responsible for the higher diversity of bird species in Western Ghats, India (Nirmala, 2016). Some studies showed that the greater abundance of insects was occurred in the winter season resulting in more migrants (Gunnersson, 1996; Arun, 2000; Nirmala, 2016). In the winter season of FRI,

72 species were noted including 22 winter visitors and 14 resident/winter migrants (out of 36, 29 bird species are insectivores). Moreover, 47 of 72 bird species are insectivores.

Table-4. Species, genera, and family richness in different seasons

Seasons	Family [a] (%) [b]	Genera [a] (%) [b]	Species [a] (%) [b]
Winter	42 (95%)	59 (87%)	72 (83%)
Summer	32 (73%)	43 (63%)	49 (56%)
Rainy	35 (80%)	48 (71%)	59 (68%)

[a] Number of species, genera, and families found in each season

[b] Percentage of the total number of species, genera and families found in all seasons combines

Table-5. Comparison of the Shannon-Wiener and Simpson Index in different seasons

Seasons	*H*	*J*	*$^{e}H'$*	*1-D*
Winter	3.2858	0.7683	10.1772	0.93
Summer	2.8429	0.7305	7.7478	0.8873
Rainy	3.1559	0.774	9.0942	0.9253

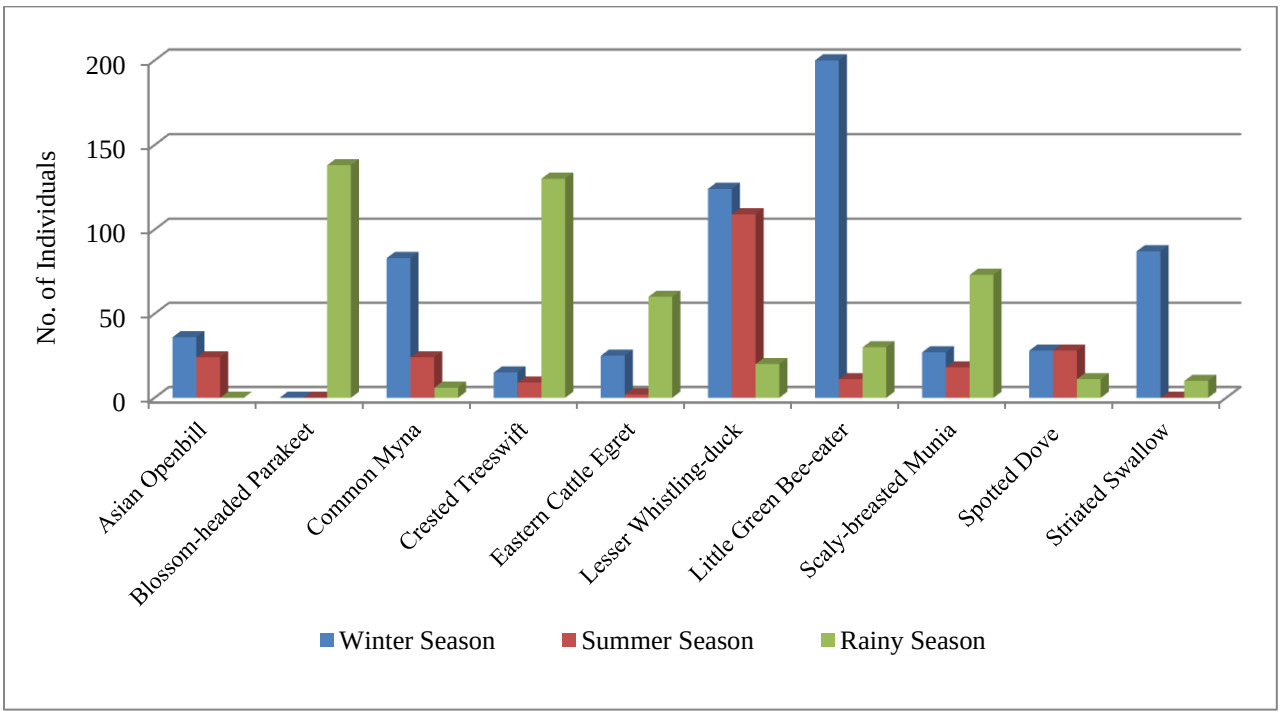

Figure-4. Four Most Abundant Species Found in Three Seasons

Table-6: Nonparametric Kruskal–Wallis tests for Comparison of Species Richness and Abundance among Three Seasons

Variables	Winter Season	Summer Season	Rainy Season	P-value
Species Richness				**0.15**
Mean	53	39.3333	38.6667	
Median	56.5	40	39.5	
Species Abundance				**0.08**
Mean	512.25	297.3333	245.6667	
Median	520	301	207	

p significant level: p < .05000

4.3. Seasonal Effects on Bird Species Diversity

Regression analysis indicated that the average temperature showed significantly negative correlation with species richness (p= 0.004) while data collection days showed a significantly positive correlation with species richness (p= 0.045). It meant that the number of bird species decreases when the temperature rise, and the more bird species richness increases, the more bird surveys were performed. Rainfall and rainy days did not influence bird species (Table-7). Moreover, all climatic variables and data collection days did not show any correlation with species abundance (Table-8). Nirmala (2016) found that there was a significantly negative correlation between maximum/minimum temperature and species abundance or richness whereas rainfall showed positive correlation with them.

Table-7: Liner Regression Analysis between Bird Species Richness/Abundance and Climatic Variables and Number of Field Surveys

Variables	Beta	Standard Error	P-value
Species Richness			
Average Temperature (°C)	-0.603	0.578	**0.004**
Rainfall (mm)	-0.533	0.018	0.136
Rainy Days	0.164	0.327	0.617
Data Collection Days	0.362	0.519	**0.045**
Species Abundance			
Average Temperature (°C)	-0.360	21.585	0.212
Rainfall (mm)	-0.096	0.668	0.872
Rainy Days	-0.255	12.238	0.662
Data Collection Days	0.365	19.389	0.217

p significant level: p < .05000

5. Conclusion and Recommendation

That the composition of species becomes richer with higher index value means the good environment (Kim et al., 2012). The FRI campus possessed the high levels of tree species and bird diversities. It is a good place for biodiversity especially 35 residents, 22 migratory bird species (25 percent of total bird species), 2 endemic species (one third of Myanmar endemic species), 2 near threatened species and 1 sensitive species. Nowadays, one in eight bird species is threatened with global extinction because of ecosystem disturbance, and habitat fragmentation. Detailed studies of feeding habits and non-breeding and breeding habitats of resident species, endemic species, near threatened species, vulnerable species and endangered species should be carried out to conserve them effectively because of their highly specific habitat requirements.

This is a preliminary study on bird diversity of the FRI campus. This study cannot cover all aspects influencing bird diversity especially the availability of food resources especially plant and insect. The results of this study did not show significant differences in bird diversity among seasons. There were also no significant correlations in some climatic factors with species richness and abundance. However, the data collection days affected positively species richness. Further research should give attention on systematic inventory on biodiversity related with bird species, microclimatic variables and more bird watching.

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References

Acevedo MA, and Aide TM., 2008. Bird community dynamics and habitat associations in Karst, Mangrove and Pterocarpus forest fragment in an urban zone. Carib. J. Sci., 44: 402-416.

Ali S, and Ripley SD., 1983. Handbook of Birds of India and Pakistan. Compact edition. New Delhi, India: Oxford University Press.

Arun, P. R., 2000. Seasonal variations in the abundance of insect groups in a natural moist deciduous forest of Western Ghats. *Ph. D. Thesis*, Bharathiar University, Coimbatore.

ASEAN-Korea Environmental Cooperation Project (AKECOP) 2016 Annual Report: Assessment of tree species diversity in Forest Research Institute Arboretum

Bibby, C., Burgess, N.D., and Hill, D.A., 1992. Bird Census Techniques. Academic Press, London.

Biodiversity And Nature Conservation Association (BANCA), 2014. Water birds from the Gulf of Mottama.

Birdlife International, 2017. Avibase- Bird Checklists of the World. URL: http://www. birdlife.org/datazone Cambridge, U.K.

Blake, J. G. and B. A. Loiselle., 1991. Variation in resource abundance affects capture rates of birds in three lowland habitats in Costa Rica. Auk 108:114–130.

Carrascal LM, Potti J, and Sa´nchez-Aguado FJ., 1987. Spatio-temporal organization of the bird communities in two Mediterranean montane forests. Holarctic Ecol 10:185–192

Chace, J.F., and Walsh, J.J., 2006. Urban effects on native avifauna: a review. Landscape Urban Plann. 74, 46–69.

Department of Agricultural Research, 2016-2017. Meteorological Data Collection

eBird, 2017. http:www.ebird.org

Ehrlich, P.R., and Wilson, E.O., 1991. Biodiversity studies: science and policy. Science 253, 758–762.

Gunnersson, B., 1996. Bird predation and vegetation structure affecting spruce living Arthropods in a temperate forest. *Journal of Animal Ecology*. 65(3): 389-397

Gabadage et al. / Journal of Asia-Pacific Biodiversity 8, 2015. Avifaunal diversity in the peripheral areas of the Maduruoya National Park in Sri Lanka: With conservation and management implications

Honkanen M, Roberge J-M, Rajasa¨rkka¨A, and Mo¨nkko¨nen M., 2010. Disentangling the effects of area, energy and habitat heterogeneity on boreal forest bird species richness in protected areas. Global Ecol Biogeogr 19:61–71

Hostetler, M., 1999. Scales, birds and human decisions: A potential for integrative research in urban ecosystems. Landscape and Urban Planning, 49, 15–19.

https://en.wikipedia.org/wiki/Bird

IUCN, 2017.The IUCN Red List of Threatened Species. Version 2017.3. www.iucnredlist. org. Downloaded on 19 December 2017.

Karp, D.S., Mendenhall, C.D., Sandí, R.F., Chaumont, N., Ehrlich, P.R., Hadly, E.a., Daily, G.C., 2013. Forest bolsters bird abundance, pest control and coffee yield. Ecol. Lett. 16, 1339–1347. http://dx.doi.org/10.1111/ele.12173.

Karasov, W. H., 1990. Digestion in birds: chemical and physiological determinants and ecological implications, *Studies in Avian Biology*, vol 13, no 39, pp. l-4.

Kim W-Y., Min-gyeong Sin M-g., Song H-c., Kim Y-m., Sung H-C., 2012. Bird Diversity of Gokdudo · Daehangdo · Mokdo Islands in Dadohaehaesang National Park of Korea. Journal of Korean Nature Vol. 5, No. 4 293-297.http:// dx.doi.org/10.7229/ jkn. 2012. 5.4.293

Kissling, W. D., C. Rahbek and K. Böhning-Gaese, 2007. Food plant diversity as broad-scale determinant of avian frugivore richness, *Proceedings of the Royal Society B: Biological Sciences*, vol 274, no 1611, pp. 799–808.

Kissling, W. D., C. H. Sekercioglu and W. Jetz, 2012. Bird dietary guild richness across latitudes, environments and biogeographic regions, *Global Ecology and Biogeography*, vol 21, no 3, pp. 328–340.

Koen, J. H., 1992. Medium – term fluctuations of birds and their potential food resources in the Knysna forest. *Ostrich*. 63: 21 – 30.

Kwon, Y.S., D.W. Kim, W.S. Lee, I.K Kwon, W.K. Paek and J.C. Yoo., 2007. Birds of Hongdo Island Used as a Breeding or Stopover Site in Korea. Kor. J. Orni. 14(1): 51-60.

Lee R. Dice, 1945. Measures of the amount of ecologic association between species. Ecology, Vol. 26, No. 3, pp. 297-302

Lee, W.S., T.H. Koo and J.Y. Park., 2000. A field guide to the birds of Korea. LG Evergreen Foundation. Seoul. 156 pp.

Lee, W-S.et al., 2014. Biodiversity of Mt.Popa, Myanmar. National Institute of Biological Resources. Incheon. 224 pp.

Leito A, Truu J, Roosaluste E, Seep K, and Podier I., 2006. Long term dynamics of breeding birds in broad-leaved deciduous forest on Hanckasti Island in the West-Estonian archipelago. Ornis. Fennica, 83: 124-130.

López-Calleja, M. V. and F. Bozinovic, 1999. Feeding behavior and assimilation efficiency of the Rufoustailed Plantcutter: a small avian herbivore, *Condor,* vol 101, pp. 705–710.

Lwin, K.N. & Thwin, K.M.M., 2003. Birds of Myanmar.

MacArthur RH, MacArthur JW., 1961. On bird species diversity. Ecology 42:594–599.

Magurran; Anne, E., 1988. Ecological Diversity and Its Measurement. Princeton University Press, New Jersey.

Margalef, R., 1968. Perspectives in ecological theory. Chicago, University of Chicago Press, 112 pp.

Matsuba, M., Nishijima, and S., Katoh, K., 2016. Effectiveness of corridor vegetation depends on urbanization tolerance of forest birds in central Tokyo, Japan. Urban For. Urban Green. 18, 173–181, http://dx.doi.org/10.1016/j.ufug.2016. 05.011

Myers, S., 2016. Wildlife of Southeast Asia. Published by Princeton University Press.

National Biodiversity Strategy and Action Plan (NBSAP) of Forest Department 2015-2020

Newton I., 2007. The migration ecology of birds. Academic Press, London

Nirmala et.al., 2016. Food availability influences the seasonality of bird community in tropical forest, Western Ghats. Int J Cur Res Rev. Volume 8. Issue 2

Niemela, J., 1999. Ecology and urban planning. Biodiver. Conserv. 8, 119–131.

Pielou, E.C., 1975. Ecological diversity, Wiley, New York. 165 pp.

Poulin, B., G. Lefebvre and R. McNeil, 1994. Characteristics of feeding guilds and variation in diets of birds species of three adjacent tropical sites. *Biotropica*. 26: 187-197.

Ramchandra, 2013. Diversity and richness of bird species in newly formed habitats of Chandoli National Park in Western Ghats, Maharashtra State, India, Biodiversity Journal, 2013, 4 (1): 235-242

Robson, C., 2008. New Holland field guide to the birds of South-East Asia. New Holland Publishers: second edition

Sekercioglu, C.H., Daily, G.C., and Ehrlich, P.R., 2004. Ecosystem consequences of bird declines. Proc. Natl. Acad. Sci. USA 101, 18042–18047. http://dx.doi.org/ 10.1073/pnas.0408049101.

Sekercioglu, C.H., Ehrlich, P.R., Daily, G.C., Aygen, D., Goehring, D., and Sandi, R.F., 2002. Disappearance of insectivorous birds from tropical forest fragments. Proc. Natl. Acad. Sci. USA 99, 263–267. http://dx.doi.org/10.1073/pnas.012616199.

Shannon, C.E. and W.Weaver, 1949. The mathematical theory of communication. Univ.of Illinois press, Urban-Champaign, 117pp.

Suárez-Seoane S, García de la Morena EL, Morales Prieto MB, Osborne PE, de Juana E 658, 2008. Maximum entropy niche-based modelling of seasonal changes in little 659 bustard (Tetrax tetrax) distribution. Ecol Model 219:17-29

Taninthayi Nature Reserve Project, 2008. A report on birds surveyed in Taninthayi Nature Reserve.

Turner, B.L., Clark, W.C., Kates, R.W., Richards, J.F., Mathews, J.T., and Meyer, W.B., 1990. The Earth as Transformed by Human Action. Cambridge University Press and Clark University, Cambridge.

Vallejo Jr et al. / Landscape and Urban Planning 89, 2009. 75–85 "The distribution, abundance and diversity of birds in Manila'slast greenspaces"

Van Bael, S.A., Philpott, S.M., Greenberg, R., Bichier, P., Barber, N.A., Mooney, K.A., Gruner, D.S., 2008. Birds as predators in tropical agroforestry systems. Ecology 89, 928–934. http://dx.doi.org/10.1890/06-1976.1.

Wagner J., 1981. Seasonal change in guild structure: oak woodland insectivorous birds. Ecology 62:973–981

Wang, Z.J., 1995. Bird diversity as a measure of decline in forest ecosystems. In: Pei, S.J. (Ed.), Regional Study on Biodiversity: Concepts, Frameworks, and Methods. Yunnan University Press, Kunming, pp. 173–181.

Wang, Z.J., and Carpenter, C., 1997. The changing of forest environment and bird distribution in the Jinuo mountain. Yunnan Geographic Environment Research 9 (1), 85–91 (in Chinese).

Wenny , D. G., DeVault, T. L., Johnson, M. D., Kelly, D., and Sekercioglu, C. H., 2011. The need to quantify ecosystem services provided by birds. The Auk, 128(1), 1–14.

Yang, G., Xu, J., Wang, Y., Wang, X., Pei, E., Yuan, X., Li, H., Ding, Y., and Wang, Z., 2015. Evaluation of microhabitats for wild birds in a Shanghai urban area park. Urban For. Urban Green. 14, 246–254, http://dx.doi.org/10.1016/j.ufug.2015.02.005.

Appendex-1: Checklist of bird species noted in the Forest Research Institute campus

Order	Family	Genus	Species (Scientific)	Common Name	No. of Individuals of Bird Species			
					Winter	Summer	Rainy	All Seasons
Anseriformes								
	Anatidae							
		Dendrocygna						
			javanica	Lesser Whistling-duck	124	109	20	124
		Tadorna						
			ferruginea	Ruddy Shelduck	30	0	0	30
Podicipediformes								
	Podicipedidae							
		Tachybaptus						
			ruficollis	Little Grebe	6	3	6	6
Ciconiiformes								
	Ciconiidae							
		Anastomus						
			oscitans	Asian Openbill	36	24	0	36
Suliformes								
	Phalacrocoracidae							
		Microcarbo						
			niger	Little Cormorant	5	2	20	20
Pelecaniformes								
	Ardeidae							
		Ixobrychus						
			cinnamomeus	Cinnamon Bittern	0	0	2	2
		Ardea						
			alba	Great Egret	4	0	1	4
			intermedia	Intermediate Egret	1	1	8	8
		Egretta						
			garzetta	Little Egret	1	0	0	1
		Bubulcus						
			coromandus	Eastern Cattle Egret	25	8	60	60
		Ardeola						
			bacchus	Chinese Pond Heron	0	1	0	1
			grayii	Indian Pond Heron	16	2	2	16
Accipitriformes								
	Accipitridae							
		Pernis						
			ptilorhynchus	Oriental Honey-buzzard	2	1	2	2
		Circus						
			melanoleucos	Pied Harrier	1	0	0	1
		Accipiter						
			badius	Shikra	1	0	0	1
		Milvus						
			migrans	Black Kite	1	1	1	1
Gruiformes								
	Rallidae							
		Amaurornis						
			phoenicurus	White-breasted Waterhen	1	1	1	1

Charadriiformes								
	Charadriidae							
		Charadrius						
			dubius	Little Ringed Plover	6	0	1	6
	Scolopacidae							
		Actitis						
			hypoleucos	Common Sandpiper	3	0	0	3
	Turnicidae							
		Turnix						
			suscitator	Barred Buttonquail	0	2	2	2
Columbiformes								
	Columbidae							
		Columba						
			livia	Rock Pigeon	16	4	0	16
		Streptopelia						
			tranquebarica	Red Collared Dove	5	25	23	25
			chinensis	Spotted Dove	28	28	8	28
		Treron						
			phoenicopterus	Yellow-footed Green Pigeon	4	2	32	32
Cuculiformes								
	Cuculidae							
		Centropus						
			sinensis	Greater Coucal	2	1	3	3
		Clamator						
			jacobinus	Pied Cuckoo	0	0	2	2
		Eudynamys						
			scolopaceus	Asian Koel	0	1	1	1
		Cacomantis						
			sonneratii	Banded Bay Cuckoo	0	0	1	1
Caprimulgiformes								
	Hemiprocnidae							
		Hemiprocne						
			coronata	Crested Treeswift	15	9	130	130
Bucerotiformes								
	Upupidae							
		Upupa						
			epops	Common Hoopoe	5	4	8	8
Coraciiformes								
	Alcedinidae							
		Alcedo						
			atthis	Common Kingfisher	2	0	1	2
		Halcyon						
			smyrnensis	White-throated Kingfisher	3	1	2	3
	Meropidae							
		Merops						
			orientalis	Little Green Bee-eater	200	13	30	200
			leschenaulti	Chestnut-headed Bee-eater	2	0	4	4
	Coraciidae							
		Coracias						
			benghalensis	Indian Roller	6	0	0	6
Piciformes								

	Megalaimidae							
		Psilopogon						
			haemacephala	Coppersmith Barbet	0	0	2	2
			lineatus	Lineated Barbet	1	0	0	1
	Picidae							
		Jynx						
			torquilla	Eurasian Wryneck	1	1	0	1
		Dendrocopos						
			analis	Freckle-breasted Woodpecker	1	0	1	1
			mahrattensis	Yellow-crowned Woodpecker	2	2	1	2
Falconiformes								
	Falconidae							
		Falco						
			severus	Oriental Hobby	1	0	0	1
Psittaciformes								
	Psittaculidae							
		Psittacula						
			finschii	Grey-headed Parakeet	30	0	0	30
			roseata	Blossom-headed Parakeet	0	138	42	138
Passeriformes								
	Vangidae							
		Tephrodornis						
			pondicerianus	Common Woodshrike	6	2	4	6
	Aegithinidae							
		Aegithina						
			tiphia	Common Iora	4	4	7	7
	Campephagidae							
		Pericrocotus						
			roseus	Rosy Minivet	6	0	0	6
		Coracina						
			macei	Large Cuckooshrike	0	0	2	2
	Laniidae							
		Lanius						
			cristatus	Brown Shrike	2	0	0	2
			collurioides	Burmese Shrike	17	3	7	12
	Oriolidae							
		Oriolus						
			tenuirostris	Slender-billed Oriole	1	0	0	1
			xanthornus	Black-hooded Oriole	1	0	0	1
	Dicruridae							
		Dicrurus						
			macrocercus	Black Drongo	10	16	7	16
			leucophaeus	Ashy Drongo	2	0	0	2
			hottentottus	Hair-crested Drongo	17	0	0	17
	Monarchidae							
		Hypothymis						
			azurea	Black-naped Monarch	3	0	0	3
	Corvidae							
		Urocissa						
			erythrorhyncha	Red-billed Blue Magpie	8	2	4	8
		Dendrocitta						

			vagabunda	Rufous Treepie	2	0	1	2
		Corvus						
			splendens	House Crow	1	1	0	1
	Alaudidae							
		Mirafra						
			microptera	Burmese Bushlark	21	10	16	21
	Hirundinidae							
		Cecropis						
			striolata	Striated Swallow	87	3	10	87
	Pycnonotidae							
		Pycnonotus						
			flaviventris	Black-crested Bulbul	0	0	2	2
			cafer	Red-vented Bulbul	50	10	18	50
			blanfordi	Streak-eared Bulbul	16	16	10	16
	Phylloscopidae							
		Phylloscopus						
			trochiloides	Greenish Warbler	3	0	0	3
	Cisticolidae							
		Orthotomus						
			sutorius	Common Tailorbird	2	1	4	4
		Prinia						
			hodgsonii	Grey-breasted Prinia	8	5	4	8
	Timaliidae							
		Chrysomma						
			sinense	Yellow-eyed Babbler	1	0	4	4
	Leiothrichidae							
		Turdoides						
			gularis	White-throated Babbler	12	14	18	18
	Muscicapidae							
		Copsychus						
			saularis	Oriental Magpie-robin	4	2	2	4
			malabaricus	White-rumped Shama	2	0	2	2
		Ficedula						
			albicilla	Taiga Flycatcher	5	0	0	5
		Saxicola						
			maurus	Eastern Stonechat	4	0	0	4
			caprata	Pied Bushchat	3	0	1	3
	Turdidae							
		Geokichla						
			citrina	Orange-headed Thrush	0	2	1	2
	Sturnidae							
		Gracupica						
			contra	Asian Pied Starling	0	1	2	2
		Sturnia						
			malabarica	Chestnut-tailed Starling	14	0	0	14
		Acridotheres						
			tristis	Common Myna	83	24	6	83
			burmannicus	Vinous-breasted Starling	0	5	6	6
			fuscus	Jungle Myna	15	16	3	16
	Chloropseidae							
		Chloropsis						
			aurifrons	Golden-fronted Leafbird	6	0	0	6
	Nectariniidae							
		Cinnyris						
			asiaticus	Purple Sunbird	13	6	15	15

	Motacillidae							
		Motacilla						
			alba	White Wagtail	10	0	0	10
		Anthus						
			hodgsoni	Olive-backed Pipit	0	3	0	3
	Passeridae							
		Passer						
			domensticus	House Sparrow	8	2	4	8
			flaveolus	Plain-backed Sparrow	10	8	4	10
	Estrildidae							
		Lonchura	striata	White-rumped Munia	0	0	3	3
			punctulata	Scaly-breasted Munia	27	18	73	73