SPECIES DIVERSITY AND FACTOR AFFECTING THE ABUNDANCE OF FARMLAND-DEPENDENT BIRDS IN WEST NAWALPARASI, NEPAL

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Submitted To

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Kirtipur, Nepal

May, 2023

DECLARATION

I hereby declare that the work presented in this thesis has been done by myself and has not been submitted elsewhere for the award of any degree. All sources of information have been acknowledged explicitly by reference to the author (s) or institution (s).

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This is to recommend that the thesis entitled **"Species Diversity and Factor Affecting the Abundance of Farmland-Dependent Birds in West Nawalparasi, Nepal"** has been carried out by Mrs. Kamala Poudel for the partial fulfillment of Master's Degree of Science in Zoology with special paper Ecology and Environment. This is her original work and has been carried out under my supervision. To the best of my knowledge, this thesis work has not been submitted for any other degree in any institution.

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On the recommendation of Supervisor Dr. Bishnu Prasad Bhattarai, this thesis submitted by Mrs. Kamala Poudel entitled "Species Diversity and Factor Affecting the Abundance of Farmland-Dependent Birds in West Nawalparasi, Nepal" is approved for the examination and submitted to the Tribhuvan University in partial fulfillment of the requirements for Master's degree of the requirements for Master's degree of Science in Zoology with special paper Ecology and Environment.

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CERTIFICATE OF ACCEPTANCE

This thesis submitted by Mrs. Kamala Poudel entitled **"Species Diversity and Factor Affecting the Abundance of Farmland-Dependent Birds in West Nawalparasi, Nepal"** has been accepted as partial fulfillment for the requirements of Master's Degree of Science in Zoology with special paper Ecology and Environment.

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LIST OF ABBREVIATIONS

CITIES	Convention on International Trade in Endangered Species of Wild Fauna
DNPWC	Department of National Parks and Wildlife Conservation
GLM	Generalized Linear Model
GPS	Global Positioning System
IUCN	International Union for Conservation of Nature
LC	Least Concern
NRBD	National Red list Bird Databook
NT	Near Threatened
VU	Vulnerable

ABSTRACT

Farmland-dependent birds are those found around or on the farm, feeding on various crops and breeding in hedges near the farm. Farmlands are crucial in sustaining many bird species. Bird richness on agricultural lands is thought to be a useful predictor of wildlife health and the health of the plants and invertebrates on which they eat. This study was carried out in West Nawalparasi District with the objective to explore the species diversity and factors affecting the abundance of farmland-dependent birds. Data was taken from the centroid points of 56 randomly selected 500m by 500m grids. The birds were observed for 20 minutes in a circle of a 250m radius using the visual encounter method. Altogether 110 species belonging to 17 orders and 46 families were recorded. Passeriformes (56 species) was found to be the dominant order. Among 110 species 84 species were recorded in the winter season, 48 species in the rainy season, and 40 species in the summer season. Shannon-Weiner diversity index showed the highest bird diversity in the winter season (H= 3.53) than in the rainy (H= 3.21) and summer (H= 2.91) seasons, whereas evenness was higher in the rainy season (E=0.516) than in the summer season and winter seasons. Among 110 species, 81 species were resident, 10 species were passage migrants, 9 species were winter visitors, 6 species were summer visitors and 3 species were partial migrants. Three globally vulnerable species i.e. Asian Wollyneck (*Ciconia episcopus)*, Lesser Adjutant (*Leptoptilos javanicus)*, and Sarus Crane (*Grus antigone)* categorized in IUCN Red List were recorded. Different habitat and disturbance variables which included distance to the nearest road, distance to the nearest village, distance to the nearest water body and crop types had a positive significant impact and distance to the nearest tree had a negative significant impact on the bird abundance. The existence of migratory, residential, and threatened bird species in Western Nawalparasi District revealed the uniqueness of the bird habitat in the area; thus, a site-specific management plan is required to conserve these bird species.

1. INTRODUCTION

1.1 General Background

Birds are excellent eco-indicators, showing the condition of the ecosystem in places like wetlands, forest edges, and important river basins (Niemi 1985). Birds and their diversity serve as an effective bio-indicator (Joshi & Bhatt 2015) and serve as a symbol of the overall biodiversity and health of the ecosystem (Gregory & van Strien 2010). By being a part of the food web, birds play a significant role in the ecology (Hussain 1995). Birds are essential to the resilience and maintenance of the ecosystem from the point of view of ecosystem functions (Sekercioglu 2006). In Nepal, 53% of the country's most threatened birds live in forests, 27% in wetlands, 15% in grasslands, 8% in cultivated land, 5% in shrubs, 9% in open canopy, 3% near human settlements, and 1% in semi-desert habitats (Inskipp et al. 2013). Birds choose different habitats based on the protection, feeding possibilities, and breeding places available. The availability of food, sufficient cover and nesting locations, the species' adaptation and tolerance level, and the degree of threats or prey vulnerability are all factors that influence bird preferences (Girma et al. 2017).

Nine percent of the known bird species in the world are found in Nepal (Grimmett et al. 2016). Eight hundred and ninety-one (891) bird species have been identified in Nepal (DNPWC 2019). Among them, 42 species are globally threatened, and 172 species are nationally threatened (BirdLifeInternational 2020). The great diverse climatic and topographical difference within the nation has produced a variety of ecosystem types, which is the cause of the richness in bird diversity (Poudel et al. 2021). The diversity, abundance, and distribution of birds are affected by foraging opportunities and suitable nesting sites at the varied land cover, including forests, shrubs, grasslands, wetlands, agricultural land, and urban areas (Rahbek & Graves 2001, Price et al. 2014).

The agricultural ecosystem is regarded as a crucial habitat for birds since it offers breeding and foraging grounds (Flohre et al. 2011). To preserve the ecological balance in an agricultural ecosystem, birds are recognized as an important species (Manning et al. 2006). Farmland-dependent birds forage on the farm and build nests in the hedges near the farm area (Benton et al. 2003). Although farmland birds are

directly related to people and human settlement, farmers and locals are unaware of their significance (Tscharntke et al. 2005). The birds are crucial to the ecology because they aid in pollination, the management of harmful pests, dispersal, and the formation of the framework for the survival of other wildlife habitats (Inskipp & Baral 2010).

Farmland birds are going through a global population decrease due to a variety of anthropogenic factors (Katuwal et al. 2021). The main cause of the decline in farmland-dependent bird populations has been identified as agricultural intensification (Guldemond et al. 2010). More diverse crop rotations, a restriction on pesticide usage, and heterogeneous landscapes are some examples of "bird-friendly" agricultural techniques that are predicted to increase the number of food resources and nesting sites for birds (Wilcox et al. 2014). The main issue facing farmland birds are changes in agriculture, such as excessive pesticide and fertilizer use, the growing of cash crops in place of rice, which has traditionally been grown in Nepal, and the intensification of agriculture leading to the loss of uncultivated field changes and corners, which provide valuable habitat for birds and other wildlife (Inskipp & Baral 2010).

Farmland in Nepal supports approximately 21% (180 species) of Nepal's birds, with approximately 11% being globally threatened (Inskipp et al. 2017). However, the government and conservation organizations in Nepal have primarily focused on protected areas, with little effort on farmlands (Baral et al. 2012, Inskipp et al. 2016). Although bird populations in Nepal are declining (Inskipp et al. 2016, Katuwal et al. 2021), little is known about their status in farmlands. The lack of information has made it difficult to develop conservation plans and government policies (Katuwal et al. 2021).

1.2 Objectives of the Study

1.2.1 General Objective

- To explore the species diversity and factors affecting the abundance of farmland-dependent birds in West Nawalparasi District, Nepal.

1.2.2 Specific Objectives

- To determine the diversity of farmland-dependent birds in West Nawalparasi District, Nepal.

- To examine the factor affecting bird abundance in the study area.

1.3 Rationale of the Study

Birds play a vital role in the maintenance of many ecosystems by delivering a variety of ecological services (Whelan et al. 2008). Nepal has done a considerable amount of work on threatened birds, particularly globally threatened birds (Thakuri 2007). In contrast, essentially little monitoring of common bird species or those that visit agricultural lands has been done (Katuwal et al. 2021). Many researchers in Nepal have done studies on bird diversity and distribution in diverse ecosystems, with a focus on national parks and protected regions. There is no evidence of previous scientific research within the West Nawalparasi District. Because they occupy a diverse range of habitats, bird populations on farmlands are thought to be a valuable indicator of the overall state of wildlife and the countryside (Gregory et al. 2003). Recognizing these facts and the importance of studying avifauna on farmland, this study was designed to provide information about the status, diversity, and factors affecting abundance of farmland-dependent birds.

2. LITERATURE REVIEW

2.1 Bird Diversity

The species diversity and richness of a region are determined by its habitat, topography, latitude, climate, and resource availability (da Silva et al. 2014). Bird species diversity was found primarily in environments far from human settlements, with high annual mean temperatures and more roughness (Ghimire et al. 2021). Mittelbach et al. (2001) highlight productivity, species-area effect (Rahbek 1997), vegetation type (MacArthur et al. 1966), and temperature (McCain 2009) as factors that contribute to the pattern of diversity and richness. Many variables that interact in both space and time have an impact on the diversity and number of birds in a given landscape (Orians & Wittenberger 1991).

Climate has a direct and indirect impact on diversity because it limits the physiological tolerance of species and serves as a species filter (Currie 1991, Brown 2001). Several studies have confirmed that climatic conditions are significant in generating species richness and determining broad patterns of biodiversity (McCain 2007, Rowe 2009, Chen et al. 2017).

Diversity is one of the most important community characteristics, as it influences stability, productivity, and migration (Stirling & Wilsey 2001). Adhikari et al. (2018) recorded in the Barandabhar Corridor Forest, 304 bird species from 18 orders and 69 families including 59% residents, 8% summer visitors, 32% winter visitors, and 1% vagrants. There are 141 bird species reported from Khata Corridor which is grouped into 12 orders and 43 families (Chaudhari et al. 2009).

Reino et al. (2009) found out during their research that steppe birds of conservation concern may suffer as a result of forest plantations, which may enhance general bird diversity and abundance in nearby farms. Hedge length has a greater impact on bird richness than management, greatly increasing the number of species (Batáry et al. 2010). Hedges provide important nesting, feeding, and sheltering sites for birds in agricultural areas, so hedges are important in conserving avifaunal diversity, so more hedgerows and careful management of them can contribute to farmland bird conservation (Batáry et al. 2010).

In Hetauda, Makawanpur, Nepal's Karra River, Parajuli (2016) showed that the bird population was more diverse in the winter than it was in the summer. Shah (2021) carried out a study to identify the diversity and factors affecting bird abundance at Dullu Municipality Dailekh. This study revealed that the bird species were more diversified in forest areas than on agricultural land. Bird occurrences were significantly impacted by various environmental factors, including canopy cover, the closest distance to a forest habitat, and nearest distance to a water supply. For both seasons, the species richness was favorably connected with the proximity to agricultural land, although it declined with increasing distance from water sources and canopy cover.

The presence of bird species is supported by forest; for example, disturbed forest and indigenous forest have a higher species richness than farmlands and plantation forest (Bett et al. 2016) . However, it varied according to season; a greater number of bird species were observed on farms during the dry season and in forest environments during the wet season (Dagnaw & Mesele 2017).

According to a study by Šálek et al. (2018), active farmsteads are important areas for local bird diversity and host species conservation in the agricultural landscape.

2.2 Factors Affecting Bird Abundance

The bird abundance was affected by vegetation composition, altitude, and climate because it affects the availability of food which enhances the migration (Girma et al. 2017). The spatiotemporal distribution of natural resources affects the diversity and abundance of birds. Due to the habitat's diversity in vegetation and complexity, Tanalgo et al. (2015) found that the highest proportion of species was found in agroforests, rice fields, and damaged roads in the Philippines.

Seasonal variation had a significant effect on the avian population (Parajuli 2016). Seasonal variations in food and rainfall cause changes in bird species occurrence and abundance (Tonkin et al. 2017). Farmland bird richness and abundance increased with increasing tree numbers but decreased with increasing house numbers also seasonal variation and cropping practice significantly influenced the richness of all farmland birds and resident birds only, whereas species abundances vary by season only (Katuwal et al. 2022).

Wetlands, open forests, and grasslands in Chitwan National Park were shown to have higher threatened bird variety and abundance, whereas distance from a road and a village, as well as the presence of livestock, had a considerably detrimental impact on bird abundance (Adhikari et al. 2019). Farmsteads are recognized to be significant during the winter since species richness was seen there substantially more often than in other seasons and this study also offers current farmland bird conservation strategies, emphasizing preservation in non-farming settings like working farmsteads (Šálek et al. 2018). Kiros et al. (2018) conducted a preliminary study on bird diversity and abundance from Wabe fragmented forests Southwestern Ethiopia and their result revealed that the abundance of birds showed significant differences between the sites.

Birds are valuable models for researching a number of environmental issues and understanding the structure of the local bird community in a given area is essential to understanding the significance of local landscapes for avian conservation (Kattan & Franco 2004). According to Lees et al. (2022) birds are likely the most well-inventoried big taxonomic class of creatures, allowing for a unique insight into how the Anthropocene has changed their distributions and conservation status in space and time. According to the IUCN Red List, the status of the world's birds has gradually declined since the first thorough evaluation in 1988. Highly endangered species are becoming extinct, whereas widespread species are declining dramatically. The assessment of the avian community is a vital tool in the conservation of biodiversity and the identification of conservation strategies. Understanding the diversity and composition of bird communities is critical for determining the health of the local ecosystem and regional landscapes (Sethy et al. 2015). The majority of bird studies focused on the level of protected areas, forests, and landscapes. Ecosystems on farms are not a research priority for conservationists. So, this study was done to assess the significance of farmland-dependent birds to close this research gap.

3. MATERIALS AND METHODS

3.1 Study Area

The study was conducted in the farmlands of West Nawalparasi District, located in the Lumbini Province Nepal. The study area encompasses the lowlands of Nawalparasi District from Bardaghat in the east to Sunwal in the west (DCCO, 2015).

The forest of Nawalparasi lowland supports a high diversity of flora and fauna. The Nawalparasi forest lies between Bardaghat to Sunwal at the base of the Siwalik Hills of the Nawalparasi District. This area is largely used for agriculture and almost all of the southern part is intensively farmed. Forests of this area are managed by local communities, as community forests. The forest is mainly Sal (*Shorea robusta*) with Saj (*Terminalia tomentosa*) as the co-dominant species. In degraded areas, there are Sissoo (*Dalbergia sissoo*) plantations. Agriculture is the mainstay occupation of the people of Nawalparasi where crop cultivation is done in two seasons. Main crop cultivated in agricultural land are paddy, maize, mustard, wheat, sugarcane, etc. The annual minimum and maximum temperature of Nawalparasi ranges from 17.5°c to 29.6°c, respectively (Pandey et al. 2020).

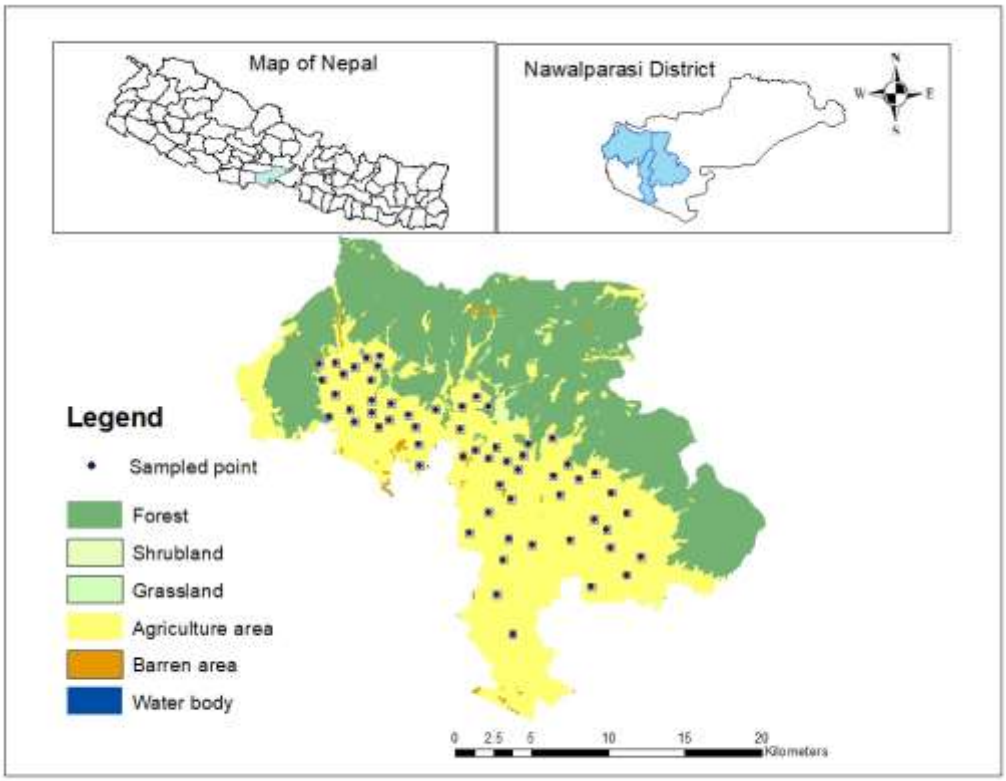

Figure 1. Map of the study area showing land cover types and grid sampled point

3.2 Data Collection

3.2.1 Bird Survey

The study was carried out by dividing the entire study area into 500m by 500m grids. The grid was created through the fishnet tool using ArcGIS software. For the study, grids were chosen at random by random sampling method. The sample size of the grid was calculated by using Slovin's formula (Slovin 1960).

$$\text{Sample size } (n) = N/1+Ne^2$$

Where,

n = sample size

N = total number of grids

e = margin of error (e = 0.05)

Three hundred and twenty-six of the grids were chosen by random sampling, and of those, only 56 grids were used for data collection because grid in the forest area, border area, city area, and incomplete grids were excluded from the study area. The centroid of the selected grid's points was obtained from Google Earth and then uploaded to GPS (Garmin eTrex 10) for navigation. GPS was also used to confirm the points while in the field. For the bird survey, the point count method was used to record all of the individual birds in the farmlands (Gregory et al. 2003). Points were fixed in the centroids of the grids chosen. By using the visual encounter method, the species, and the number of individuals of birds, as well as habitat and disturbance parameters, were recorded within a 250m radius of each point with the help of range finder. By using binoculars, each point recorded the species and number of individuals of birds for 20 minutes and photographs were taken whenever possible.

The birds were observed in the plot from 7 a.m. to 10 a.m. and 3 p.m. to 6 p.m. during the summer and rainy season while from 10 a.m. to 4 p.m. noon during the winter season. Data were collected in July 2022 (rainy season), in May 2022 (summer season) and in January 2023 (winter season). The birds were identified using the field guidebook Birds of Nepal (Grimmett et al. 2016).

3.3 Environmental Variables

3.3.1 Habitat Variables

As a substitute for resource availability, the presence of trees was recorded by direct observation, the distance to the nearest tree was noted using a range finder, and the distance to the nearest forest and water body was measured using point data and Google Earth.

3.3.2 Disturbance Variables

The study area's human disturbance factors were determined by the distance to the nearest road and the distance to the nearest village. Distance to the nearest village was measured using point data and Google Earth, whereas the distance to the roads was estimated in the field and confirmed by Google Earth.

Table 1. Environmental variable and their codes used

S.N.	Habitat and Disturbance variables	Details	Codes used
1.	Distance to the nearest forest	Euclidean distance measured from sampling point to the nearest forest by using Google Earth Pro.	NFD
2.	Distance to the nearest tree	Euclidean distance measured from sampling point to the nearest tree by using range finder	NTD
3.	Distance to the nearest water body	Euclidean distance measured from sampling point to the nearest water source by using Google Earth Pro.	NWD
4.	Distance to the nearest village	Euclidean distance measured from sampling point to the nearest settlement by using Google Earth Pro.	NVD
5.	Distance to the nearest roads	Euclidean distance measured from the sampling point to the nearest roads by using Google Earth Pro.	NRD

3.3.3 Feeding Guild Classification

The feeding guilds of the recorded species were classified using the field guidebook 'Birds of Nepal' and classified into five types (Grimmett et al. 2016) based on food insectivores (feeding on insects, larvae, worms, spiders, crustaceans, mollusks, etc.), omnivores (feeding on both plants and animals), carnivores (feeding on fishes, amphibians, reptiles, birds, and mammals), granivorous (feeding on seeds, grains), and frugivorous (feeding on plant leaves, grains, twig, fruits, berries, nectars, figs, and drupes).

3.4 Data Interpretation and Statistical Analysis

All field survey data were entered into a Microsoft Excel 2010 for analysis. The diversity indices were determined using "PAST 4.07 Version" software (Hammer et al. 2001). The status of residential and migratory birds was assessed with the help of the "Birds of Nepal" field guidebook (Grimmett et al. 2016). The conservation status of the birds was identified by IUCN Red List along with the CITES category (DNPWC and BCN 2018).

3.4.1 Diversity Index

Shannon-Weiner Index

It is useful for quantifying diversity and comparing species diversities across ecosystems in various ecological conditions. The Shannon-Weiner diversity index was used to determine species diversity (Shannon 1948).

In Shannon's index, the ratio of each component is multiplied by the loge of the ratio (ni/N) and summed it.

Mathematically,

$$\bar{H} = -\sum \left(\frac{ni}{N}\right) loge \left(\frac{ni}{N}\right)$$

Where,

$\bar{H}$ = Shannon’s index of diversity

ni = number of species in a community

N= total value for all species in a community.

The higher value of $\overline{H}$ shows the higher diversity and the lower value shows the lower diversity. The maximum value of $\overline{H}$ can be more than one.

3.4.2 Evenness Index

Evenness is a measure of the relative abundance of different species that contribute to an area's richness. Evenness is a key component of diversity indices because it expresses how evenly individuals in a community are distributed among different species. The evenness index was calculated to determine whether the species were distributed evenly across the study area during different seasons. It is calculated as,

$E = H'/H_{max}$

Where,

H'= Shannon's index of diversity

H'_{max}= maximum possible value of H' if every species is equally likely and equal to ln(s)

S = Species Richness is the total number of species.

If we have the value near 0, then the diversity is said to be uneven distribution and when the value is nearer to 1, the diversity is said to be an even distribution.

3.4.3 Simpson's Index

Determines the probability that any bird species that were randomly chosen from a sample would be of the same species (or some category other than species)(Simpson 1949).

Index of dominance (D) = $\sum (ni/n)^2$

Where,

ni= number or biomass or energy flow for each species

N= total value for all species.

The value of D ranges from "0 to 1." There is less dominance if the value is closer to 0, but more dominance if the value is closer to 1. With this index, 0 denotes unlimited diversity and 1 denotes the absence of diversity. That is, the diversity decreases as the D value increases.

A generalized linear model (GLM) with Poisson distribution was used to determine variables influencing the abundance of birds. R software was used to perform GLM (RCoreTeam 2021). Distance to the nearest road, distance to the nearest forest, distance to the nearest tree, distance to the nearest village, and distance to the nearest water body and crop types were all tested for multi-collinearity (Haitovsky 1969). Because all variables were not highly correlated ($r<0.7$), we used all of them for further study. Before using the generalized linear model in this study, the response variables were tested for normal distribution using the Shapiro test in R software (RCoreTeam 2021). The bird species in the area were dispersed with $P<0.05$. Therefore, bird abundance was used as a response variable for a further GLM.

4. RESULTS

4.1 Species Diversity

A total of 5354 individuals of birds belonging to 110 species from 46 families and 17 orders were recorded during the fieldwork in three different seasons. Among the observed birds, Passeriformes was the most dominant order. Among the recorded 46 families, the family Muscicapidae and Ardeidae had the highest number of bird species (seven species) followed by Accipitridae (six species), Cisticolidae, Columbidae, Motacillidae, phylloscopidae and Sturnidae (five species for each).

Table 2. Orders of birds recorded along with the number of family and species

S.N	Orders	Number of families	Number of species
1	Passeriformes	22	56
2	Pelecaniformes	2	8
3	Coraciiformes	3	6
4	Accipitriformes	1	6
5	Charadriformes	3	5
6	Columbiformes	1	5
7	Piciformes	2	4
8	Ciconiformes	1	3
9	Cuculiformes	1	3
10	Anseriformes	1	2
11	Psittaciforms	1	2
12	Strigiformes	1	2
13	Suliformes	1	2
14	Gruiformes	2	2
15	Bucerotiformes	2	2
16	Apodiformes	1	1
17	Falconiformes	1	1

A total of 48 species, representing 27 families and 13 orders, were recorded during the rainy season, compared to 40 species, representing 26 families and nine orders, during the summer, and 84 species, representing 42 families and 17 orders, during the winter.

The order Passeriformes had the most species documented over all three seasons, while the least number of species were recorded on orders Bucerotiformes in rainy, the Gruiformes in summer, and the Apodiformes and Falconiformes in the winter.

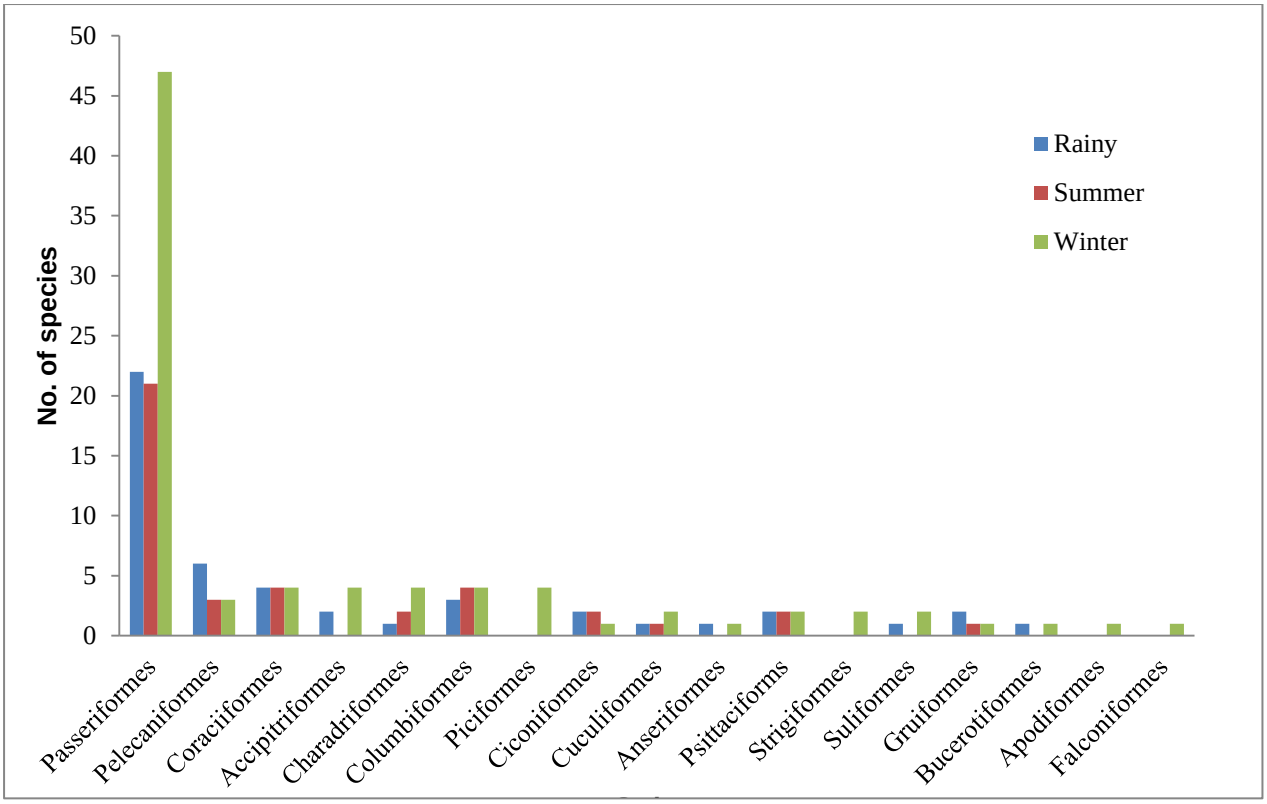

Figure 2. Number of bird species in different order in different seasons

According to this study, the Shannon-Weiner index of diversity (H) was 3.369. This result shows farmland of Western Nawalparasi District is rich in diversity of aviafauna. The evenness index was extremely low (E=0.264), indicating that the bird diversity was distributed unevenly. Simpson's dominance index (D) of farmland birds in Nawalparasi was 0.064. As a result, no single species dominates the study area. This result indicates that bird diversity is high in farmlands.

This study reported that the farmland bird's Shannon-Weiner diversity index (H) was higher in the winter (i.e., H= 3.534) than in the rainy (i.e., H= 3.21) and summer (i.e., H= 2.913) seasons, whereas evenness was higher in the rainy season than in the summer season and winter seasons. Summer was determined to be more dominant than the other two seasons for farmland bird dominance (Table 3).

Table 3. Diversity indices, evenness, and dominance of birds in different seasons

	Rainy	Summer	Winter	All
Taxa_S	48	40	84	110
Dominance_D	0.062	0.08415	0.05285	0.06467
Simpson_1-D	0.938	0.9159	0.9472	0.9353
Shannon_H	3.21	2.913	3.534	3.369
Evenness_eˆH/S	0.5169	0.4602	0.4077	0.264

During the study, a high number of insectivorous species were recorded (n = 47), and omnivorous and carnivorous species were recorded equally (n = 25), with granivorous (n = 8) and frugivorous (n = 5) species being the least recorded.

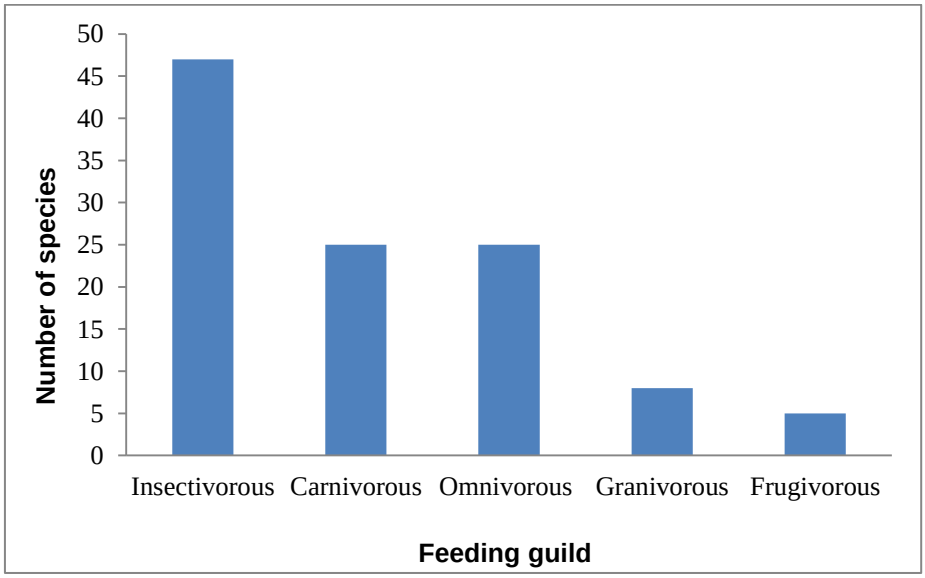

Figure 3. Number of Species in feeding guilds

Several conservation-priority species were observed during the study. The study area contained three Vulnerable (IUCN 2020), 11 nationally threatened species (four Vulnerable and seven Near Threatened) (Inskipp et al. 2017), and eight CITIES II (CITIES 2021), enlisted bird species.

Table 4. List of threatened bird species recorded on the farmland of Nawalparasi

S.N.	Common Name	IUCN	NRDB	CITIES
1	Asian Openbill		VU	
2	Wollyneck Stork	VU	NT	
3	Baya Weaver		NT	
4	Crested Serpented-Eagle			II
5	Great Cormorant		NT	
6	Lesser Adjutant	VU	VU	
7	Plain Martin		NT	
8	Hume's Leaf-Warbler		VU	
9	Plum-Headed Parakeet			II
10	Shikra			II
11	Jungle Owlet			II
12	Long Legged Buzzard			II
13	Crested Goshawk			II
14	Sarus Crane	VU	VU	II
15	Black Kite			II
16	Ruddy Shelduck		NT	
17	River Lapwing		NT	
18	Small Pratincole		NT	

IUCN = International Union for Conservation of Nature, NRDB = National Red list Data Book, CITIES = Convention on International Trade in Endangered species of Wild Fauna

The conservation status of the study's farmland-dependent birds was classified as Least Concern (LC) or Vulnerable by the IUCN (VU). The majority of the birds observed during the field survey were classified as Least Concern by the IUCN.

The farmland-dependent birds of the study were classified as highly abundant (over 250 individuals), abundant (201-250), common (101-200), common (51-100), fairly common (16-50), and rare below (15 individuals). The birds in the fairly common category were more frequently recorded, followed by the rare; common and the very abundant category was the least recorded (Figure 5).

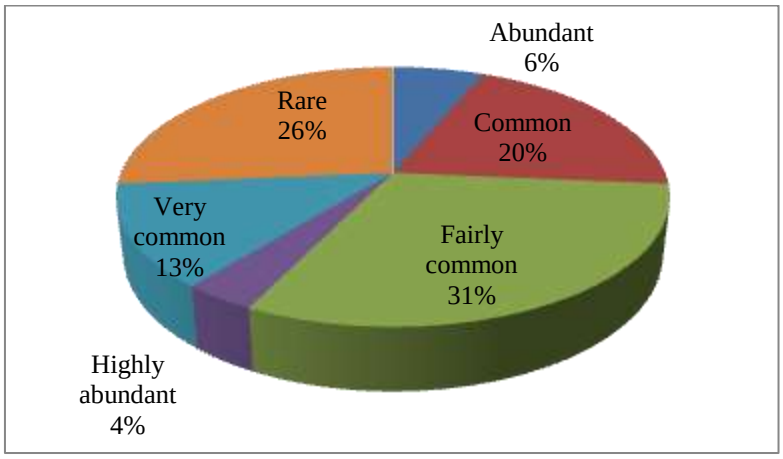

Figure 4. Local status of birds according to Local Category

During the study period, 81 species of residential birds, 9 species of winter visitors, 6 species of summer visitors, 3 species of partial migrants and 10 species of passage migrants birds were recorded (Figure 6).

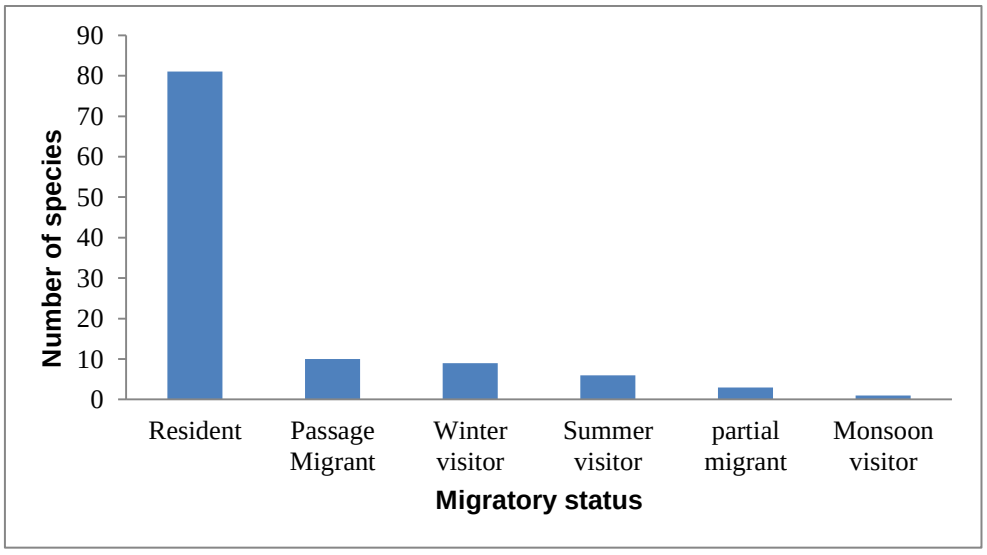

Figure 5. Migratory status of birds and number of species recorded in the study area

4.2 Factors Affecting the Bird Abundance

Different factors (habitat and disturbance) and crop type were taken for determining their effects on the farmland-dependent bird's abundance by using GLM. The distance of the nearest road, nearest water body, nearest tree, and the nearest village and crop type had both positive and negative effects on the abundance of birds. P value in table showed the variable was statistically significant or not. It was found that during the rainy season, the abundance of birds significantly associated positively ($p<0.05$) with the distance to the nearest road, distance to the nearest water body, and distance to the nearest village and significantly associated negatively ($p<0.05$) with the distance to the nearest tree. There was no significant effect of the crop types and distance to the nearest forest on the abundance of all species in the rainy season. The distance to the nearest tree had a negative significant association with bird abundance throughout the summer, while a positive significant association was found with the distance to the nearest water body on the abundance of bird species. This study also found that there was a significant effect of the crop types on the abundance of bird species in the summer season. During the winter season, there was a significantly positive association between the bird species abundance and distance to the nearest water body. Furthermore, abundance of birds was significantly associated positively with distance to the nearest village and crop types. These finding showed that abundance of farmland bird species increase with the increase in distance to the water body and village and decrease with the decrease in distance to the water body and village (Table 5).

Table 5. GLM with Poisson distribution showing the effects of environmental factors of the rainy season, summer season and winter season on bird abundance in West Nawalparasi district

	Model Parameters	**Estimate**	**Std. Error**	**Z value**	**P value**
Rainy Season	NRD	5.82E-04	2.38E-04	2.447	**0.0144***
	NFD	-1.37E-05	1.19E-04	-0.115	0.908
	NDT	-1.02E-02	1.58E-03	-6.481	**<0.0001****
	Crop types	2.26E-01	2.42E-01	0.934	0.350
	NVD	7.48E-03	1.20E-03	6.23	**<0.0001****
	NWD	5.09E-04	9.25E-05	5.503	**<0.0001****
Summer Season	NRD	4.23E-04	2.62E-04	1.613	0.106
	NFD	-2.58E-04	1.49E-04	-1.728	0.084
	NDT	-5.507E-03	1.483e-03	-3.713	**0.000205****
	Crop types	0.4075	0.1323	-3.08	**0.00207****
	NVD	2.22E-03	1.32E-03	1.679	0.093
	NWD	7.23E-04	9.49E-05	7.618	**<0.0001****
Winter Season	NRD	0.000472	0.000334	1.413	0.157
	NFD	-0.0001922	0.000198	-0.972	0.331
	NDT	-0.0008684	0.001458	-0.596	0.551
	Crop types	0.1111	0.1276	8.709	**<0.0001****
	NVD	0.0047138	0.001539	3.063	**0.00219****
	NWD	0.0007327	0.000116	6.295	<**0.0001****

From the study the generalized linear modeling (GLM) shows the significant difference in feeding guild species richness in response to environmental factor with insectivores, carnivores and frugivores whereas no significant difference was shown in feeding guild species richness from different environmental variable with omnivores and granivores (Table 6).

Table 6. GLM with Poisson distribution showing the effects of the environmental factor on the feeding guild of bird species richness in West Nawalparasi District

Insectivorous richness				
Model Parameters	**Estimate**	**Std. Error**	**Zvalue**	**P value**
Distance to the nearest road	4.27E-04	2.13E-04	2.011	**0.0443***
Distance to the nearest forest	-5.27E-04	3.15E-04	-1.675	0.0940.
Distance to the nearest tree	-6.84E-03	3.23E-03	-2.117	**0.0343***
Distance to the nearest village	3.84E-03	2.19E-03	1.754	0.0794.
Distance to the nearest water body	-7.83E-05	2.02E-04	-0.388	0.6982
Omnivorous richness				
Distance to the nearest road	-2.25E-04	4.75E-04	-0.473	0.636
Distance to the nearest forest	-5.56E-04	5.80E-04	-0.958	0.338
Distance to the nearest tree	-1.89E-03	4.67E-03	-0.404	0.686
Distance to the nearest village	-2.29E-03	3.66E-03	-0.626	0.531
Distance to the nearest water body	-1.05E-05	3.26E-04	-0.032	0.974
Granivorous richness				
Distance to the nearest road	4.31E-05	5.35E-04	0.081	0.936
Distance to the nearest forest	-9.63E-04	7.20E-04	-1.338	0.181
Distance to the nearest tree	-5.94E-03	6.85E-03	-0.867	0.386
Distance to the nearest village	-6.37E-04	4.50E-03	-0.142	0.887
Distance to the nearest water body	-3.41E-04	4.32E-04	-0.789	0.43
carnivorous richness				
Distance to the nearest road	9.13E-04	3.17E-04	2.883	**0.00394****
Distance to the nearest forest	-1.10E-03	4.75E-04	-2.313	**0.02070***
Distance to the nearest tree	-1.78E-03	4.51E-03	-0.395	0.69274
Distance to the nearest village	1.07E-04	3.33E-03	0.032	0.9743
Distance to the nearest water body	-7.62E-05	3.03E-04	-0.252	0.80112
Frugivorous richness				
Distance to the nearest road	6.13E-04	4.47E-04	1.373	0.1697
Distance to the nearest forest	-1.67E-03	6.74E-04	-2.479	**0.0132***
Distance to the nearest tree	-4.57E-03	5.88E-03	-0.776	0.4376
Distance to the nearest village	-8.04E-04	4.06E-03	-0.198	0.843
Distance to the nearest water body	1.91E-04	3.27E-04	0.586	0.5579

5. DISCUSSION

In the current study, high diversity of birds was recorded within the limited study area. This could be due to suitable habitat as well as food for the birds. According to Inskipp et al. (2017), the farmlands of Nepal are home to 21% of all bird species. From the study area 110 species of birds as well as three species that are globally threatened were recorded in the farmlands of Nawalparasi. As a result of being closer to foraging locations for forest birds that are present in diverse habitats and the easy availability of food for the species in farmland, it was found that these farmlands had a high diversity of farmland-dependent birds. Relatively high species diversity of avian fauna could be attributed to the various habitat types that constitute the area, probably for shelter and foraging opportunities (Girma et al. 2017). The diversity of bird species is high, this might be due to seasonal fluctuations in farming on this research area's agricultural land. The highest number of birds was recorded for the order Passeriformes. Globally, the order Passeriformes has a wider distribution and higher population. The presence of most Passeriformes birds in the study region may be caused by migrating birds or the residential behavior of the bird of that order (Shah 2021). Not only in this area, but the Passeriformes was also numerically dominant order in Khata corridor Forest, Nepal (Chaudhari et al. 2009) and in Madhari Himal in Annapurna Conservation Area, Central Nepal (Pandey et al. 2020).

Any particular habitat type has a dynamic bird community that varies seasonally (Avery & Riper 1989). As a result, the diversity and richness of the bird population may fluctuate as the seasons change. In comparison to the summer and rainy seasons, the study indicated that the winter season had higher species richness which may be due to the assemblage of migrating birds, the favorable ecological and climatic conditions, as well as the abundance of food (Parajuli 2016). In Nepal, about 150 different kinds of birds migrate from north to south throughout the winter, and agricultural fields offer some of these migratory birds with a suitable habitat (Grimmett et al. 2016, Elsen et al. 2017). The outcome was consistent with research done by (Katuwal et al. 2018) which found that more species were documented in winter than in summer. Certain species have the ability to migrate geographically to improve their search for resources (Almazán-Núñez et al. 2018) and open areas may be more favorable for foraging (Otieno et al. 2011). In a study done in the Banke National Park, it was found that the diversity of birds was greater in the winter

because early winter blossoming ensured food supply. As species richness was seen in active farmsteads substantially more frequently in the winter than in other seasons, the farmsteads are known to be important throughout the winter (Šálek et al. 2018). Similarly, due to migration timing, as well as the availability of thick leaves on trees and bird being less vocal during the breeding period could influence in summer's low species count (Katuwal et al. 2018).

According to the findings of the study, the dominant feeding guild was insectivores which was comparable with the study carried out by (Kumar & Sahu 2020). The presence of various insect groups makes it easier for insectivorous bird species to find food. Insectivorous birds are habitat specialists but they used agriculture fields and residential areas for foraging as the insect diversity is high in agriculture fields (Redhead et al. 2018, Schumm et al. 2020, Bastola et al. 2022). Insectivores are the most common guild in agricultural landscapes in other studies (Redlich et al. 2018, Narayana et al. 2019, Katuwal et al. 2022) as various insects are sufficiently found in different crops (Geddes & Iles 1991). However, cropping practices, which change with the season, also influence the distribution of insectivorous species (Katuwal et al. 2022). This study found that the guilds of carnivores were more diverse than those of granivores and frugivores, which suggests that many predator species regularly use agricultural landscapes for foraging and that farmlands make good habitats for their prey (Singleton et al. 2021).

Various environmental factors such as distance to the nearest road, water bodies, trees, villages, and crop types played a vital role in bringing the change in the bird abundance along the study area. According to the findings of this study, the relationship between road villages and crop types on species abundance was positively significant, with closer distance to the road resulting in lower abundance also the closer distance to the village resulting in lower species abundance. Similar findings were discussed in the threatened birds of Chitwan National Park, which revealed that disturbance variables such as distance from roads and distance from settlements or villages had a positive significant impact on bird distribution (Adhikari et al. 2019). Other studies have found a low abundance of birds in settlement areas due to increased disturbances, construction activities, and vehicle noise, all of which pose a hazard to birds (Adhikari et al. 2018, Inskipp et al. 2017). Many studies have found a negative relationship between species richness, occurrence, and abundance of

birds, indicating that birds are mostly declining near roads, with higher traffic than lower traffic (Brotons & Herrando 2001, Fuller et al. 2001). It was found that crop types positively impacted the bird species abundance. The selection of crops has an impact on the bird assemblage because different crop fields (such as wheat, mustard, or maize, or combinations of these) provide acceptable habitats for birds (Katuwal et al. 2022).

This study found that distance to the nearest tree negatively impacted bird species abundance. The presence of trees plays a vital role in driving bird species composition. Many birds, including common and globally vulnerable species found in agricultural landscapes, need trees for nesting and resting (Douglas et al. 2014, Koju et al. 2019). Katuwal et al. (2022) support the results by stating that farmland bird richness increased with increasing tree numbers. There was a significant positive correlation between bird abundance and distance to the nearest water bodies means that as the distance from the water body increases, bird abundance also increases. In other words, places farther from bodies of water tend to have a higher level of species abundance. This may be due to several factors such as habitat heterogeneity, resource availability, and human impacts (Fahrig & Merriam 1985). Davis (1981) supports the result by stating that water is a vital resource for many species. Areas close to water bodies may be more heavily used and competition for resources and areas farther from water bodies may be less impacted by human activities, leading to higher species diversity and abundance (Fahrig 2003).

6. CONCLUSION AND RECOMMENDATIONS

The study region is considered as a home of a bird species, including migrants, residents, and threatened species. According to the current study's findings, bird diversity and species richness were higher during the winter season than during the rainy season and summer seasons, as showed by the Shannon-Weiner diversity index, which revealed that birds were more diverse in the winter season and farmland in West Nawalparasi provide suitable habitats for various bird species. There was a positive significant impact of the road, village, water body, and different crop types on the abundance of bird species, and a negative significant impact of the tree on the abundance of bird species.

Farmland birds were more affected by seasonal variation, environmental factors, and crop varieties. The presence of globally vulnerable species as well as species listed in CITES Appendix II showed the area's importance in conservation of these species.

Few recommendations from this study are:

- High diversity of birds in the study area was found, so more research on farmland-dependent birds should be designed.
- Study was carried out in limited farmland area of West Nawalparasi District, so entire farmland area should be studied for the farmland-dependent birds.

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APPENDICES

List of birds with scientific names, order, and family, seasons, feeding guild, migratory status and IUCN Status

Note: R = Rainy season, S = Summer season, W = Winter season

S. N.	Common Name	Zoological Name	Order	Family	Seasons	Feeding Guild	Migratory S.	IUCN Status
1	Black Kite	*Milvus migrans*	Accipitriformes	Accipitridae	R, W	Carnivorous	Passage migrant	Least Concern
2	Crested Goshwak	*Accipiter trivirgatus*	Accipitriformes	Accipitridae	R	Carnivorous	Resident	Least Concern
3	Crested-serpent Eagle	*Spilornis cheela*	Accipitriformes	Accipitridae	W	Carnivorous	Resident	Least Concern
4	Himalayan Buzzard	*Buteo refectus*	Accipitriformes	Accipitridae	W	Carnivorous	Passage migrant	Least Concern
5	Long-legged Buzzard	*Buteo rufinus*	Accipitriformes	Accipitridae	W	Carnivorous	Passage migrant	Least Concern
6	Shikra	*Accipiter badius*	Accipitriformes	Accipitridae	W	Carnivorous	Resident	Least Concern
7	Lesser-whistling Duck	*Dendrocygna javanica*	Anseriformes	Anatidae	R	Omnivorous	Resident	Least Concern
8	Ruddy Shelduck	*Tadorna ferruginea*	Anseriformes	Anatidae	W	Omnivorous	Winter migrant	Least Concern
9	House Swift	*Apus nipalensis*	Apodiformes	Apodidae	W	Insectivorous	Resident	Least Concern

10	Eurasian Hoppoe	*Upupa epops*	Bucerotiformes	Upupidae	W	Insectivorous	Resident	Least Concern
11	Indian-grey Hornbill	*Ocyceros birostris*	Bucerotiformes	Bucerotidae	R	Omnivorous	Resident	Least Concern
12	Green Sandpiper	*Tringa ochropus*	Charadriiformes	Scolopacidae	W	Insectivorous	Winter migrant	Least Concern
13	Little-ringed Plover	*Charadrius dubius*	Charadriiformes	Charadriidae	S	Insectivorous	Winter migrant	Least Concern
14	Red-watled Lapwing	*Vanellus indicus*	Charadriiformes	Charadriidae	R, S	Carnivorous	Resident	Least Concern
15	River Lapwing	*Vanellus duvaucelii*	Charadriiformes	Charadriidae	W	Insectivorous	Resident	Least Concern
16	Small Pratincole	*Glareola lactea*	Charadriiformes	Glareolidae	W	Insectivorous	Partial migrant	Least Concern
17	Asian Openbill	*Anastomus oscitans*	Ciconiiformes	Ciconiidae	R, S	Carnivorous	Resident	Least Concern
18	Lesser Adjutant	*Leptoptilos javanicus*	Ciconiiformes	Ciconiidae	R, W	Carnivorous	Resident	Vulnerable
19	Wolly-necked Stork	*Ciconia episcopus*	Ciconiiformes	Ciconiidae	S	Carnivorous	Resident	Vulnerable
20	Eurasian-collared Dove	*Streptopelia decaocto*	Columbiformes	Columbidae	R, S, W	Granivorous	Resident	Least Concern
21	Oriental-turtle Dove	*Streptopelia orientalis*	Columbiformes	Columbidae	S, W	Granivorous	Winter migrant	Least Concern

22	Rock Pigeon	*Columba livia*	Columbiformes	Columbidae	R, S, W	Granivorous	Resident	Least Concern
23	Spotted Dove	*Spilopelia chinensis*	Columbiformes	Columbidae	R, W	Granivorous	Resident	Least Concern
24	Yellow-footed Green Pigeon	*Treron phoenicopterus*	Columbiformes	Columbidae	S	Granivorous	Resident	Least Concern
25	Blue-tailed bee-eater	*Merops philippinus*	Coraciiformes	Meropidae	R, W	Insectivorous	Summer migrant	Least Concern
26	Common Kingfisher	*Alcedo atthis*	Coraciiformes	Alcedinidae	R, W	Carnivorous	Resident	Least Concern
27	Green bee-eater	*Merops orientalis*	Coraciiformes	Meropidae	R, S	Insectivorous	Summer migrant	Least Concern
28	Indian Roller	*Coracias benghalensis*	Coraciiformes	Coraciidae	S, W	Carnivorous	Resident	Least Concern
29	Pied Kingfisher	*Ceryle rudis*	Coraciiformes	Alcedinidae	S	Carnivorous	Resident	Least Concern
30	White-throated Kingfisher	*Halcyon smyrnensis*	Coraciiformes	Alcedinidae	R, S, W	Carnivorous	Resident	Least Concern
31	Common hawk-cuckoo	*Hierococcyx varius*	Cuculiformes	Cuculidae	R	Insectivorous	Resident	Least Concern
32	Greater Coucal	*Centropus sinensis*	Cuculiformes	Cuculidae	S, W	Omnivorous	Resident	Least Concern
33	Lesser Coucal	*Centropus bengalensis*	Cuculiformes	Cuculidae	W	Omnivorous	Resident	Least Concern

34	Eurasian common Kestral	*Falco thinnunculu*	Falconiformes	Falconidae	W	Insectivorous	Winter migrant	Least Concern
35	Sarus Crane	*Grus antigone*	Gruiformes	Gruidae	R	Omnivorous	Resident	Vulnerable
36	White-breasted Waterhen	*Amaurornis phoenicurus*	Gruiformes	Rallidae	R, S, W	Omnivorous	Summer migrant	Least Concern
37	Ashy Drongo	*Dicrurus leucophaeus*	Passeriformes	Dicruridae	R	Insectivorous	Partial migrant	Least Concern
38	Ashy Prinia	*Prinia socialis*	Passeriformes	Cisticolidae	R	Insectivorous	Resident	Least Concern
39	Asian-pied Starling	*Gracupica contra*	Passeriformes	Sturnidae	R, W	Omnivorous	Resident	Least Concern
40	Barn Swallow	*Hirundo rustica*	Passeriformes	Hirundinidae	R, S	Insectivorous	Summer migrant	Least Concern
41	Baya Weaver	*Ploceus philippinus*	Passeriformes	Ploceidae	S	Omnivorous	Resident	Least Concern
42	Black Drongo	*Dicrurus macrocercus*	Passeriformes	Dicruridae	R, S, W	Insectivorous	Resident	Least Concern
43	Black Hooded Oriole	*Oriolus xanthornus*	Passeriformes	Oriolidae	W	Insectivorous	Resident	Least Concern
44	Black Redstart	*Phoenicurus ochruros*	Passeriformes	Muscicapidae	W	Insectivorous	Resident	Least Concern
45	Blyth's Warbler	*Phylloscopus reguloides*	Passeriformes	Phylloscopidae	W	Insectivorous	Resident	Least Concern

46	Brahminy Starling	*Sturnia pagodarum*	Passeriformes	Sturnidae	W	Omnivorous	Resident	Least Concern
47	Brown rock Chat	*Oenanthe fusca*	Passeriformes	Muscicapidae	W	Insectivorous	Resident	Least Concern
48	Brown Shrike	*Lanius cristatus*	Passeriformes	Laniidae	W	Insectivorous	Winter migrant	Least Concern
49	Chestnut-tailed Starling	*Sturnia malabarica*	Passeriformes	Sturnidae	W	Omnivorous	Resident	Least Concern
50	Cinerous Tit	*Parus major*	Passeriformes	Paridae	W	Insectivorous	Resident	Least Concern
51	Common Chiffchaff	*Phylloscopus collybita*	Passeriformes	Phylloscopidae	W	Omnivorous	Winter migrant	Least Concern
52	Common Lora	*Aegithina tiphia*	Passeriformes	Aegithinidae	W	Insectivorous	Resident	Least Cocern
53	Common Myna	*Acridotheres tristis*	Passeriformes	Sturnidae	R, S, W	Omnivorous	Resident	Least Concern
54	Common Tailorbird	*Orthotomus sutorius*	Passeriformes	Cisticolidae	S, W	Insectivorous	Resident	Least Concern
55	Crimson Sunbird	*Aethopyga siparaja*	Passeriformes	Nectariniidae	W	Insectivorous	Resident	Least Concern
56	Eurasian tree Sparrow	*Passer montanus*	Passeriformes	Passeridae	S, W	Granivorous	Resident	Least Concern
57	Greenish Warbler	*Phylloscopus trochiloides*	Passeriformes	Phylloscopidae	W	Insectivorous	Passage migrant	Least Concern

58	Grey-backed Shrike	*Lanius tephronotus*	Passeriformes	Laniidae	W	Insectivorous	Resident	Least Concern
59	Grey-breasted Prinia	*Prinia hodgsonii*	Passeriformes	Cisticolidae	R	Insectivorous	Resident	Least Concern
60	Grey Bushchat	*Saxicola ferreus*	Passeriformes	Muscicapidae	W	Insectivorous	Resident	Least Concern
61	Grey-headed Canary-flycatcher	*Culicicapa ceylonensis*	Passeriformes	Stenostiridae	W	Insectivorous	Partial migrant	Least Concern
62	Grey Wagtail	*Motacilla cinerea*	Passeriformes	Motacillidae	W	Insectivorous	Resident	Least Concern
63	House Crow	*Corvus splendens*	Passeriformes	Corvidae	R, S, W	Omnivorous	Resident	Least Concern
64	House Sparrow	*Passer domesticus*	Passeriformes	Passeridae	R, S, W	Granivorous	Resident	Least Concern
65	Hume's leaf Warbler	*Phylloscopus humei*	Passeriformes	Phylloscopidae	W	Insectivorous	Passage migrant	Least Concern
66	Indian Golden Oriole	*Oriolus kundoo*	Passeriformes	Oriolidae	S	Omnivorous	Summer migrant	Least Concern
67	Indian Jungle Crow	*Corvus culminatus*	Passeriformes	Corvidae	R, S, W	Omnivorous	Resident	Least Concern
L	Jungle Babbler	*Turdoides striata*	Passeriformes	Leiotrichidae	R, S, W	Omnivorous	Resident	Least Concern
69	Jungle Myna	*Acridotheres fuscus*	Passeriformes	Sturnidae	R, S	Omnivorous	Resident	Least Concern

70	Jungle Prinia	*Prinia sylvatica*	Passeriformes	Cisticolidae	W	Insectivorous	Resident	Least Concern
71	Large Cuckooshrike	*Coracina macei*	Passeriformes	Campephagidae	W	Insectivorous	Resident	Least Concern
72	Long-tailed Shrike	*Lanius schach*	Passeriformes	Laniidae	R, W	Insectivorous	Resident	Least Concern
73	Olive-backed Pipit	*Anthus hodgsoni*	Passeriformes	Motacillidae	W	Omnivorous	Winter migrant	Least Concern
74	Oriental Magpie-robin	*Copsychus saularis*	Passeriformes	Turdidae	R, S, W	Insectivorous	Resident	Least Concern
75	Oriental White-eye	*Zosterops palpebrosus*	Passeriformes	Zosteropidae	W	Insectivorous	Resident	Least Concern
76	Paddyfield Pipit	*Anthus rufulus*	Passeriformes	Motacillidae	R, S, W	Omnivorous	Resident	Least Concern
77	Pied Bushchat	*Saxicola caprata*	Passeriformes	Muscicapidae	R, S, W	Insectivorous	Resident	Least Concern
78	Plain Martin	*Riparia paludicola*	Passeriformes	Hirundinidae	W	Insectivorous	Resident	Least Concern
79	Plain Prinia	*Prinia inornata*	Passeriformes	Cisticolidae	S	Insectivorous	Resident	Least Concern
80	Purple Sunbird	*Cinnyris asiaticus*	Passeriformes	Nectariniidae	S, W	Insectivorous	Resident	Least Concern
81	Red-rumped Swallow	*Cecropis daurica*	Passeriformes	Hirundinidae	W	Insectivorous	Resident	Least Concern
82	Red-vented Bulbul	*Pycnonotus cafer*	Passeriformes	Pycnonotidae	R, S, W	Omnivorous	Resident	Least Concern

83	Red-whiskered Bulbul	*Pycnonotus jocosus*	Passeriformes	Pycnonotidae	R, S, W	Omnivorous	Resident	Least Concern
84	Rufous Treepie	*Dendrocitta vagabunda*	Passeriformes	Corvidae	R, W	Omnivorous	Resident	Least Concern
85	Scaly-breasted Munia	*Lonchura punctulata*	Passeriformes	Estrildidae	R, S, W	Granivorous	Resident	Least Concern
86	Siberian Rubythroat	*Luscinia calliope*	Passeriformes	Muscicapidae	W	Insectivorous	Passage migrant	Least Concern
87	Siberian Stonechat	*Saxicola maurus*	Passeriformes	Muscicapidae	W	Insectivorous	Passage migrant	Least Concern
88	Taiga Flycatcher	*Ficedula albicilla*	Passeriformes	Muscicapidae	W	Insectivorous	Passage migrant	Least Concern
89	Tickell's leaf Warbler	*Phylloscopus affinis*	Passeriformes	Phylloscopidae	W	Insectivorous	Resident	Least Concern
90	White-bellied Drongo	*Dicrurus caerulescens*	Passeriformes	Dicruridae	W	Insectivorous	Resident	Least Concern
91	White-browed Wagtail	*Motacilla maderaspatensis*	Passeriformes	Motacillidae	R, S	Insectivorous	Resident	Least Concern
92	White Wagtail	*Motacilla alba*	Passeriformes	Motacillidae	R, W	Insectivorous	Passage migrant	Least Concern
93	Cattle Egret	*Bubulcus ibis*	Pelecaniformes	Ardeidae	R, S, W	Carnivorous	Resident	Least Concern
94	Great Egret	*Ardea alba*	Pelecaniformes	Ardeidae	R	Carnivorous	Resident	Least Concern

95	Indian Pond Heron	*Ardeola grayii*	Pelecaniformes	Ardeidae	R, W	Carnivorous	Resident	Least Concern
96	Intermediate Egret	*Ardea intermedia*	Pelecaniformes	Ardeidae	R	Carnivorous	Resident	Least Concern
97	Little Egret	*Egretta garzetta*	Pelecaniformes	Ardeidae	R, W	Carnivorous	Resident	Least Concern
98	Purple Heron	*Ardea purpurea*	Pelecaniformes	Ardeidae	R	Carnivorous	Monsoon migrant	Least Concern
99	Red-naped Ibis	*Pseudibis papillosa*	Pelecaniformes	Threskiornithidae	S	Omnivorous	Resident	Least Concern
100	Yellow Bittern	*Ixobrychus sinensis*	Pelecaniformes	Ardeidae	S	Carnivorous	Summer migrant	Least Concern
101	Black-rumped Flameback	*Dinopium benghalense*	Piciformes	Picidae	W	Frugivorous	Resident	Least Concern
102	Blue-throated Barbet	*Psilopogon asiaticus*	Piciformes	Megalaimidae	W	Frugivorous	Resident	Least Concern
103	Coppersmith Barbet	*Psilopogon haemacephalus*	Piciformes	Megalaimidae	W	Frugivorous	Resident	Least Concern
104	Lineated Barbet	*Psilopogon lineatus*	Piciformes	Megalaimidae	W	Omnivorous	Resident	Least Concern
105	Plum-headed Parakeet	*Psittacula cyanocephala*	Psittaciformes	Psittacidae	R, S, W	Frugivorous	Resident	Least Concern
106	Rose-ringed Parakeet	*Psittacula krameri*	Psittaciformes	Psittacidae	R, S, W	Frugivorous	Resident	Least Concern

107	Jungle Owlet	*Glaucidium radiatum*	Strigiformes	Strigidae	W	Carnivorous	Resident	Least Concern
108	Spotted Owlet	*Athene brama*	Strigiformes	Strigidae	W	Carnivorous	Resident	Least Concern
109	Great Cormorant	*Phalacrocorax carbo*	Suliformes	Phalacrocoracidae	W	Carnivorous	Winter migrant	Least Concern
110	Little Cormorant	*Phalacrocorax niger*	Suliformes	Phalacrocoracidae	R, W	Carnivorous	Passage migrant	Least Concern

PHOTO PLATES

Lesser Adjutant

Asian Openbill

Little Egret

Asian-pied Starling

White-throated Kingfisher

Paddyfield Pipit

Sarus Crane

Asian Wollyneck

Red-naped Ibis

Scaly-breasted Munia

Long-tailed Shrike

Plum-headed Parakeet

Common Stonechat

Ashy Prinia

White-browed Wagtail

Red-wattled Lapwing

Lineated Barbet

Black Drongo