

**BIRD SPECIES DIVERSITY AND COMPOSITION IN BANAGANGA
RIVER BASIN, LUMBINI, NEPAL**



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Submitted To

Central Department of Zoology
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Kirtipur, Kathmandu, 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 for any degree. All sources of information have been acknowledged explicitly by reference to the author (s) or institution (s).

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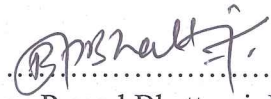
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RECOMMENDATION

This is to recommend that the thesis entitled “**BIRDS SPECIES DIVERSITY AND COMPOSITION IN BANGANGA RIVER BASIN, LUMBINI, NEPAL**” has been carried out by **Mrs. Janaki Kunwar** 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 our knowledge, this thesis work has not been submitted for any other degree in any institution.

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CERTIFICATE OF ACCEPTANCE

This thesis submitted by Mrs. Janaki Kunwar entitled “**BIRD SPECIES DIVERSITY AND COMPOSITION OF BIRDS IN BANGANGA RIVER BASIN, LUMBINI, 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

Abbreviated form	Details of abbreviations
CCA	Canonical Correspondence Analysis
DD	Data Deficient
DCA	Detrended Correspondence Analysis
EN	Endangered
GLM	Generalized Linear Model
GPS	Global Positioning System
IUCN	International Union for Conservation of Nature
LC	Least Concern
NRBD	National Redlist Bird Databook
NT	Nationally Threatened
RE	Regionally Extinct
VU	Vulnerable

ABSTRACT

Birds play a key role in ecological balance of environment. Studying bird diversity and composition of birds helps in biodiversity conservation. The purpose of this research was to explore the bird species diversity and composition in the Banganga River Basin, Lumbini, Nepal. The Banganga River Basin consists of different habitat types like forest, agricultural land, and wetlands. A point count method was used for the bird survey. Birds were surveyed within 42 points on every 1 Km distance and from a fixed point in the center, birds data and environmental parameters were recorded within 250-meter radius. Altogether, 1467 individuals of birds belonging to 127 species from 19 orders and 44 families were recorded. The Shannon-Weiner diversity index was found to be 4.14, and the evenness index was recorded as 0.49. The diversity of avifauna was higher in the winter season than it was in the summer season. The highest number of species recorded was from the order Passeriformes (n=59). A total of 12 threatened species were found in the study area. Among the total bird species recorded, more were residential birds followed by winter, summer, passage, and monsoon visitor birds. Carnivores, granivores, and omnivores showed significant relationships with different habitat types, while frugivores did not show any relationship with habitat types. This study concluded that Banganga River Basin is rich in avifauna diversity due to its complex, heterogeneous habitats, bird diversity and composition can be affected by the habitat heterogeneity and environmental factors.

1. INTRODUCTION

1.1 Background

Nepal is rich in biodiversity and has a significant share of global biodiversity (Paudel et al. 2011, Poudel et al. 2021). Due to climatic variation, geography and physiography, Nepal is rich in avifauna, having 891 species, i.e., 8.87% of the global species (DNPWC 2019, Bastola et al. 2022). Among the recorded species in Nepal, 168 species have been counted as nationally threatened (NT), of which 64 species are Critically Endangered, 44 endangered (EN), 64 Vulnerable (VU) and 22 are Data Deficient (DD) (Inskipp et al. 2016). In total, 43 bird species are globally threatened, nine Critically Endangered, nine Endangered, eight Regionally Extinct (RE) species in Nepal (Inskipp et al. 2016). The only endemic bird of Nepal is the Spiny babbler (*Acanthoptila nipalensis*).

The primary habitats of birds are mountains, forests, wetlands, and grassland (Nepal 2011). Wetland provides home to a large group of migratory and resident bird species because it has a huge amount of nutritional value and productivity (Paracuellos 2006). About 77% of Nepal's breeding birds are found in forests and bushes (Grimmett et al. 2000). Most of the birds that are residents of Nepal (around 550 species among 886 species) are seasonal altitudinal migrants, and these species come down for wintering at low altitudes and breed at higher altitudes in the mountainous region (Inskipp et al. 2016).

The river corridor plays a vital role in the conservation and protection of birds and supplies appropriate accommodation for breeding and roosting of bird species (Maciusik et al. 2010). The river system acts as a riparian zone, providing vegetation and debris with enough food for the species' existence (Rosenberg et al. 1997). The diversity of birds in an area can be largely affected by the river corridor (Bennett et al. 2014); thus, it acts as a vital area for the conservation of the species (Miller et al. 1998). The richness and diversity of bird species can also be correlated with the distribution of field margins, agricultural systems, types of vegetation, and climatic conditions (Basnet et al. 2016).

Birds play a vital role in the food chain and help to maintain ecological balance, which means they also indicate the environmental level of pollution (Bibi & Ali 2013). Exploration of the status of the avian species with respect to their diversity and abundance can guide in the regional and landscape levels management (Canterbury et al. 2000, Neupane et al. 2020). They have important ecological roles in forest and agricultural

ecosystems, mainly in pollination, controlling pests, and seed dissemination (Whelan et al. 2008, Mulwa et al. 2012, Basnet et al. 2016).

To improve effectiveness in the maintenance of bird diversity, knowledge of feeding guilds is necessary (Li et al. 2019). Bird diversity can be studied with respect to their feeding guilds, which play a vital role in understanding the complexity of an ecosystem and furnishing information about habitat types (Azman et al. 2011). Due to variations in vegetation cover, bird distribution and feeding guilds may be affected (Zhang et al. 2013, Hu et al. 2018).

Bird species richness and composition can be influenced by the seasonal change in the climate (Blake & Loiselle 2000, Williams et al. 2010). Factors like soil type, elevation, slope aspects, and vegetation cover, as well as biotic gradients such as predation, competition, and plant cover heterogeneity, greatly affects the diversity of bird species in any particular place (Sheta et al. 2011). Seasonal change in the climate acts as an important characteristic of mountainous ecosystems, which influence the temporal dynamics of bird species richness and composition (Poudel et al. 2021). Bird community composition was strongly influenced by habitat loss at the patch and landscape scale, species richness remained largely unaffected in Atlantic Forest of Brazil (Banks-Leite et al. 2012).

1.2 Objectives

1.2.1 General objective

1. The main objective of this study was to investigate the bird species diversity and composition in Banaganga River Basin, Lumbini, Nepal.

1.2.2 Specific objectives

1. To determine bird diversity in Banganga River Basin, Lumbini, Nepal.
2. To evaluate bird species composition in the study area.

1.3 Rationale of the study

Gathering information on avifauna diversity and composition is important to know the health status of the landscapes (Neupane et al. 2020). The Banganga River is one of the main river of Kapilvastu and Arghakhanchi districts and the area near the river is facing tremendous pressure of developmental works of roads, walking trails and housing. Knowing the richness and composition of the bird species found in the Banganga River

basin can serve as a foundation for the further research and efforts to conserve the region's threatened and locally endemic species. Thus, this study helps to explore the factors affecting bird diversity and composition of birds in Banganga River Basin.

2. LITERATURE REVIEW

2.1 Bird diversity

The structure of the bird community acts as a function of habitat heterogeneity. The research conducted by Pandey et al. (2021) in Mardi Himal, Central Nepal, recorded 673 individuals out of 112 bird species from 35 families under 13 orders and concluded that the composition of the bird community differs with the types of habitats and their feeding guilds, which is the most important factor (Pandey et al. 2021). Bastola et al. (2022) conducted research on environmental factors influencing bird diversity in Kahundanda Hillscape, Pokhara, Nepal and reported 101 total species of 18 orders and 41 families. They revealed that environmental factors like habitat types, human disturbance and closeness to water bodies are important for the conservation of birds in human-dominated areas (Bastola et al. 2022).

Bird diversity can be greatly affected by the vegetation composition, altitude and climate and seasonality. Dangaura et al. (2020) conducted out a study in the avian richness of the Basanta Protected Forest of far-western lowland Nepal, in which 381 bird species were recorded from 78 families and 19 orders. Similarly, (Neupane et al. 2020) conducted research on bird diversity in Kaligandaki River Basin, Annapurna Conservation Area, Nepal, and revealed a total of 1036 individuals of 120 bird species from 33 families and eight orders and concluded that study of all season is necessary to know the diversity of birds.

Mahata & Sharma (2023) carried out research on bird diversity in the Bagmati River basin and factors affecting their abundance, in which 67 bird species of 11 orders and 28 families were recorded. The study shows that the area is rich in biodiversity, and factors affecting its abundance are the presence of trees, distance to water sources, roads, open land, settlement, temperature, and elevation (Mahata & Sharma 2023). Adhikari et al. (2018) conducted a study on water bird diversity and their conservation threats in Barandabhar corridor forest in Chitwan District, Nepal, in which 3664 individuals of 54 species, 11 orders and 13 families were recorded and concluded that annual flooding, human disturbance, habitat loss, water quality decline, and chemical pollution are the major threats of water birds. Ghimire et al. (2021) carried out research on bird diversity at different altitudes in the Central Nepal Himalayas, in which a total of 1331 individuals belonging to

82 species and 24 families were recorded. This study concluded that sampled localities position, altitude, habitat used, and various environmental gradients are major determinants for bird diversity (Ghimire et al. 2021).

Poudel et al. (2021) conducted a study on factors affecting bird species richness and composition in the Tibrekot Community Forest of Kaski District and recorded 166 bird species. This study shows that the major influencing factor for bird species was the season (Poudel et al. 2021). Additionally, Basnet et al. (2016) carried out research at low altitudes as hotspots of bird diversity in the hilly region of the Central Himalayas, Nepal, and recorded 6522 bird individuals, 146 species, 77 genera, and 23 families, concluding that altitude is the major factor determining bird species richness and composition.

Avifauna diversity is sensitive to the change in the environmental factors. Adhikari et al. (2019) conducted research on factors affecting bird diversity and distribution of threatened birds in Chitwan National Park of Nepal and reported a total of 437 individuals of globally threatened birds belonging to 19 species, 9 families, and 8 orders, concluding that human disturbance is the major influencing factor. Nepali (2019) carried out a study on seasonal variation of bird diversity in Dhaneshwor Baikiwa Community Forest in Kavrepalanchowk District, in which 108 bird species of 15 orders and 43 families were reported. This study revealed that habitat type, distance to the nearest settlement, fodder collection, livestock grazing, and human trails affect bird diversity (Nepali 2019). Kunwar et al. (2023) conducted research on topic bird diversity along an elevational gradient in Shivapuri Nagarjun National Park, Nepal, and reported 130 species from 40 families and 12 orders. This study concluded that environmental factors and elevational gradients with complex habitats are responsible for shaping bird diversity patterns (Kunwar et al. 2023).

2.2 Species composition

Species composition can be determined by the types of vegetation cover, habitat, and environmental factors (Fayolle et al. 2014). Nepal consists of a broad range of habitat types, such as tropical, subtropical, temperate, subalpine and alpine zones (Inskipp 1989, Shah 2021). Birds utilize various kinds of habitats, such as forest, grassland, and wetland, for their survival. Based on habitat or vegetation cover use, birds can be classified into forest specialists, wetland specialists, and lowland grassland specialists (Gyawali 2021).

The higher number of species of birds are inhibited in forests, followed by wetlands, grasslands, agricultural land, and human settlements (DNPWC 2011). Forests support a higher occurrence of birds due to their complex structure of vegetation as compared to farmlands (Bett et al. 2016). However, sometimes it may vary with respect to season; a higher number of bird species was reported in farmland during dry seasons and in forest in the wet seasons in North Nandi Forest, Kenya (Bett et al. 2016).

Numerous studies are carried out in Kapilvastu District on the bird diversity, but only in the Jagdishpur Reservoir, and the most recent study was carried out by Bhusal et al. (2020) on Diversity and abundance of winter wetlands birds and Poudel (2019) on Diversity and Conservation Status of Wetland Birds. Similarly, in Arghakhanchi District, research has been carried out only in the Chure Mountain Range, and the research was conducted by Pokhrel (2013) on Chure forestry conservation and management plan and in Gherabhir by Bhusal et al. (2023) on Population and Productivity of the Critically Endangered White-Rumped Vulture (*Gyps bengalensis*). However, extensive assessment of avian diversity, their abundance and relation with environmental factors around Banganga River is still lacking. So, this study tries to fill this gap.

3. MATERIALS AND METHODS

3.1 Study area

The study area was the Banaganga River basin in Kapilvastu and Arghakhanchi districts. The origin of the Banganga River is the hills of Siwalik Himalaya, and after following a 100-kilometer distance in Nepal, it reaches Siddharthnagar district of eastern Uttar Pradesh (Prakash 2016). Arghakhanchi lies in between 27° 45' to 28 ° 06' N latitude and 80 ° 54' to 83 ° 23' E longitude and has an area of 1193 km² (CBS 2022). The climatic conditions of the district range from tropical to temperate, and most of the region lies in subtropical areas. About 68% of total area is covered by Mahabharata range, and the rest by Siwalik Hills (APEC, 2016). The average minimum and maximum temperatures of the study area lie between 25 to 27 °C in May-July and 5 to 7 °C in January (DHM, 2022). The elevational range of the district varies from 305m to 2515m above sea level. Arghakhanchi District has a complex topography, variation in climate and other physical features that make this district rich in habitats with plants like *Pinus roxburghii*, *Castanopsis indica*, *Shorea robusta*, *Schima wallichii* etc. with tropical, sub-tropical and temperate forest types. Similarly, Kapilvastu district covers approximately an area of 1,738 km². The summer is hot and humid with temperatures above 41 °C, and winters are cold and humid. It has an altitude range of 93 to 1,491 meters above sea level. Geographically, Rupandehi District lies in the east, Dang in the northwest, Arghakhanchi District in the north, Balrampur district with in Awadh Region of Uttar Pradesh, India, in the west, and Siddharthnagar district in the Purvanchal Region of Uttar Pradesh, India, in the south.

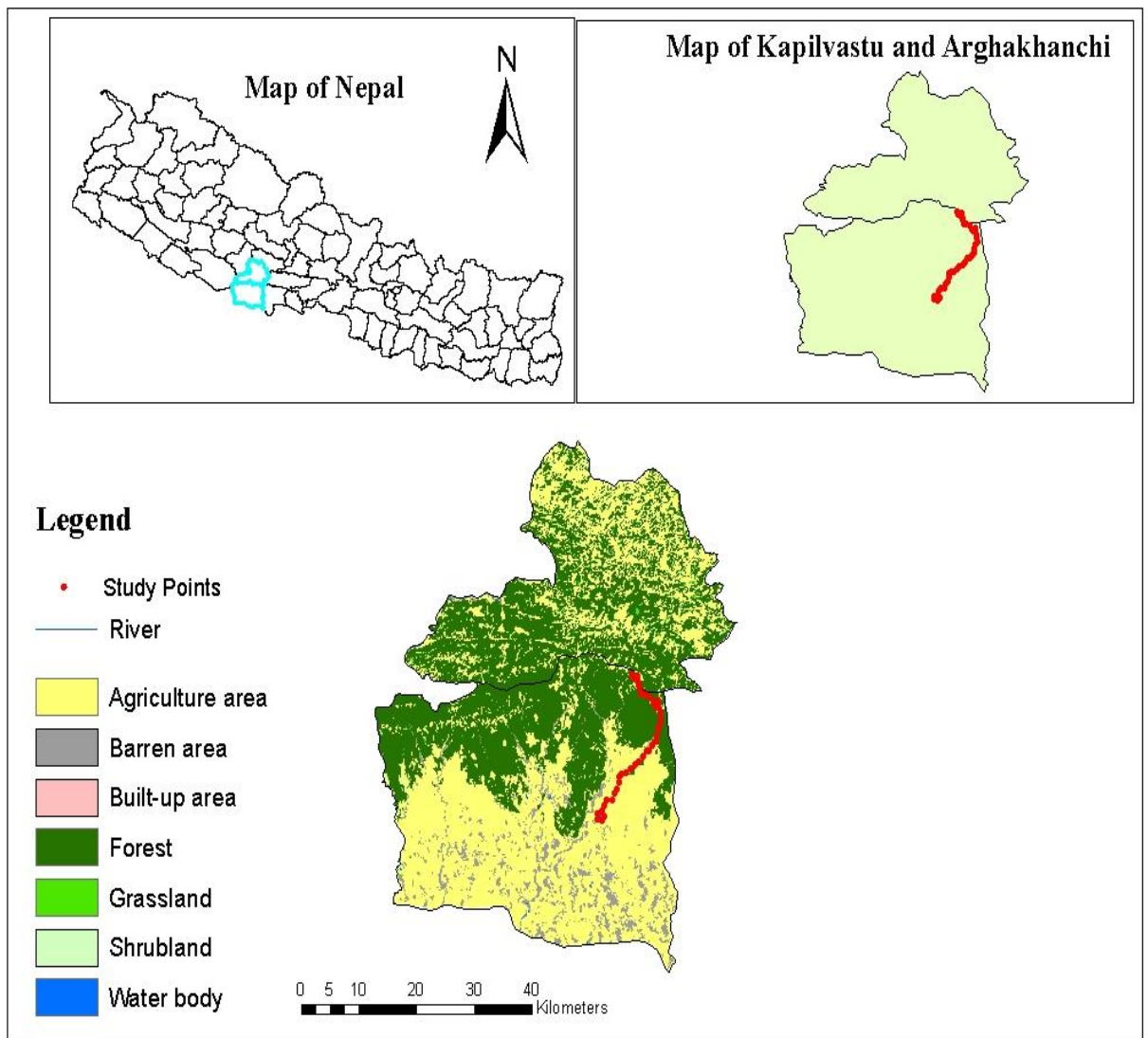


Figure 1. Map of the study area showing study points

3.2 Materials

1. GPS (Garmin eTrex 10)
2. Camera (Nikon D5600 with 300 mm Zoom Lens)
3. Binoculars: Bushnell Falcon 10x50
4. Field guidebook “Birds of Nepal” (Grimmett et al. 2016)
5. Record sheets
6. Map of the study area
7. Rangefinder

3.3 Data collection

3.3.1 Bird observation

Prior to beginning the real research, a preliminary field survey was carried out to identify the probable sighting locations by speaking with local people, visiting potential places, and reading pertinent literature. Sampling of birds was done at different habitats, including the river basin, which covers forests, settlements, farmlands, and wetlands. Habitats were categorized based on presence of vegetation.

For the observation of the bird, the point count method was used to record the number of species in two seasons, summer and winter (Bibby et al. 2000, Sarkar et al. 2009). This method is used to estimate the population density, trend of population and preference of habitat, mainly in birds (Johnson 1995). Birds were surveyed within 42 points on every 1 Km distance and from a fixed point in the center, birds were recorded within 250-meter radius. A digital rangefinder was used to measure the radius of 250 m. The entire study area was along the Banaganga River basin, which is about 41 km in length. The point count sites were placed approximately every one kilometer. The length of the time spent at each point was 20 minutes. The birds were observed directly using binoculars, and photographs were taken using a Nikon D5600 camera with 300 mm Zoom Lens whenever possible for identification and documentation. For the identification of birds, the field guide – ‘Birds of Nepal’ (Grimmett et al. 2016) was used. Bird observation was done early in the morning from 7:00 to 11:00 during the summer (May) and winter (January and February) seasons. A total of 20 days were spent in the field, including 10 days in the summer and 10 days in the winter.

3.3.2 Environmental Variables

The entire study area consists of three different habitats: forest, water, and agricultural land. Variables like distance to the nearest forest, water resource, settlement, and agricultural land were taken at each point. All these variables were estimated during the field visit and confirmed by aerial distance using Google Earth Pro. To extract the climatic data of mean annual precipitation and mean annual temperature for the coordinates of bird count locations with a resolution of 1 Km x 1 Km, the WorldClim database was used.

Table 1. Habitat used and code.

Variables	Details	Code
Forest	Areas dominated by dense trees with mixed vegetation types such as Sal, Sissoo etc.	Frst
Wetland	Areas consisting of marshes, swamps, rivers and saturated land.	Wtr
Agricultural land	Areas dominated by production of crops and rearing of livestock.	Aglnd
Temperature	Extracted from the Worldclim database.	Temp
Precipitation	Extracted from the Worldclim database.	Preci
Distance to the nearest forest	Euclidean distance measured from sampling point to the nearest forest by using Google Earth Pro.	DF
Distance to the nearest settlement	Euclidean distance measured from sampling point to the nearest settlement by using Google Earth Pro.	DS
Distance to the nearest agricultural land	Euclidean distance measured from sampling point to the nearest farmland by using Google Earth Pro.	DA
Distance to the nearest waterbody	Euclidean distance measured from sampling point to the nearest water source by using Google Earth Pro.	DW

3.4 Data Analysis

Data obtained from the field was entered and organized in Microsoft Excel 2013 for analysis. The different indices of species diversity were calculated by using PAST v 4.03 (Hammer et al. 2001).

Shannon-Wiener diversity and the evenness index were calculated from the collected data. Additionally, birds were classified into different residential statuses on the basis of their movement in different seasons, i.e., summer visitor, winter visitor, monsoon visitor, passage migrants, and residential (Grimmett et al. 2016, Dangaura et al. 2020). Bird species

were also classified into omnivores (feeding on both plants and animals), herbivores (feeding on plants' leaves, stems, roots, and rhizomes), carnivores (feeding on amphibians, reptiles, mammals, and fish), granivores (feeding on grains and seeds), insectivores (feeding on insects, spiders, and worms), frugivores (feeding on fruits and berries), and nectarivores (feeding on the nectar of flowers) (Inskipp et al. 2016).

Shannon-Wiener diversity (H'):

Shannon-Wiener diversity is a dominance index as it provides more weight to common or dominant species and a few rare species with fewer numbers will not affect diversity (Simpson 1949).

It can be calculated by using formula:

$$H' = - [\sum P_i \ln P_i]$$

Where, H' = Shannon's index of diversity

P_i= the proportion of individuals in the ith species

n_i= Importance value for each species (number of individuals)

N= Total importance value (Total number of individuals)

Evenness index (E):

Evenness is a statistical tool which is used to compare the actual diversity value to the maximum possible diversity by using evenness.

It can be calculated by using formula:

$$E = H' / \log S$$

Where = Shannon's index of diversity

S = Species richness is the total number of species

The variables influencing diversity and composition of avifaunal species were analyzed using multivariate analysis, i.e., Generalized Linear Model (GLM) on R software (Team 2021). A multicollinearity test was done for all the environmental variables. Distance to the nearest settlement, distance to the nearest forest, distance to the nearest water body and distance to the nearest agricultural land, elevation, temperature, and precipitation were not highly correlated ($r < 7$), so these variables were used for further analysis. This study used

the Shapiro-Wilk test with the help of 'lme4' package on R software before GLM to know whether the response variables were normally distributed or not. Bird species recorded in the study area were highly dispersed with $P < 0.05$. Therefore, bird richness as a response variable was used for further GLM, and Poisson regression was done.

Canonical Correspondence Analysis (CCA) was performed by using CANOCO v4.5 (Ter Braak & Smilauer 1998) to analyze the association between bird species and different habitat types. Firstly, Detrended Correspondence Analysis (DCA) was done to determine the appropriate analysis (Correa-Metrio et al. 2014). During analysis, the gradient length was higher than three, so CCA analysis was performed. Habitat type was considered as independent variable, while species data with different feeding guilds were considered as dependent variable. The Monte-Carlo permutation test was done by using 499 permutations, and the result was presented in the form of biplot. While doing the analysis, the feeding guild (herbivores and nectivores) was discarded if there were less than three species due to lower statistical power (Weiher et al. 1998, Gyawali 2021).

4. RESULTS

4.1 Bird diversity

A total of 1467 individuals of birds belonging to 127 species from 19 orders and 44 families were recorded during the field visit. Order Passeriformes were found to be the most abundant with fifty-nine species followed by Charadriiformes (ten), Accipitriformes (eight), Gruiformes, Pelecaniformes and Coraciiformes (six from each order), Anseriformes and Otidiformes (five from each order), Columbiformes (four), Cuculiformes, Strigiformes, Piciformes and Psittaciformes (three from each order) and lastly Podicipediformes, Caprimulgiformes, Suliformes, Bucerotiformes, Galliformes and Cariamiformes consist of only one species from each order (Figure 2). Among all the families recorded the highest number of species is found in Muscicapidae which accounts for 11 species.

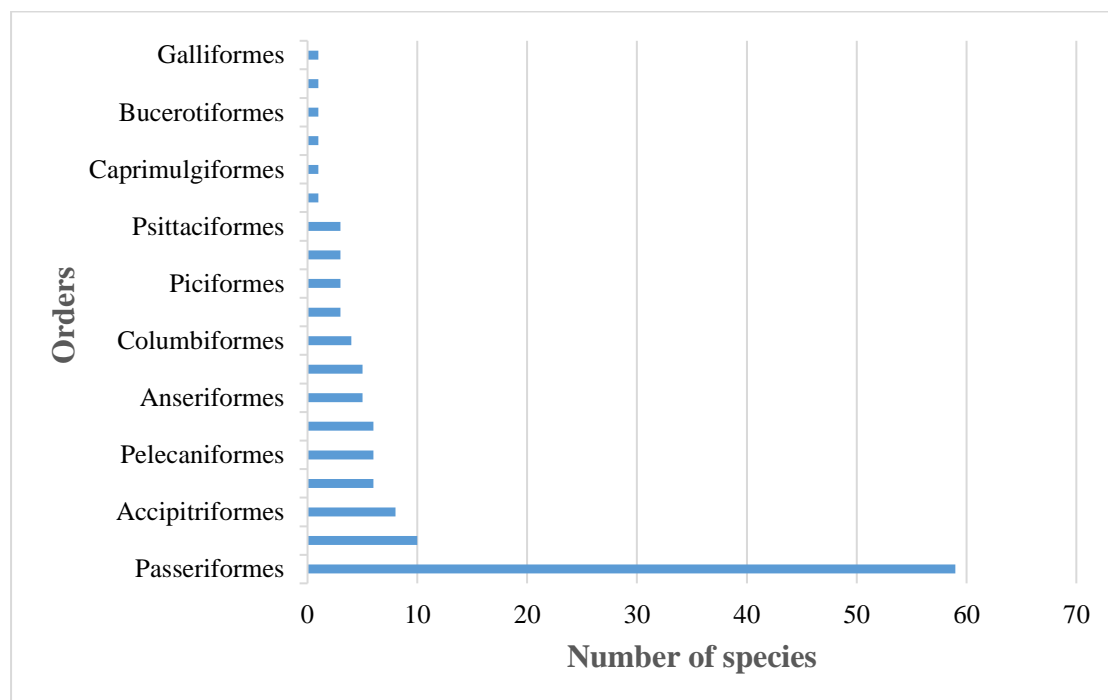


Figure 2. Number of bird species with different orders

From the collected data based on migratory status, 79% of bird species were residential (R), 13% were winter visitors (WV), 5% were summer visitors (SV), 2% were passage migrants (PM) and 1% were monsoon visitors. The number of residential birds was higher

in summer (n = 76) while in winter (66) only. Two passage migrants, Black-winged Stilt and Marsh Sandpiper, and one monsoon visitor, Watercock were recorded during the study.

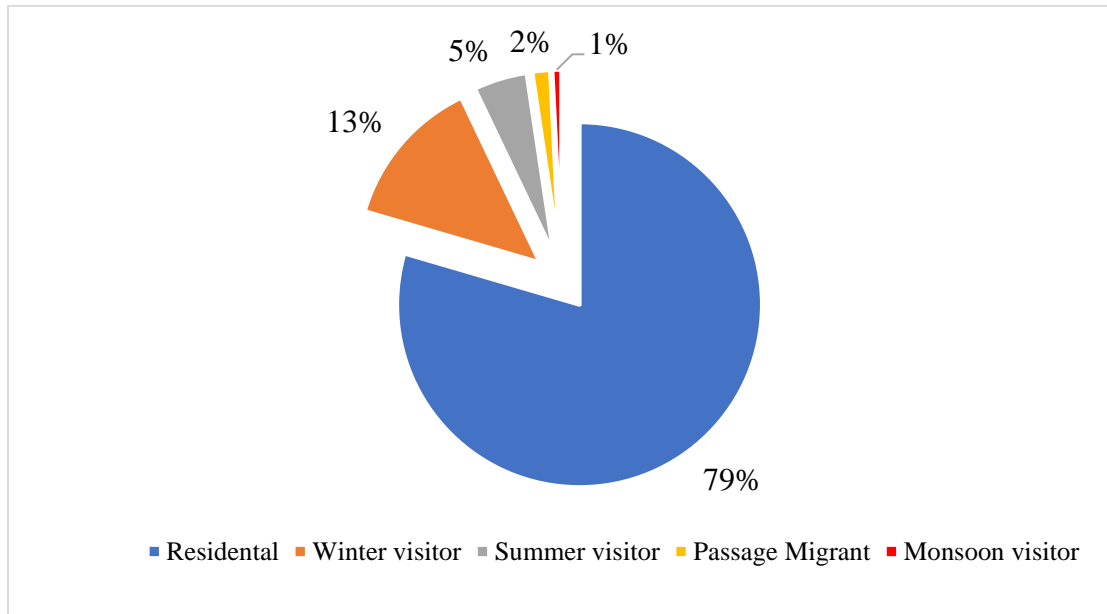


Figure 3. Migratory status of birds in the study area

Among all the recorded bird species Ferruginous Duck (*Aythya nyroca*) and Himalayan Vulture (*Gyps himalayensis*) were found in winter season and Alexandrine Parakeet (*Psittacula eupatria*) was in summer, and all three are Near Threatened (NT) species in IUCN Red List Category. Similarly, Common Pochard (*Aythya ferina*) was found in winter, Sarus Crane (*Antigone antigone*) and Lesser Adjutant (*Leptoptilos javanicus*) were found in both seasons and are Vulnerable (VU) species in both the IUCN Red List Category and National Red List Series. Common Pochard and Asian Woollyneck were found in summer, and Alexandrine Parakeet are NT species in the National Red List Series. Asian Openbill (*Anastomus oscitans*), Black Stork (*Ciconia nigra*) and Pheasant-tailed Jacana (*Hydrophasianus chirurgus*) were found in summer, and Brown Fish-owl (*Ketupa zeylonensis*), Himalayan Vulture and Little Bunting (*Emberiza pusilla*) were found in winter, and all are VU species in the National Red List Series (Table 3 and Figure 4)

Table 2. Threatened status of bird species in Banganga River Basin, Lumbini, Nepal according to IUCN Red List Category and National Red List Series (NRDB) 2021. Note: VU= Vulnerable, NT= Near Threatened, LC= Least Concern, Wtlnd=Wetland, Aglnd=Agricultural land and Frst= Forest.

S.N.	Name	Scientific Name	Order	Family	IUCN	NRDB	Habitat
1	Common Pochard	<i>Aythya ferina</i>	Anseriformes	Anatidae	VU	NT	Wtlnd
2	Ferruginous Duck	<i>Aythya nyroca</i>	Anseriformes	Anatidae	NT	VU	Wtlnd
3	Sarus Crane	<i>Antigone antigone</i>	Gruiformes	Rallidae	VU	VU	Aglnd
4	Lesser Adjutant	<i>Leptoptilos javanicus</i>	Otidiformes	Ciconiidae	VU	VU	Aglnd
5	Asian Openbill	<i>Anastomus oscitans</i>	Otidiformes	Ciconiidae	LC	VU	Aglnd
6	Black Stork	<i>Ciconia nigra</i>	Otidiformes	Ciconiidae	LC	VU	Aglnd
7	Asian Woollyneck	<i>Ciconia episcopus</i>	Otidiformes	Ciconiidae	VU	NT	Aglnd
8	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i>	Charadriiformes	Jacanidae	LC	VU	Wtlnd
9	Brown Fish-owl	<i>Ketupa zeylonensis</i>	Strigiformes	Strigidae	LC	VU	Frst
10	Himalayan Vulture	<i>Gyps himalayensis</i>	Accipitriformes	Accipitridae	NT	VU	Frst
11	Alexandrine Parakeet	<i>Psittacula eupatria</i>	Psittaciformes	Psittacidae	NT	NT	Frst
12	Little Bunting	<i>Emberiza pusilla</i>	Passeriformes	Emberizidae	LC	VU	Aglnd

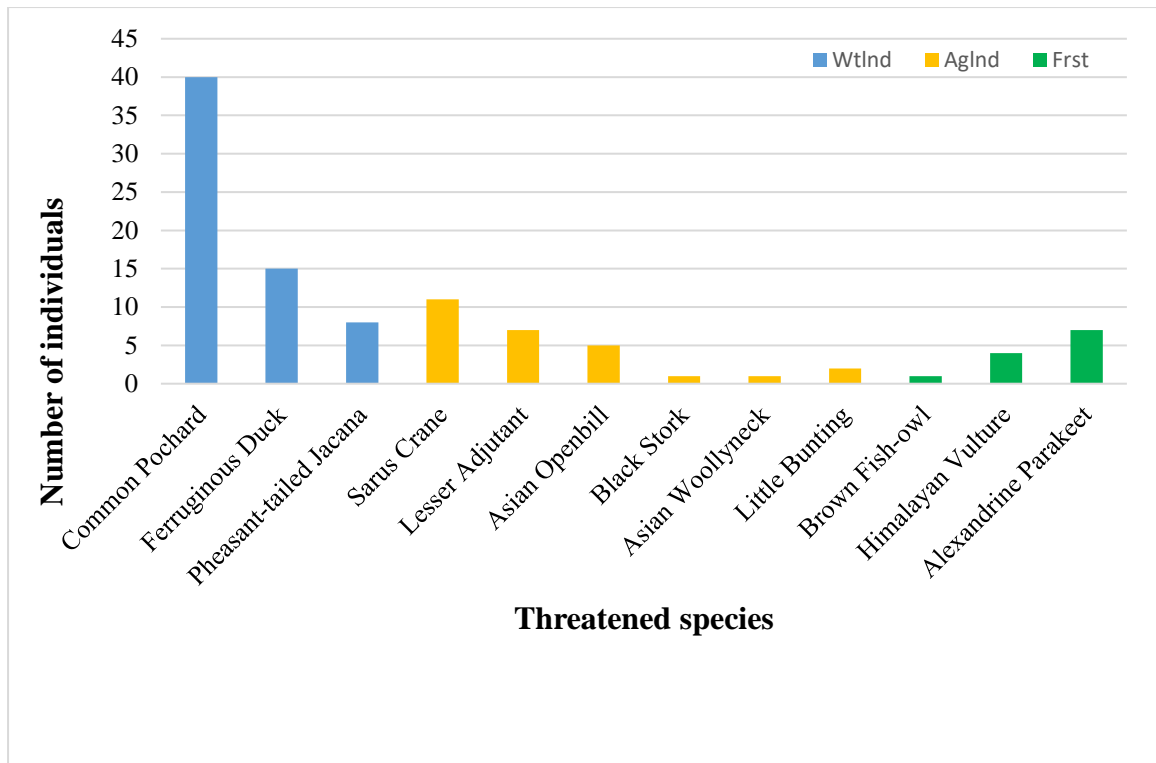


Figure 4. Threatened species number in different habitat

Omnivores were recorded the highest i.e., 51 and Herbivores (Eurasian Wigeon) and Nectivores (Purple Sunbird) were recorded the least i.e., one species of each. Similarly, Carnivores (38), Insectivores (26), Frugivores (6) and Granivores (4) species were found.

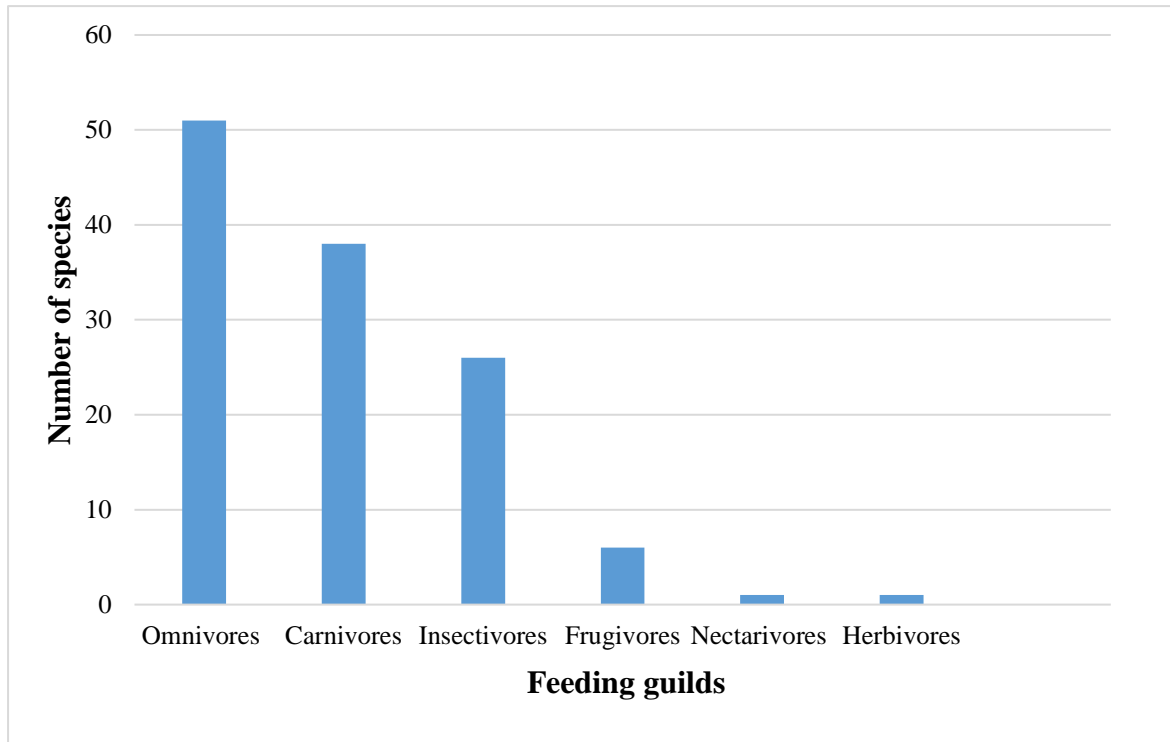


Figure 5. Number of species of different feeding guilds

The overall Shannon-Weiner diversity index was found to be 4.15 and the evenness index was recorded as 0.49. The analysis of observed data shows that the winter season had more diverse avifauna species ($H' = 3.88$) than summer ($H' = 3.75$). In the same way, birds are more evenly distributed in winter season (0.49) than the summer ($E = 0.53$).

Table 3. Seasonal bird species richness, diversity index, and evenness

Season	Species richness	Shannon- Wiener diversity index	Evenness
Summer	85	3.75	0.49
Winter	92	3.88	0.53
Overall	127	4.15	0.49

Out of 19 orders, 15 were recorded in both the winter and summer seasons. Galliformes order was only recorded in summer season, while three orders (Podicipediformes, Caprimulgiformes and Cariamiformes) were only recorded in winter season. Order Passeriformes and Anseriformes were consisted the highest number of individuals in the

winter, similarly, Passeriformes and Coriamiformes were consisted of the highest in the summer season (Figure 5).

Species richness was comparatively higher in winter (n = 92) and lower in summer (n = 85). The top five most abundant species in winter season are Himalayan Bulbul (*Pycnonotus leucogenys*), Red-crested Pochard (*Netta rufina*), Common Pochard (*Aythya ferina*), Rock Dove (*Columba livia*), Jungle Babbler (*Turdoides striata*) and Plum-headed Parakeet (*Psittacula cyanocephala*). In summer season the most abundant species are Asian Green Bee-eater (*Merops orientalis*), Lesser Whistling-duck (*Dendrocygna javanica*), Blue-tailed Bee-eater (*Merops philippinus*), House Sparrow (*Passer domesticus*) and Rock Dove (*Columba livia*). Similarly, the species that are abundant in both seasons are Rock Dove (*Columba livia*), Jungle Babbler (*Turdoides striata*), Little Cormorant (*Microcarbo niger*), Red-wattled Lapwing (*Vanellus indicus*), Red-whiskered Bulbul (*Pycnonotus jocosus*).

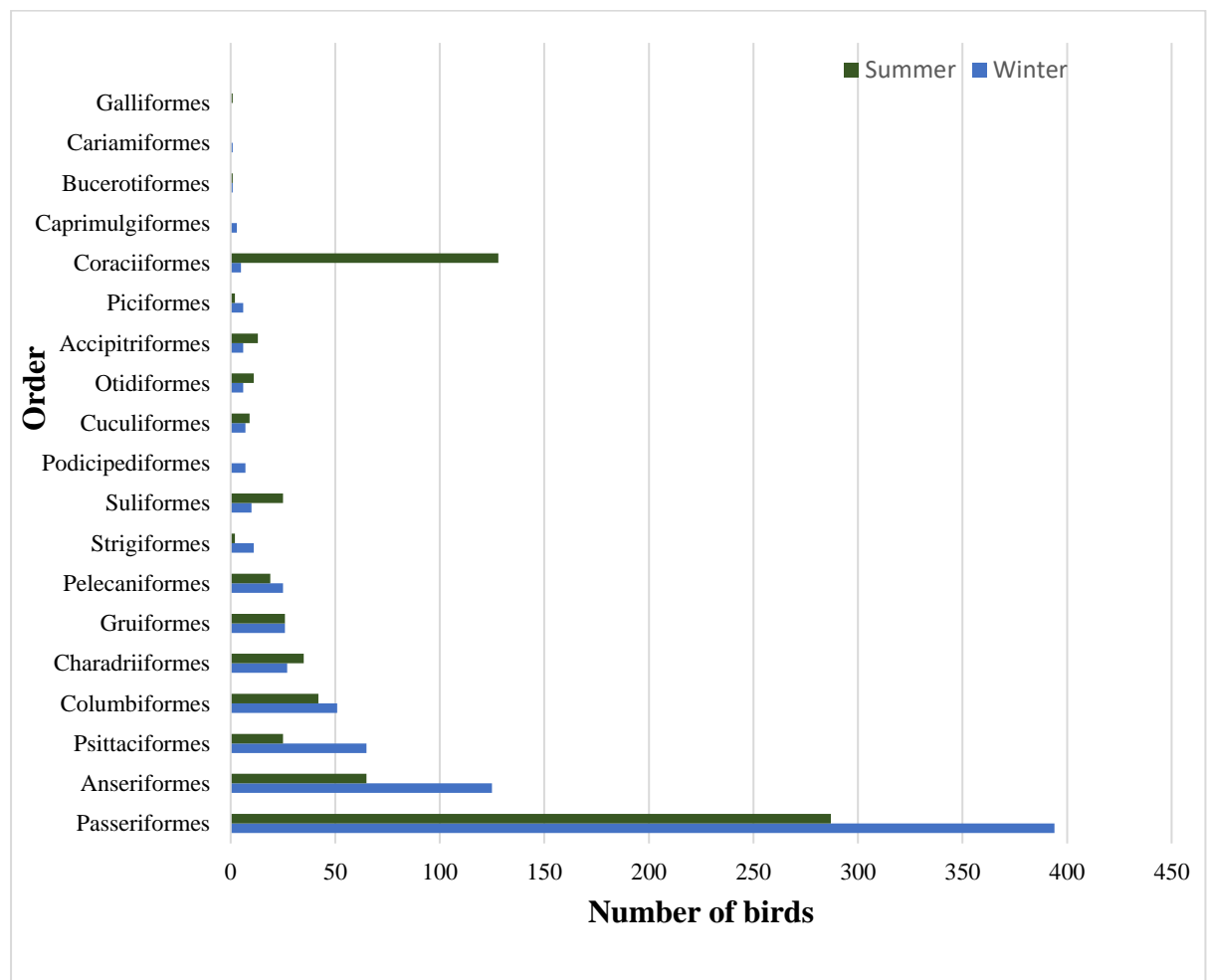


Figure 6. Number of birds by order in different season

4.2 Species composition

The Generalized Linear Model shows a varying relationship between environmental variables and bird species richness. Distance to settlement and temperature shows positive association with species richness and distance to water, while distance to agricultural land and precipitation shows negative association with the species richness. Elevation and distance to forest did not show any significant influence on species richness.

Table 4. Generalized linear model (GLM) with Poisson distribution showing the effects of environmental factors on species richness.

Parameters	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-2.32183	4.4524541	-0.521	0.60204
DF	2.36E-05	7.02E-05	0.337	0.7364
DW	-0.00102	0.0001249	-8.186	<0.0001 ***
DA	-0.00128	0.0002167	-5.916	<0.0001 ***
DS	0.00221	0.0002676	8.259	< 0.0001 ***
Elevation	0.000471	0.0008818	0.534	0.59317
Precipi	-0.00522	0.0007018	-7.438	<0.0001 ***
Temp	0.563677	0.1763799	3.196	0.00139 **

Significant codes 0 '***' 0.001 '**' 0.01 '*'

4.2.1 Effect of habitat on the feeding guild composition

The feeding guild composition of the species were tested for the habitat, forest, wetland, and agricultural land. The Monte-Carlo permutation test of significance of all the canonical axes shows the significant preference of the carnivore's species (Trace= 1.346, F-ratio= 1.586, p= 0.0020) to different habitat types (Figure 6). Carnivores were mostly associated with forests. In a similar way, granivores also show significant preference (Trace=1.424, F- ratio= 2.862, p=0.0240) to different habitat types (Figure 7). Granivores were mostly associated with agricultural land. Omnivores (Trace= 1.221, F-ratio= 1.923, Trace p= 0.0020) illustrate the significant preference to different habitat types (Figure 8)9. Omnivores were associated with wetlands. However, the Monte-Carlo permutation test of significance of all canonical axes illustrates no significance relationship of insectivores.

(Trace=0.695, F-ratio= 0.804, p=0.7940) and frugivores (Trace= 0.897, F-ratio= 0.803, p= 0.6280) to habitat types (Figure 9 and 10). Besides this, herbivores and nectivores were eliminated because they consist of only one species of each, which is not sufficient for statistical analysis.

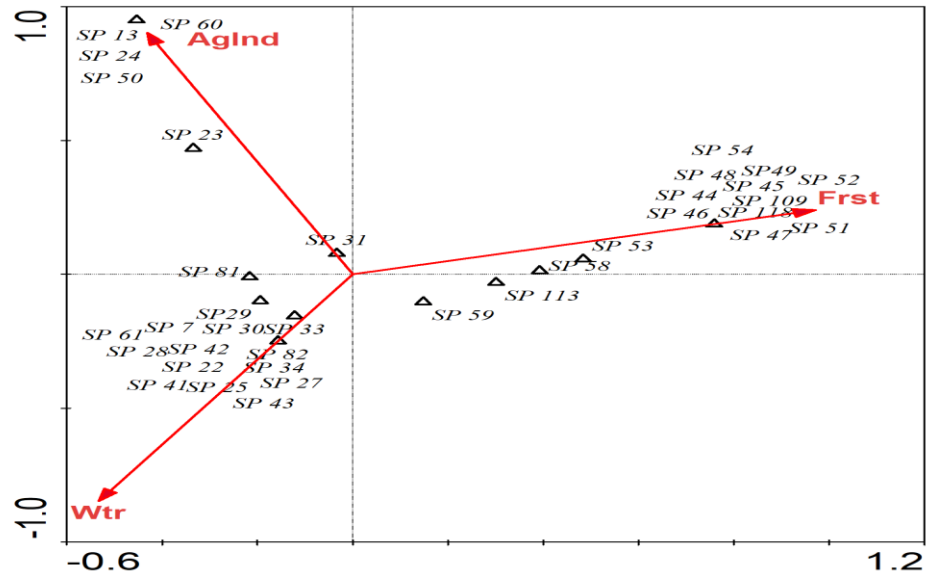


Figure 7. CCA biplot showing response of carnivore species to habitat types. The triangle represents the species common name, and the arrow represents each of the habitat types.

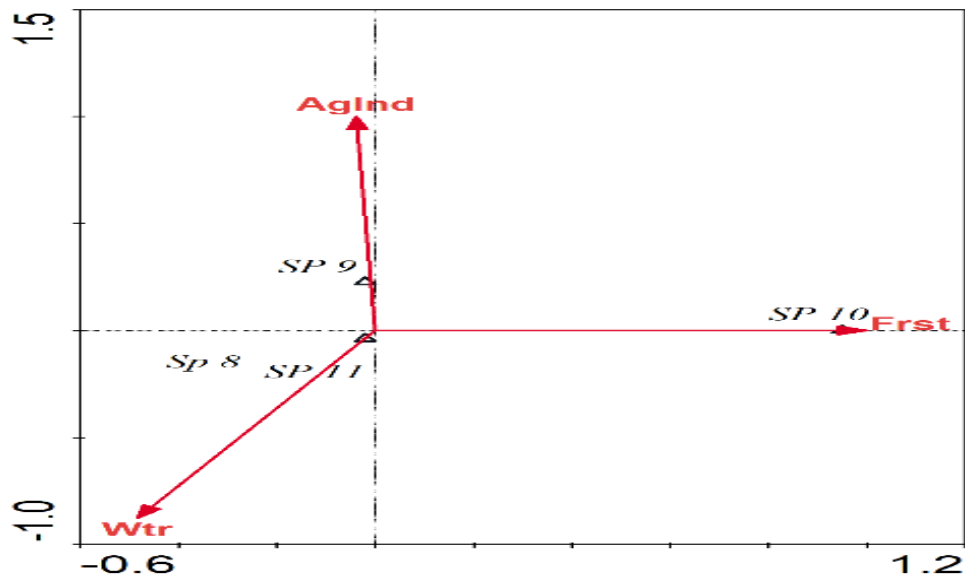


Figure 8. CCA biplot showing response of granivore species to habitat types. The triangles represent the species common name, and the arrow represents each of the habitat types.

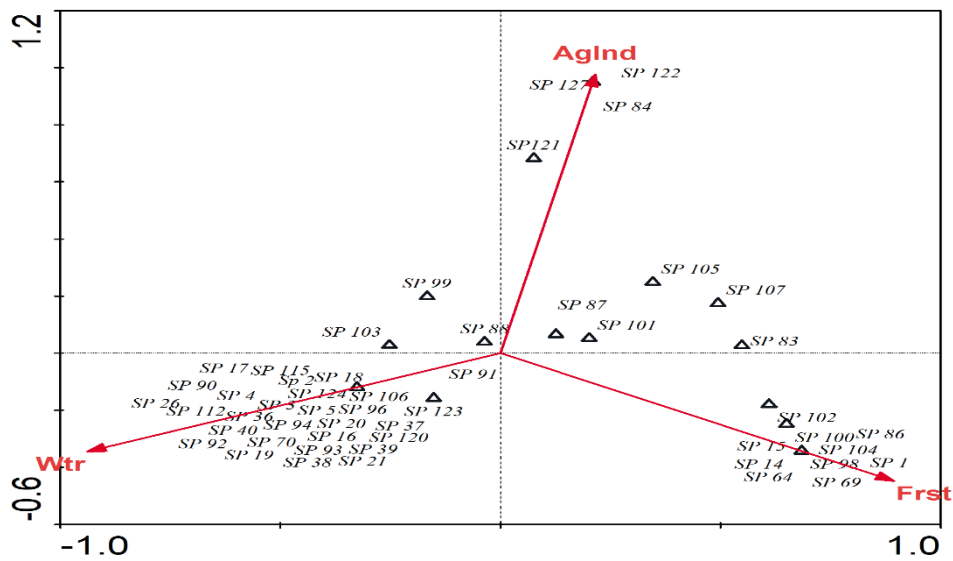


Figure 9. CCA biplot showing response of omnivore species to habitat types. The triangles represent the species common name, and the arrow represents each of the habitat types.

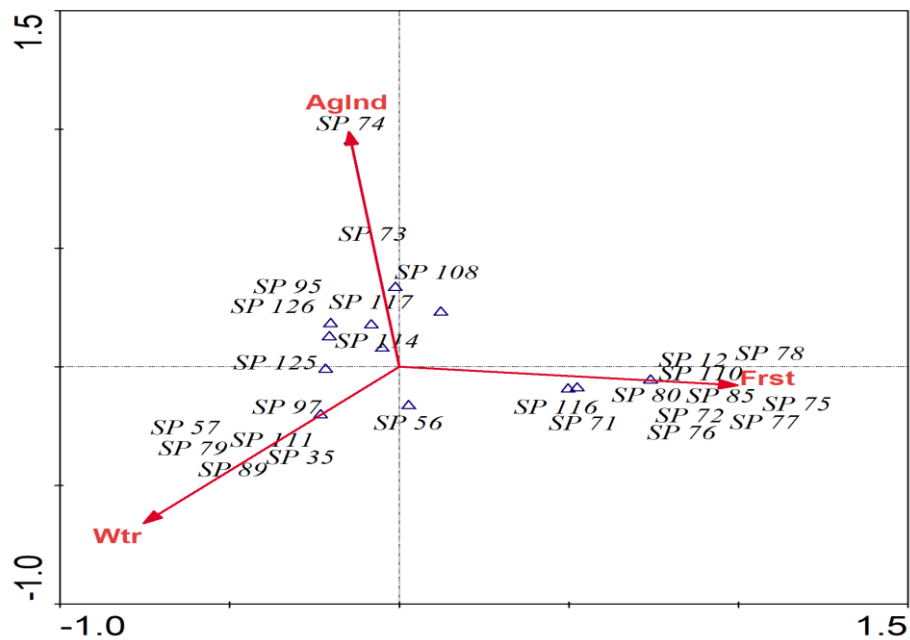


Figure 10. CCA biplot showing response of insectivore species to habitat types. The triangles represent the species common name, and the arrow represents each of the habitat types.

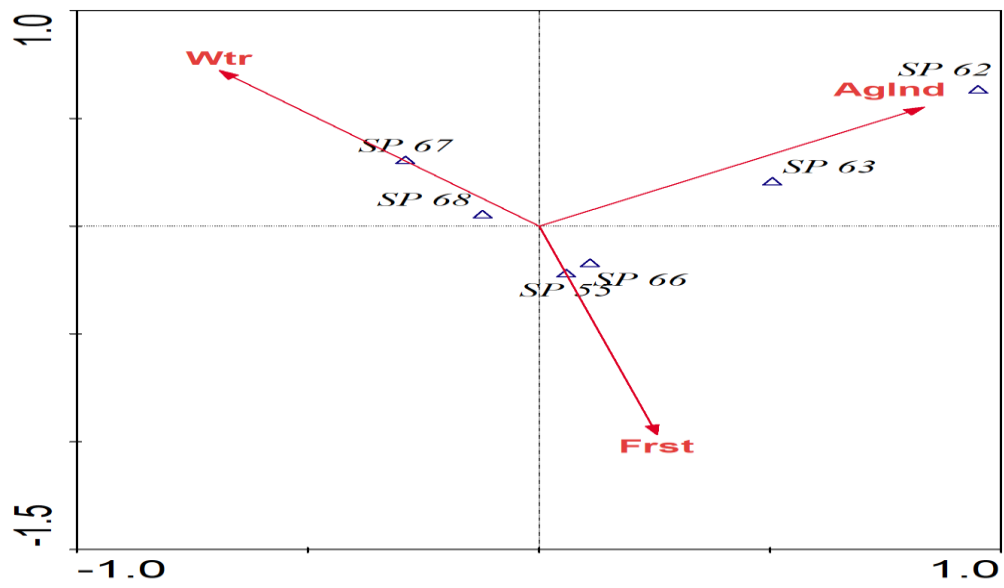


Figure 11. CCA biplot showing response of frugivore species to habitat types. The triangles represent the species common name, and the arrow represents each of the habitat types.

5. DISCUSSION

This study found that there was high bird diversity (4.14) in the Banganga River basin. This may be due to habitat diversity, land use type and connectivity. Nowadays a higher number of bird diversity is found in smaller areas that may be due to greater habitat heterogeneity (Shah 2021). Due to distinctly varied habitat type, vegetation cover and climatic conditions along the Kaligandaki River Basin, it consist of high species diversity and richness (Neupane et al. 2020). Similarly, a highly diverse community of avifauna was found in the Basanta Protected Forest because of diverse forest, land use type and connectivity between protected areas (Dangaura et al. 2020).

The highest number of birds recorded for the order Passeriformes in the study area may be because of migratory status of birds and also due to residential behavior of birds of this order which is similar to the research done by Shah (2021). Furthermore, there is a higher distribution and population of the order Passeriformes in the world (Mahata & Sharma 2023). The family Muscicapidae consist of higher number of species due to favorable place and climate to breed which helps in higher production of young ones, also may be the increase in migratory birds and residential nature of birds of these species (Møller et al. 2010, Shah 2021, Mahata & Sharma 2023). The higher number of winter migratory birds are found than summer visitor birds which may be due to the rise in temperature and reduction in availability of food in summer season than in winter (Jha & Mckinley 2015). Similarly, presence of higher percentage of winter visitors bird may be due to favorable ecological and climatic conditions (Parajuli 2016).

The number of omnivore species were recorded more because of their generalist nature with a broad range of diets and their tolerance nature (Samia et al. 2015). The species richness and diversity was higher in winter season in the study area which may be due to temporal changes in community composition that can lead to increment in the local and altitudinal migration of birds (Barcante et al. 2017, Delany et al. 2017). Presence of many foliage insects increases because of seasonal defoliation of plants, which is the nutriment for the insectivores (Katuwal et al. 2018). According to (Katuwal et al. 2018) low number bird species in the summer season may be due to migration period, less vocal during the breeding period and dense leaves obscuring vision.

A decrease in temperature is associated with declines in bird species richness due to decrease in vegetation and the rise in the slope and precipitation which is similar to the finding of Katuwal et al. (2016). The result shows the decrease in species richness with decrease in distance to nearest settlements due to the anthropogenic pressure near settlement which is similar to findings of Bastola et al. (2022) in Kahundanda Hillscape, Pokhara, Nepal. Agricultural land provides higher food availability which leads to increase in number of bird species (Tanalgo et al. 2015).

The study area consists of some threatened bird species like Common Pochard, Ferruginous Duck, Himalayan Vulture, Sarus Crane, Little Bunting, Lesser Adjutant, Asian Woollyneck, Asian Openbill, Black Stork, Brown Fish-owl, Pheasant-tailed Jacana, and Alexandrine Parakeet (IUCN 2021). These birds may be threatened due to land-use practices. The land-use change affects the habitat, structure, and composition of species (Brawn et al. 2001). Wetland provides habitat for a higher number of bird species because different sources of food and foraging are available in it and also wetland birds are heterogeneous in their feeding habits (Ali et al. 1987, Kumar & Gupta 2009).

Carnivores are associated with the forest vegetation in the study area; this may be due to the fine canopy cover in the forest that aids in nest building and breeding (Kumar & Gupta 2009). Granivores birds are found in abundant number in agricultural land due to availability of the food resources associated with agricultural lands since larger amount of weed-seed grains are held in cultivations and fallow lands that may provide food specially for seedeaters, doves, sparrows and weavers (Mahiga et al. 2019, Panda et al. 2021). Occurrence of higher numbers of omnivore species in the wetland may be due presence of habitat heterogeneity which means it consists of both the aquatic plants and animals like phytoplankton, zooplankton, insect, crustacean, protozoa, rotifer and other vertebrates and invertebrates to feed them. Insectivores do not show significant association with all types of habitats which is similar to Katuwal et al. (2018) in Kathmandu valley, Nepal. Less number of frugivores and nectivores were recorded may be due to lack of fruiting trees (Thakuri 2007).

6. CONCLUSION AND RECOMMENDATION

The avian study conducted in the Banaganga River Basin showed that there was high bird diversity in that area and consisted of 127 species of birds. The study area plays a key role in providing habitat, food, and breeding to the birds. The bird diversity was higher in winter season as compared to summer season because of migratory birds in winter. Carnivores, omnivores, and insectivores show the significant association with the different types of habitats. This study concluded that bird diversity and composition

The recommendation for the further research based on my study is the study area consists of many threatened and migratory birds, so a site-specific management plan should be implemented for the conservation of these species.

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APPENDICES

1. Checklist of birds of study area with order, family, species code of birds with status, feeding guild and IUCN and National Red List.

Note: R= Residential, WV= Winter visitor, SV= Summer visitor and PM= Passage migrant.

S.N.	English Name	Scientific Name	Order	Family	Code	IUCN	National	Migratory Status	Feeding guilds
1	Black-winged Kite	<i>Elanus caeruleus</i>	Accipitriformes	Accipitridae	SP 47	LC	LC	R	C
2	Oriental Honey-buzzard	<i>Pernis ptilorhynchus</i>	Accipitriformes	Accipitridae	SP 48	LC	LC	R	C
3	Crested Serpent-eagle	<i>Spilornis cheela</i>	Accipitriformes	Accipitridae	SP 49	LC	LC	R	C
4	Himalayan Vulture	<i>Gyps himalayensis</i>	Accipitriformes	Accipitridae	SP 50	NT	VU	WV	C
5	Booted Eagle	<i>Hieraaetus pennatus</i>	Accipitriformes	Accipitridae	SP 51	LC	LC	WV	C
6	Shikra	<i>Accipiter badius</i>	Accipitriformes	Accipitridae	SP 52	LC	LC	R	C

7	Black Kite	<i>Milvus migrans</i>	Accipitriformes	Accipitridae	SP 53	LC	LC	R	C
8	White-eyed Buzzard	<i>Butastur teesa</i>	Accipitriformes	Accipitridae	SP 54	LC	LC	R	C
9	Lesser Whistling-duck	<i>Dendrocygna javanica</i>	Anseriformes	Anatidae	SP 2	LC	LC	R	O
10	Red-crested Pochard	<i>Netta rufina</i>	Anseriformes	Anatidae	SP 3	LC	LC	WV	O
11	Common Pochard	<i>Aythya ferina</i>	Anseriformes	Anatidae	SP 4	VU	NT	WV	O
12	Ferruginous Duck	<i>Aythya nyroca</i>	Anseriformes	Anatidae	SP 5	NT	VU	WV	O
13	Eurasian Wigeon	<i>Mareca Penelope</i>	Anseriformes	Anatidae	SP 6	LC	LC	WV	H
14	Indian Grey Hornbill	<i>Ocyrceros birostris</i>	Bucerotiformes	Bucerotidae	SP 55	LC	LC	R	F
15	Alpine Swift	<i>Tachymarptis melba</i>	Caprimulgiformes	Apodidae	SP 12	LC	LC	R	I
16	Common Kestrel	<i>Falco tinnunculus</i>	Cariamiformes	Falconidae	SP 65	LC	LC	R	C
17	Black-winged Stilt	<i>Himantopus himantopus</i>	Charadriiformes	Recurvirostridae	SP 34	LC	LC	PM	C

18	Little Ringed Plover	<i>Charadrius dubius</i>	Charadriiformes	Charadriidae	SP 35	LC	LC	R	I
19	River Lapwing	<i>Vanellus duvaucelii</i>	Charadriiformes	Charadriidae	SP 36	LC	LC	R	O
20	Red-wattled Lapwing	<i>Vanellus indicus</i>	Charadriiformes	Charadriidae	SP 37	LC	LC	R	O
21	Greater Painted-snipe	<i>Rostratula benghalensis</i>	Charadriiformes	Rostratulidae	SP 38	LC	LC	R	O
22	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i>	Charadriiformes	Jacanidae	SP 39	LC	VU	R	O
23	Bronze-winged Jacana	<i>Metopidius indicus</i>	Charadriiformes	Jacanidae	SP 40	LC	LC	R	O
24	Common Sandpiper	<i>Actitis hypoleucos</i>	Charadriiformes	Scolopacidae	SP 41	LC	LC	WV	C
25	Green Sandpiper	<i>Tringa ochropus</i>	Charadriiformes	Scolopacidae	SP 42	LC	LC	WV	C
26	Marsh Sandpiper	<i>Tringa stagnatilis</i>	Charadriiformes	Scolopacidae	SP 43	LC	LC	PM	C
27	Rock Dove	<i>Columba livia</i>	Columbiformes	Columbidae	SP 8	LC	LC	R	G
28	Spotted Dove	<i>Stigmatopelia chinensis</i>	Columbiformes	Columbidae	SP 9	LC	LC	R	G

29	Oriental Turtle-dove	<i>Streptopelia orientalis</i>	Columbiformes	Columbidae	SP 10	LC	LC	R	G
30	Eurasian Collared-dove	<i>Streptopelia decaocto</i>	Columbiformes	Columbidae	SP 11	LC	LC	R	G
31	Asian Green Bee-eater	<i>Merops orientalis</i>	Coraciiformes	Meropidae	SP 56	LC	LC	SV	I
32	Blue-tailed Bee-eater	<i>Merops philippinus</i>	Coraciiformes	Meropidae	SP 57	LC	LC	SV	I
33	Indian Roller	<i>Coracias benghalensis</i>	Coraciiformes	Coraciidae	SP 58	LC	LC	R	C
34	Common Kingfisher	<i>Alcedo atthis</i>	Coraciiformes	Alcedinidae	SP 59	LC	LC	R	C
35	Pied Kingfisher	<i>Ceryle rudis</i>	Coraciiformes	Alcedinidae	SP 60	LC	LC	R	C
36	White-breasted Kingfisher	<i>Halcyon smyrnensis</i>	Coraciiformes	Alcedinidae	SP 61	LC	LC	R	C
37	Greater Coucal	<i>Centropus sinensis</i>	Cuculiformes	Cuculidae	SP 13	LC	LC	R	C
38	Indian Cuckoo	<i>Cuculus micropterus</i>	Cuculiformes	Cuculidae	SP 14	LC	LC	SV	O

39	Asian Koel	<i>Eudynamys scolopaceus</i>	Cuculiformes	Cuculidae	SP 15	LC	LC	R	O
40	Black Francolin	<i>Francolinus francolinus</i>	Galliformes	Phasianidae	SP 1	LC	LC	R	O
41	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	Gruiformes	Rallidae	SP 16	LC	LC	R	O
42	Watercock	<i>Gallicrex cinerea</i>	Gruiformes	Rallidae	SP 17	LC	LC	Monsoon	O
43	Purple Swamphen	<i>Porphyrio porphyrio</i>	Gruiformes	Rallidae	SP 18	LC	LC	WV	O
44	Common Moorhen	<i>Gallinula chloropus</i>	Gruiformes	Rallidae	SP 19	LC	LC	R	O
45	Common Coot	<i>Fulica atra</i>	Gruiformes	Rallidae	SP 20	LC	LC	WV	O
46	Sarus Crane	<i>Antigone antigone</i>	Gruiformes	Rallidae	SP 21	VU	VU	R	O
47	Lesser Adjutant	<i>Leptoptilos javanicus</i>	Otidiformes	Ciconiidae	SP 22	VU	VU	R	C

48	Asian Openbill	<i>Anastomus oscitans</i>	Otidiformes	Ciconiidae	SP 23	LC	VU	R	C
49	Black Stork	<i>Ciconia nigra</i>	Otidiformes	Ciconiidae	SP 24	LC	VU	R	C
50	Asian Woollyneck	<i>Ciconia episcopus</i>	Otidiformes	Ciconiidae	SP 25	VU	NT	R	C
51	Red-naped Ibis	<i>Pseudibis papillosa</i>	Otidiformes	Threskiornithidae	SP 26	LC	LC	R	O
52	Black-hooded Oriole	<i>Oriolus xanthornus</i>	Passeriformes	Oriolidae	SP 69	LC	LC	R	O
53	Indian Golden Oriole	<i>Oriolus kundoo</i>	Passeriformes	Oriolidae	SP 70	LC	LC	SV	O
54	Scarlet Minivet	<i>Pericrocotus flammeus</i>	Passeriformes	Campephagidae	SP 71	LC	LC	R	I
55	Small Minivet	<i>Pericrocotus cinnamomeus</i>	Passeriformes	Campephagidae	SP 72	LC	LC	R	I
56	Black Drongo	<i>Dicrurus macrocercus</i>	Passeriformes	Dicruridae	SP 73	LC	LC	R	I

57	Ashy Drongo	<i>Dicrurus leucophaeus</i>	Passeriformes	Dicruridae	SP 74	LC	LC	R	I
58	White-bellied Drongo	<i>Dicrurus caerulescens</i>	Passeriformes	Dicruridae	SP 75	LC	LC	R	I
59	Crow-billed Drongo	<i>Dicrurus annectens</i>	Passeriformes	Dicruridae	SP 76	LC	LC	SV	I
60	Hair-crested Drongo	<i>Dicrurus hottentottus</i>	Passeriformes	Dicruridae	SP 77	LC	LC	R	I
61	Greater Racquet-tailed Drongo	<i>Dicrurus paradiseus</i>	Passeriformes	Dicruridae	SP 78	LC	LC	R	I
62	Brown Shrike	<i>Lanius cristatus</i>	Passeriformes	Laniidae	SP 79	LC	LC	WV	I
63	Grey-backed Shrike	<i>Lanius tephronotus</i>	Passeriformes	Laniidae	SP 80	LC	LC	R	I
64	Bay-backed Shrike	<i>Lanius vittatus</i>	Passeriformes	Laniidae	SP 81	LC	LC	SV	C

65	Long-tailed Shrike	<i>Lanius schach</i>	Passeriformes	Laniidae	SP 82	LC	LC	R	C
66	Rufous Treepie	<i>Dendrocitta vagabunda</i>	Passeriformes	Corvidae	SP 83	LC	LC	R	O
67	Grey Treepie	<i>Dendrocitta formosae</i>	Passeriformes	Corvidae	SP 84	LC	LC	R	O
68	Red-billed Chough	<i>Pyrrhonorax pyrrhonorax</i>	Passeriformes	Corvidae	SP 85	LC	LC	R	I
69	Red-billed Blue Magpie	<i>Urocissa erythroryncha</i>	Passeriformes	Corvidae	SP 86	LC	LC	R	O
70	House Crow	<i>Corvus splendens</i>	Passeriformes	Corvidae	SP 87	LC	LC	R	O
71	Indian Jungle Crow	<i>Corvus macrorhynchos</i>	Passeriformes	Corvidae	SP 88	LC	LC	R	O
72	Cinereous Tit	<i>Parus cinereus</i>	Passeriformes	Paridae	SP 89	LC	LC	R	I
73	Ashy-crowned Sparrow-lark	<i>Eremopterix griseus</i>	Passeriformes	Alaudidae	SP 90	LC	LC	R	O
74	Crested Lark	<i>Galerida cristata</i>	Passeriformes	Alaudidae	SP 91	LC	LC	R	O

75	Bengal Bushlark	<i>Mirafra assamica</i>	Passeriformes	Alaudidae	SP 92	LC	LC	R	O
76	Yellow-bellied Prinia	<i>Prinia flaviventris</i>	Passeriformes	Cisticolidae	SP 93	LC	LC	R	O
77	Ashy Prinia	<i>Prinia socialis</i>	Passeriformes	Cisticolidae	SP 94	LC	LC	R	O
78	Common Tailorbird	<i>Orthotomus sutorius</i>	Passeriformes	Cisticolidae	SP 95	LC	LC	R	I
79	Plain Prinia	<i>Prinia inornata</i>	Passeriformes	Cisticolidae	SP 96	LC	LC	R	O
80	Barn Swallow	<i>Hirundo rustica</i>	Passeriformes	Hirundinidae	SP 97	LC	LC	R	I
81	Black Bulbul	<i>Hypsipetes leucocephalus</i>	Passeriformes	Pycnonotidae	SP 98	LC	LC	R	O
82	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	Passeriformes	Pycnonotidae	SP 99	LC	LC	R	O
83	Himalayan Bulbul	<i>Pycnonotus leucogenys</i>	Passeriformes	Pycnonotidae	SP 100	LC	LC	R	O

84	Red-vented Bulbul	<i>Pycnonotus cafer</i>	Passeriformes	Pycnonotidae	SP 101	LC	LC	R	O
85	Jungle Babbler	<i>Turdoides striata</i>	Passeriformes	Leiotrichidae	SP 102	LC	LC	R	O
86	Brahminy Starling	<i>Sturnia pagodarum</i>	Passeriformes	Sturnidae	SP 103	LC	LC	R	O
87	Chestnut-tailed Starling	<i>Sturnia malabarica</i>	Passeriformes	Sturnidae	SP 104	LC	LC	R	O
88	Common Myna	<i>Acridotheres tristis</i>	Passeriformes	Sturnidae	SP 105	LC	LC	R	O
89	Bank Myna	<i>Acridotheres ginginianus</i>	Passeriformes	Sturnidae	SP 106	LC	LC	R	O
90	Jungle Myna	<i>Acridotheres fuscus</i>	Passeriformes	Sturnidae	SP 107	LC	LC	R	O
91	Oriental Magpie-robin	<i>Copsychus saularis</i>	Passeriformes	Muscicapidae	SP 108	LC	LC	R	I
92	Indian Robin	<i>Saxicoloides fulicatus</i>	Passeriformes	Muscicapidae	SP 109	LC	LC	R	C

93	White-rumped Shama	<i>Kittacincla malabarica</i>	Passeriformes	Muscicapidae	SP 110	LC	LC	R	I
94	Siberian Rubythroat	<i>Calliope calliope</i>	Passeriformes	Muscicapidae	SP 111	LC	LC	WV	I
95	Blue-fronted Redstart	<i>Phoenicurus frontalis</i>	Passeriformes	Muscicapidae	SP 112	LC	LC	WV	O
96	Black Redstart	<i>Phoenicurus ochruros</i>	Passeriformes	Muscicapidae	SP 113	LC	LC	WV	C
97	Pied Bushchat	<i>Saxicola caprata</i>	Passeriformes	Muscicapidae	SP 114	LC	LC	R	I
98	Common Stonechat	<i>Saxicola torquatus</i>	Passeriformes	Muscicapidae	SP 115	LC	LC	R	O
99	Brown Rockchat	<i>Oenanthe fusca</i>	Passeriformes	Muscicapidae	SP 116	LC	LC	R	I
100	Siberian Stonechat	<i>Saxicola maurus</i>	Passeriformes	Muscicapidae	SP 117	LC	LC	R	I
101	Blue whistling-thrush	<i>Myophonus caeruleus</i>	Passeriformes	Muscicapidae	SP 118	LC	LC	R	C
102	Purple Sunbird	<i>Cinnyris asiaticus</i>	Passeriformes	Nectariniidae	SP 119	LC	LC	R	N
103	Red Avadavat	<i>Amandava amandava</i>	Passeriformes	Estrildidae	SP 120	LC	LC	R	O

104	House Sparrow	<i>Passer domesticus</i>	Passeriformes	Passeridae	SP 121	LC	LC	R	O
105	Eurasian Tree Sparrow	<i>Passer montanus</i>	Passeriformes	Passeridae	SP 122	LC	LC	R	O
106	Paddyfield Pipit	<i>Anthus rufulus</i>	Passeriformes	Motacillidae	SP 123	LC	LC	R	O
107	Long-billed Pipit	<i>Anthus similis</i>	Passeriformes	Motacillidae	SP 124	LC	LC	R	O
108	White-browed Wagtail	<i>Motacilla maderaspatensis</i>	Passeriformes	Motacillidae	SP 125	LC	LC	R	I
109	White Wagtail	<i>Motacilla alba</i>	Passeriformes	Motacillidae	SP 126	LC	LC	WV	I
110	Little Bunting	<i>Emberiza pusilla</i>	Passeriformes	Emberizidae	SP 127	LC	VU	WV	O
111	Indian Pond-heron	<i>Ardeola grayii</i>	Pelecaniformes	Ardeidae	SP 27	LC	LC	R	C
112	Purple Heron	<i>Ardea purpurea</i>	Pelecaniformes	Ardeidae	SP 28	LC	LC	R	C
113	Cattle Egret	<i>Bubulcus ibis</i>	Pelecaniformes	Ardeidae	SP 29	LC	LC	R	C

114	Little Egret	<i>Egretta garzetta</i>	Pelecaniformes	Ardeidae	SP 30	LC	LC	R	C
115	Intermediate Egret	<i>Ardea intermedia</i>	Pelecaniformes	Ardeidae	SP 31	LC	LC	R	C
116	Great White Egret	<i>Ardea alba</i>	Pelecaniformes	Ardeidae	SP 32	LC	LC	R	C
117	Great Barbet	<i>Psilopogon virens</i>	Piciformes	Megalaimidae	SP 62	LC	LC	R	F
118	Blue-throated Barbet	<i>Psilopogon asiaticus</i>	Piciformes	Megalaimidae	SP 63	LC	LC	R	F
119	Black-rumped Flameback	<i>Dinopium benghalense</i>	Piciformes	Picidae	SP 64	LC	LC	R	O
120	Little Grebe	<i>Tachybaptus ruficollis</i>	Podicipediformes	Podicipedidae	SP 7	LC	LC	WV	C
121	Plum-headed Parakeet	<i>Psittacula cyanocephala</i>	Psittaciformes	Psittacidae	SP 66	LC	LC	R	F
122	Alexandrine Parakeet	<i>Psittacula eupatria</i>	Psittaciformes	Psittacidae	SP 67	NT	NT	R	F
123	Rose-ringed Parakeet	<i>Psittacula krameri</i>	Psittaciformes	Psittacidae	SP 68	LC	LC	R	F

124	Asian Barred Owlet	<i>Glaucidium cuculoides</i>	Strigiformes	Strigidae	SP 44	LC	LC	R	
125	Spotted Owlet	<i>Athene brama</i>	Strigiformes	Strigidae	SP 45	LC	LC	R	C
126	Brown Fish-owl	<i>Ketupa zeylonensis</i>	Strigiformes	Strigidae	SP 46	LC	VU	R	C
127	Little Cormorant	<i>Microcarbo niger</i>	Suliformes	Phalacrocoracidae	SP 33	LC	LC	R	C

PHOTOPLATES



Crested Serpent-Eagle



Common Tailorbird



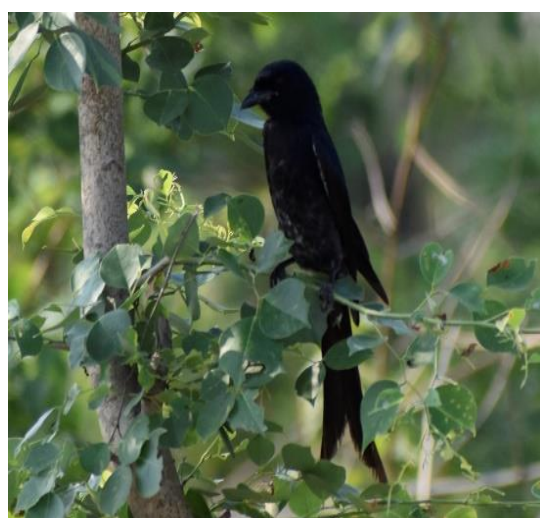
Asian Openbill



Jungle Babbler



Sarus Crane



Black Drongo



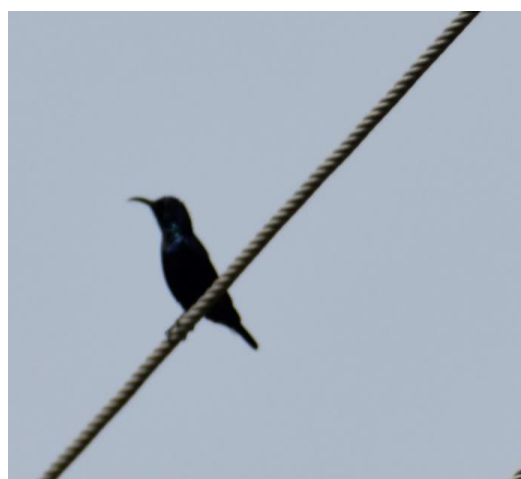
Common Moorhen



Long-tailed Shrike



White-rumped Shama



Purple Sunbird



Pheasant-tailed Jacana



Rufous Treepie



Himalayan Vulture



Black-winged Kite



Lesser Adjutant



Shikra



Bronze-winged Jacana



Plain Prinia



Red-wattled Lapwing



Greater Racquet-tailed Drongo



Little Ringed Plover



Red-crested Pochard