

**SEASONAL VARIATION OF BIRD DIVERSITY IN DHANESHWOR
BAIKIWA COMMUNITY FOREST, KAVREPALANCHOWK
DISTRICT, NEPAL**



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Submitted To

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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 specifically acknowledged by reference to author(s) or institution(s).

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This thesis work submitted by Ms. Aarati Nepali entitled “SEASONAL VARIATION OF BIRD DIVERSITY IN DHANESHWOR BAIKIWA COMMUNITY FOREST, KAVREPALANCHOWK DISTRICT, NEPAL” has been accepted as a 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
⁰ C	Degree Celsius
BCN	Bird Conservation Nepal
CCA	Canonical Correspondence Analysis
CITES	Convention on International Trades in Endangered Species of Flora and Fauna
DFO	District Forest Office
DNPWC	Department of National Parks and Wildlife Conservation
E	East
GIS	Geographic Information System
GPS	Global Positioning System
H	Hectre
Hrs	Hours
IBA	Important Bird Areas
IUCN	International Union of Conservation of Nature
m.a.s.l.	Meter above sea level
Mm	Millimeter
N	North
S.N.	Serial Number
SNP	Sagarmatha National Park
UGC	University Grants Commission

ABSTRACT

Seasonal Variation plays an important role in the survival of birds in any ecosystem as the availability of ecological requirements of birds varies with the variation in season. The study was carried out in Dhaneshwor Baikiwa Community Forest of Kavrepalanchowk District, Nepal with the main objective to explore the bird diversity and seasonal variation in the study area. Mackinnon's Listing Method and Point Count Method was used for bird survey during winter and summer season. Altogether 20 visits were made, spending 10 days in each season in the field. Altogether 108 species belonging to 15 orders and 43 families were recorded. The highest species richness was found from order Passeriformes and Muscicapidae family. Among 108 species, 81 and 72 species of birds were recorded during winter and summer season while 45 species were observed during both seasons. Shannon winner diversity index showed the highest bird diversity and evenness during winter season ($H= 3.929$) ($E=0.627$) than during summer season ($H=3.808$) ($E=0.625$). Local occurrence status revealed that out of 108 birds recorded, seven species were very common, 15 species were common, 41 species were fairly common and 45 species were rare. Among 108 species, 79 species were resident, 13 species were winter visitor, 12 species were summer visitor and four species were passage migrant. Only one globally Vulnerable and one Nearly Threatened species i.e. Asian Woollyneck (*Ciconia episcopus*) and Alexandrine Parakeet (*Psittacula eupatria*), categorised in IUCN Red List were recorded; respectively. Different habitat types and the disturbance variables which included distance to the nearest settlement, livestock, fodder collection and number of human trails had significant effect on the bird diversity. Having knowledge on bird diversity in any specific habitat will further helps to understand the ecology of particular bird species.

1. INTRODUCTION

1.1 General Background

All the organisms on this earth have their own specific habitats where they persist. Among all the organisms, birds are one of the sensitive species which show the quick response towards different changes in the habitat. Birds prefer different habitats such as forest, bushes, grasslands, wetlands, grasslands, agricultural land, urban areas and desert as these habitats provide them protection, different arrays of foraging opportunities and nesting sites (Rahbek and Graves 2001). Birds that are encountered in various habitats types indicate their tolerance to a wide range of ecological conditions (Sekercioglu 2006). Resident and breeding bird species play an important role as a bio-indicator of habitat change (Sheta et al. 2011) as most of resident birds are gregarious, and show the pronounced effect on the habitat, especially when they are locally abundant (O'Connell et al. 2007).

Seasonality plays a major role in determining the abundance and distribution of birds. It affects food and cover availability of bird population, which in turn affects breeding success and ultimately survival of the bird species (Mengesha and Bekele 2008). The distinct seasonality of rainfall and seasonal variation in the availability of food resources (Schroth et al. 2004), presence of migratory species, reproductive activities, and seasonal changes in the composition and abundance of birds, who are dependent from particular seasonal resources, are the factors that cause seasonal differences in the bird assemblage (Almazan et al. 2015). The variation in the number of captures of birds are also influenced by the arrival and departure of seasonal altitudinal migrants (Werema and Howell 2016). The relative abundance of avian species during wet and dry seasons might be related to the availability of food, habitat condition, vegetation complexity and breeding season of the species (Belay and Yihune 2017). During the wet season, many flowering plants are seen flourished which provide the sufficient food supply to birds in almost all the habitats. However, during the dry season, the deciduous trees defoliate and in the absence of food, many species of birds can be restricted to specific habitat where sufficient resource are available (Husein and Sultan 2019).

The geographical position of Nepal in the Central Himalayan, varied topography and climate along with associated diverse vegetation are some of the unique features that has led the country to harbors around 8% of the world's known bird species along with diverse group of the world's known flora and fauna (Inskipp et al. 2016). As Nepal is located in a

region of overlap between the Palearctic realm to the north and the Oriental (Indomalayan) realm to the south, the country has diverse types of habitat that contribute to the tremendously diverse avifauna. Nationally, 36 Important Bird and Biodiversity Areas (IBAs) have been identified in Nepal (Baral and Inskipp 2005). Out of 887 species recorded from Nepal, 35 species have been assessed as globally threatened species and 19 species are kept under near threatened category (DNPWC and BCN 2018). Larger birds appear to be more threatened than smaller birds (Inskipp et al. 2017).

Migratory pattern of the bird species is also one of the main reasons that cause the variations in avian community structure and differences in bird richness, social and foraging behavior in different seasons (Amador et al. 2006). Both summer and winter migratory birds constitute almost one-third of the total bird species recorded in Nepal (Inskipp et al. 2016). In Nepal, most of the Himalayan resident species are altitudinal migrants, some residents are sedentary throughout the year while some species undertake irregular movements, either locally or widely in the region, depending on the weather condition and food supply. About 62 species are summer visitors and 150 species are winter visitors migrating mainly from northern and Central Asia, some of which are also passage migrants. Some breeding birds, mainly non-Passerines in the Palearctic, migrate directly across the Himalayas to winter in the subcontinent. Large number of birds of prey use Himalayas as an east-west flyway when migrating to their breeding grounds. The raptors leave Tibetan Plateau and northern Asia and head south to uncertain wintering grounds following the Himalayan range of Nepal and India (Grimmett et al. 2016). Particularly, it has been revealed that processes acting in breeding and wintering grounds determine both the patterns of habitat occupancy and seasonal abundance in migratory bird species (Newton 2008).

Various abiotic gradients such as type of soil, climatic conditions, elevation, slope, aspects and vegetation cover as well as biotic features such as predation, competition, and heterogeneity of plant cover or state of succession can affect the diversity of birds in the particular area (Sheta et al. 2011). Besides these, deforestation, overgrazing, habitat fragmentation and habitat loss can lead to loss of diversity and differentiation in bird species assemblages. Some species require a high percentage of forest coverage to persist while others can benefit from habitat loss. Such circumstances lead to a replacement in species composition and can affect each species individually (Bank-Leite et al. 2012). Changes in properties of the habitat matrix can influence not only resources availability for

different bird species but also the connectivity between forest fragments (Watson et al. 2005).

IUCN Red List shows that there has been a steady and continuing deterioration in the status of the world's birds since the first comprehensive assessment in 1988. Highly threatened species continue to go extinct, while formerly common and widespread species are in sharp decline. The assessment of bird community is important tool in biodiversity conservation and identifications of conservation actions. Knowledge on diversity and composition of bird communities is important to determine the health status of the local ecosystem or regional landscapes (Sethy et al. 2015). However, no such study has been done in Dhaneshwor Baikiwa Community Forest about the diversity of birds and its seasonal variation. So, the study is most important for the exploration of avifauna in this area as well as for the management and conservation of bird species.

1.2 Objectives of the Study

1.2.1 General Objective

The main objective of the study was to explore the bird diversity and its seasonal variation in Dhaneshwor Baikiwa Community Forest, Kavrepalanchowk District, Nepal.

1.2.2 Specific Objectives

- To analyze the seasonal variation of bird diversity.
- To document the local occurrence, migratory and threatened status of birds.
- To identify the factors that affect the bird diversity in study area.

1.3 Rationale of the Study

Birds play an important role in maintaining the balance of many ecosystems by providing various ecological services. In Nepal, many researchers have carried out different studies on avian diversity and its seasonal variation in different ecosystems particularly emphasizing in National Parks and other protected areas. Non-Protected area covers large area and may be the home of different rare species. However, few investigations put their efforts in exploring the fauna of community forest but there is no any evidence of scientific study which has been conducted before within the present study area. Thus, this study will be helpful in providing baseline information about the diversity of avian species and in the

preparation of comprehensive checklist of bird species in the study area. The study of seasonal variation would help to know the actual status of residential birds, summer visitors, winter visitors and passage migrants in the study area so that concerned authorities could make better management and conservation of bird species in the study area.

1.4 Limitations of the Study

- Study of flying raptors and nocturnal birds was not done.
- Survey of birds in the evening was not done.

2. LITERATURE REVIEW

2.1 In Context of Seasonal Variation of Bird Diversity

Desalgn and Subramanian (2015) conducted studies on avian diversity in Angereb forest and adjacent farmland with reference to rainy and post rainy season in Northwestern Ethiopia and recorded 89 avian species from 37 families belonging to 11 orders. The results revealed the variation in avian density, diversity, richness and abundance among the site across season. The significant variation was found only in forest habitat.

Belay and Yihune (2017) carried out study on species composition, relative abundance and distribution of avian fauna in and around Zengo Forest Ethiopia during the wet and dry season. A total of 42 avian species belonging to 22 families were identified in the study area during the wet and dry season. Highest number of species was recorded on farmland during dry season and forest habitats during wet seasons. The study found no significant difference among habitats however season had an effect on avian fauna abundance in woodland habitat. Habitat destruction, deforestation, habitat fragmentation were the main threats for avian in the study area.

Girma et al. (2017) conducted study on seasonal abundance and habitat use of bird species in and around Wondo Genet Forest, south-central Ethiopia. There was a significant difference in the mean abundance of migratory bird species between dry and wet seasons. The variation in mean abundance per plot between the dry and wet seasons in the grassland habitat was significant. Slope was a good predictor for bird species abundance in the dry season while altitude and average vegetation height accounted more in the wet season.

Almazan et al. (2018) carried out the study on seasonal variation in bird assemblage composition in a dry forest of Southwestern Mexico where a total of 82 bird species belonging to 28 families were recorded. Although higher number of species was found in the dry season than in the rainy season, only the abundance of insectivorous-frugivorous and omnivorous birds was significantly higher.

Singh et al. (2018) carried out the study on avian diversity and seasonal abundance in forest habitat of Jeolikote, district Nainital, India. A total of 131 species of birds belonging to 13 orders and 42 families were recorded in winter, summer and rainy season. Maximum number of individuals were recorded during winter followed by summer and rainy season.

Muscicapidae was the most dominant family while in terms of distribution status, 76% of avian species were resident, 16% were resident altitudinal migrant, 5% were winter visitor and 3% were summer visitor.

Abie et al. (2019) conducted study on bird species diversity and distribution in case of protected area of Ethiopia. From the study, a total of 112 species were recorded. The mean of bird species abundance was significantly different between dry and wet seasons as well as the distribution of bird among habitat type was also significantly different. The highest species diversity and evenness was found in riverine forest while lowest species diversity and evenness was recorded from farmland.

2.2 In Context of Local Occurrence, Migratory and Threatened Status of Birds

Thakuri (2009) carried out an ornithological survey of Dang Deukhuri Foothill Forests and West Rapti Wetlands IBA. A total of 246 bird species belonging to 15 orders and 17 families was recorded from the year-round survey. Higher number of species was recorded during spring season than during winter season. Out of total, 185 species were resident, 50 species were winter visitor and 11 bird species were summer visitor. Among these birds, seven species were found globally threatened and another seven species nationally threatened.

Jha (2014) conducted study to find the common birds of Chitwan National Park and recorded 170 species belonging to 48 families. The highest number of species was recorded from Corvidae i.e. 18, followed by 13 species of Sylviidae and 10 species of Muscicapidae.

Katuwal et al. (2015) conducted a biodiversity survey of Chandragiri Hill, Kathmandu in which they recorded 137 species of birds in six adjoining Community forest of Chandragiri hills during entire field visit and found Chandragiri hill to be suitable for the summer visitor birds where 11 species were recorded.

Katuwal et al. (2016) reported the species richness of birds recorded in four important sacred forests of Pashupatinath, Swyambhunath, Suryabinayak and Bajrabarahi of Kathmandu Valley from 2004-2016 and recorded 1,954 bird species where 144 were residential and 51 were migratory. One globally and five nationally threatened species while 24 as rare categories species were recorded.

Chaudhary and Poudyal (2017) carried out the ornithological survey in Api Nampa Conservation Area. A total of 2,737 individuals of birds belonging to 148 species of 37 families of eight orders were recorded including four nationally threatened in addition to two globally threatened bird species. Large-billed Crow (*Corvus macrorhynchos*) was the most frequent bird, followed by Blue Whistling Thrush (*Myophonus caeruleus*) and Green-backed Tit (*Parus monticolus*).

Adhikari et al. (2018) carried out study to explore the diversity and conservation status of birds in the Barandabhar Corridor Forest, Chitwan, Nepal. A total of 304 bird species belonging to 18 orders and 69 families including 59% residential, 8% summer visitors, 32% winter visitors and 1% vagrants were recorded. The highest species richness was belonged to order Passeriformes and the least numbers of the species from order Podicipediformes. The six species of birds were highly abundant, 25 species were abundant, 117 species were very common, 103 species were common, 46 species were fairly common and seven species were rare species.

Katuwal et al. (2018) carried out study on effect of urbanization and seasonality in bird communities of Kathmandu Valley, Nepal where they recorded 85 species in summer season and 63 species in winter season. A higher number of resident species (81.37%) followed by winter (14.70%) migrant and fewer summer (3.92%) migrants was recorded. All species richness showed significant seasonal variation but not by species diversity.

Kharel (2018) conducted a general bird survey in Betana wetland, Morang, Nepal. A total of 320 individuals of birds belonging 49 species, 30 families and 15 orders were recorded with the highest number of species belonged to the order Passeriformes. The species richness and abundance of avifauna was found higher during winter season than during summer. Among total species, two species viz. Grey-headed fish eagle (*Ichthyophaga humilis*) and Lesser Adjutant Stork (*Leptoptilos javanicus*) are kept under near threatened (NT) and vulnerable (VU) category of IUCN Red List of threatened species. About 70 % of total bird recorded was resident type and about 35% of total recorded bird species common in abundance.

2.3 In Context of Factors Affecting the Bird Diversity

Tanalgo et al. (2015) conducted the study on Bird Diversity and Structure in Different Land-use Types in Lowland South-Central Mindanao, Philippines. The study area was divided into three different habitats which were agroforests, rice field and roads and heavily disturbed habitats. The highest species diversity was found in agroforests, and the lowest was recorded from roads and heavily disturbed habitats. The species composition of agroforests was more similar to rice field than to areas with high levels of disturbance, such as roads.

Basnet et al. (2016) conducted study to explore the factors affecting diversity and distribution of species of birds on different forested hills in central Nepal. A total of 6,522 individual birds belonging to 146 species, 77 genera and 23 families were recorded out of which 80% were resident birds. Forests on steep slopes intermixed with patches of open habitats on shallow soil at large spatial scales were more important for diverse bird communities than more disturbed habitats on shallow slopes. Habitat conditions were important determinants of the distribution of specific species while the number of niches was determined by large scale characteristics, such as landscape level habitat heterogeneity and altitude.

Asefa et al. (2017) conducted study on the effects of anthropogenic disturbance on bird diversity in Ethiopian montane forests. From the study, it was found that the species richness was 27% higher and bird abundance was 19% higher in unprotected forests however the species richness and abundance of forest specialists and canopy foragers were significantly higher in protected forests.

Imai et al. (2017) conducted the study in the suburban areas of Oshu and Hanamaki cities, Japan, to examine the effects of environmental factors on avian communities. The characteristics of avian communities were mainly determined by the total forested area in the landscape. The result suggested that developed bush communities increased the evenness of the avian community, whereas some raptor species preferred an open forest understory.

Wehenkel et al. (2017) examined bird species richness and diversity during the breeding and wintering seasons in the Central Sierra Madre Occidental, North Durango (Mexico) in relation to tree species diversity, tree dimension, forest stand density and site quality, density and dimension of snag trees, and various climate variables. Bird species diversity

in the wintering season was significantly and weakly to moderately associated with climate variables, tree species diversity and stand density, although not with density or dimension of snag trees.

Juliyana and Soladoye (2018) carried out the study on Factors Influencing Bird Species Richness and Abundance in Surulere Local Government Area of Lagos State, Nigeria. A total of 3,986 individuals belonging to 29 species and 20 families were recorded during the study. Species richness were found to be significantly influenced by presence of trees and was also moderated by the nature of the drainage present. Bird species abundance was significantly higher where trees were absent.

Kiros et al. (2018) conducted a preliminary study on bird diversity and abundance from Wabe fragmented forests around Gubre subcity and Wolkite town, Southwestern Ethiopia. The result revealed that the total abundance of birds showed significant difference among the three sites. In general, highest number of individual birds were counted in bushland followed by riverine forest and plantation habitat. Furthermore, bushland area had higher value of species diversity than plantation and riverine forests.

Nsor et al. (2018) assessed factors that influenced bird-habitat preference, diversity, and spatial distribution in Mole National Park. A total of 3,033 individuals and 1,648 individuals of were identified across the four habitat types in the wet and dry seasons respectively. Despite the high abundance and richness of birds in the woodland and shrub land habitats, grassland habitat was the most diverse, due to the high spatial evenness distribution of the birds. Bushfire, patchiness, and animal trampling were the key environmental determinants in bird assemblages and habitat preferences and accounted for 62.02% and 81.82% variations in the two seasons.

Adhikari et al. (2019) carried out study to identify the factors affecting diversity and distribution of threatened birds in Chitwan National Park, Nepal. A total of 437 individuals of globally threatened birds belonging to 19 species of nine families and eight orders. Presence of livestock and people caused significantly negative effects on species richness and abundance of threatened birds whereas distance from roads and villages also had a negative effect on the diversity and abundance of most of the threatened birds.

Mahiga et al. (2019) conducted study on Influence of Land-Use Type on Forest Bird Community Composition in Mount Kenya Forest to determine the influence of land-use

type on occurrence of avian foraging and forest-dependent guilds. Compared to farmlands and plantation forest, natural forest had the highest overall avian species richness and relative species richness of all except one forest-dependent foraging guild (granivores) and nonforest species, which occurred frequently only on farmlands. Plantation forest had the lowest relative richness of all avian habitat and foraging guilds.

Study on seasonal variation among bird species is carried out frequently in different parts of country. This study will explore the new area (Dhaneshwor Baikiwa Community Forest) and seasonal pattern of diversity which may be valuable to explore the overall diversity of bird and different factors which govern the pattern of variation in bird species.

3. MATERIALS AND METHODS

3.1 Study Area

3.1.1 Location and Climate

The study was conducted at Dhaneshwor Baikiwa Community Forest (27.6151 N, 85.5180 E to 27.6117 N, 85.5210 E), Banepa and Panauti Municipality of Kavrepalanchowk, Nepal (Figure 1). It lies from 1000-2000 m.a.s.l. Dhaneshwor Baikiwa Community Forest covers an area of 74.64 h and consists of 5 blocks in ward number 7 and 9 of Banepa Municipality and ward no 2 of Panauti Municipality. This forest falls in mid temperate climatic region. The temperatures are highest on average in June, at around 22.2 °C. January has the lowest average temperature of the year which is 9.6°C. During the year, the average temperatures vary by 12.6°C. About 1,745 mm of precipitation falls annually. With an average of 451 mm, the most precipitation falls in July. The variation in the precipitation between the driest and wettest months is 443 mm. The least amount of rainfall occurs in November which is 8 mm (DFO Kavrepalanchowk 2014).

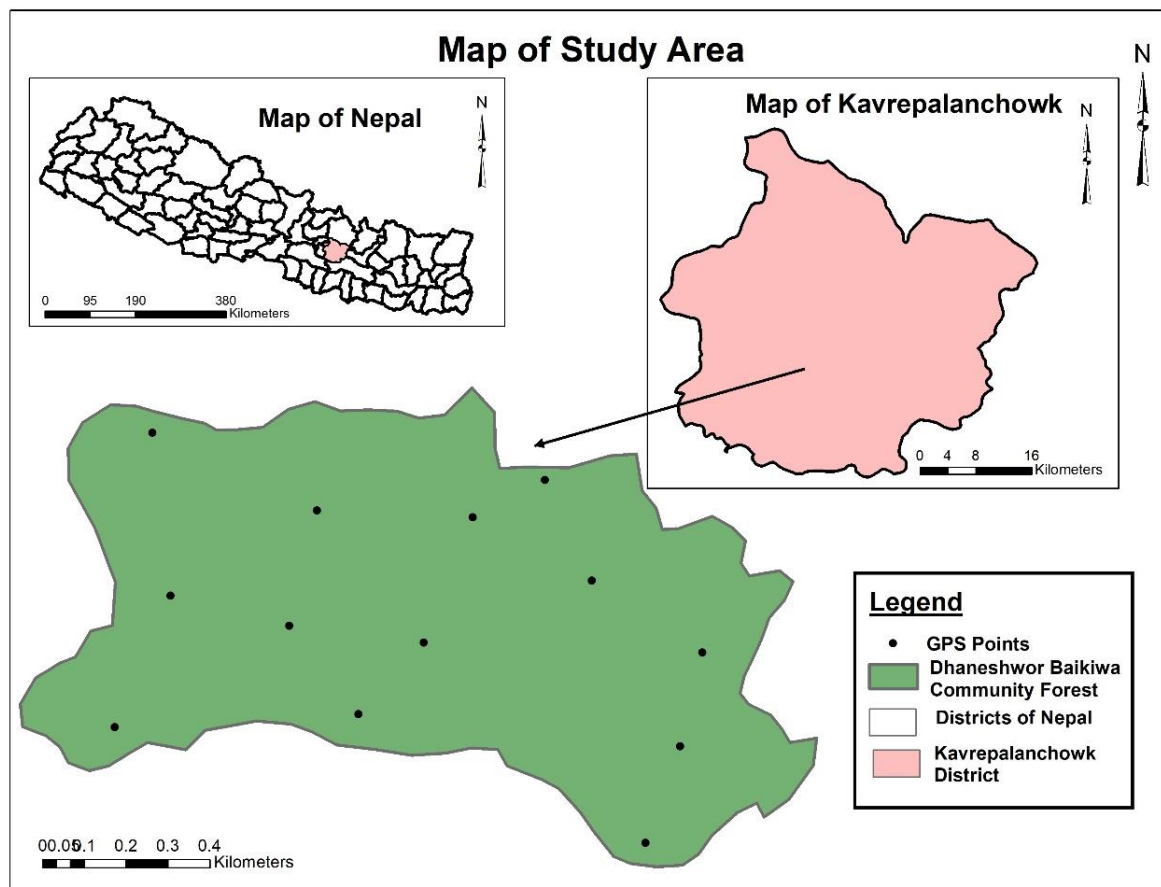


Figure 1: Map of the Study Area.

3.1.2 Flora and Fauna

The forest has temperate and sub-tropical types of vegetation. The main vegetation found in this region are Katush (*Castanopsis indica*), Chilaune (*Schima walichii*), Utis (*Alnus nepalensis*), Salla (*Pinus roxburghii*), Dudhilo (*Ficus nemoralis*), Peepal (*Ficus religiosa*), Lapsi (*Choerospondias axillaris*), Phalant (*Quercus* spp.), Moso Bamboo (*Phyllostachys pubescens*), Gurans (*Rhododendron ferrugineum*) with different types of shrubs including Banmaara (*Eupatorium glandulosum* Kunth), Amriso (*Thysanolaema maxima*), Koiralo (*Bauhinia variegata*), Kimbu (*Morus alba*), Aiselu (*Rubus ellipticus*) herbs like Titepaati (*Artemisia vulgaris*), Barro (*Terminalia bellurica*), Harro (*Terminalia chebula*) and grasses. Fauna like Leopard (*Panthera pardus*), Barking deer (*Muntiacus muntjack*), Porcupine (*Hystrix indica*), Wild boar (*Sus scrofa*), Mongoose (*Helogale parvula*) can be found in this forest. (DFO Kavrepalanchowk 2014).

3.2 Materials

- GPS: Garmin Etrex 10
- Camera: Nikon D5300 with 75-300 mm telelens
- Binocular: Olympus 8×40
- Field guide book “Birds of Nepal” (Grimmett et al. 2016)
- Record sheets

3.3 Research Design

The study was initiated by conducting a preliminary field survey during September, 2018 visiting two days to gather related information about study area. Field research design was made using the map of Dhaneshwor Baikiwa Community Forest, Google Earth and field preliminary survey. Bird sampling was done at three different habitats including the forest, shrub land and open areas in the study area. Habitat was categorized on the basis of presence of vegetation in the study area. Altogether, 13 points count stations was established within study plots representing each habitat according to the birding route and keeping each point at the difference of 200 meters. A total of 20 visits were made; 10 visits in each season. i.e. summer and winter season. Surveys were carried out within the months of 03-12 January 2019 (winter) and 25 April-3 May, 2019 (summer) to assess seasonal variation of birds.

3.4 Methods

Following methods were employed during the study period:

3.4.1 Point Count Method

Birds were observed through Point Count Method as described by (Sutherland 2006). Location of 13 points was determined using Geographic positioning system (GPS) in the birding route with the intervals of 200 m between two points. Birds observation were done early in the morning from 07:00 to 11:00 hrs. during summer and winter season. A total of 20 days was spent in the field visiting 10 days during summer season and 10 days during winter season. The area was scanned with the help of binoculars for about 20 minutes to observe, count and identify bird species. Birds were recorded by direct observation and calls aided by photographs and Field guide book “Birds of Nepal” (Grimmett et al. 2016).

3.4.2 MacKinnon’s Listing Method

Birds were also counted by using Mackinnon’s listing method (Mackinnon and Philips 1993). Each new encountered (seen and heard) species was recorded until a list of 20 species reach. Then a new list (number two) was started and another 20 species was recorded. Each list contained 20 different species but subsequent list might include species which was previously listed. During the survey, much care was taken to avoid repeating same species in the same list, but to list the species in the subsequent lists. A final running species total was obtained by extracting the number of species in list two that would not be in the list one and so on throughout all the recording for that area. Same process was repeated for both summer and winter visits separately and collectively.

In order to find the factors that affect the diversity of birds, the birds in different habitats: forest, shrub land and open habitat as well as the disturbances variables which included the distance to nearest settlement, number of trails, livestock and fodder collection were measured and noted on record sheets.

3.5 Data Analysis

Data obtained from field were arranged, organized and entered into Microsoft Excel 2016 for analysis. Nomenclature and systematic orders of birds was followed from Bird Conservation Nepal (BCN) official checklist 2018. The status of residential and migratory birds was assessed with the help of “Birds of Nepal” field guide book. The conservation status of the birds was identified by using IUCN Red List (IUCN, 2018) along with CITES category (DNPWC and BCN 2018). Bar diagram and Pie-chart were drawn by using Microsoft Excel 2016 computer software.

Species Discovery Curve was prepared for bird species on the basis of Mackinnon’s Lists. Curve was prepared by plotting cumulative total of species detected against number of list and compared across both seasons.

Avian diversity of each habitat was analyzed using Shannon-Wiener Diversity Index (H') (Shannon and Weaver 1949) which was calculated from the software PAST version 3.25 (Hammer et al. 2001). Paired T- test was performed to compare bird diversity in different habitat and seasons.

Percentage Relative abundance was calculated using formula $(R.A.) = n/N \times 100\%$

where,

n = the number of individuals of particular species recorded

N = the total number of individuals of the species

For describing frequency of occurrence and comparative abundance, the terms described by (Bull 1974) were used as follows:

Table 1: Categories of Occurrence Status of Avian Diversity

S.N.	Individual Number of Species	Abundance Categories
1.	51-200	Very Common
2.	21-50	Common
3.	5-20	Fairly Common
4.	1-4	Rare

Canonical correspondence analysis (CCA) was used to compare the association of species with different habitat types and disturbance variables. The response of different birds with habitat types and disturbance variables was performed by using Program CANOCO v4.5. The final result was presented in the form of biplot. Monte-Carlo Permutation Test by using 499 permutations under reduced model was used to identify those variables which were significantly associated. For every ordination, down weighting of rare species was done.

Table 2: Details of Variables Used for CCA Analysis.

Parameters	Variables	Description and CANACO levels
Habitat variables	Habitat types	Forest: This area was dominated by dense trees with mixed vegetation type such as Chilaune (<i>Schima walichii</i>), Katus (<i>Castanopsis indica</i>) and Utis (<i>Alnus nepalensis</i>), etc.
		Shrub land: This area was dominated by bushes and shrubs. The shrubs included Banmaara (<i>Eupatorium glandulosum Kunth</i>), Narayanpaati (<i>Buddleja paniculata</i>), etc.
		Open Areas: This area was dominated by grasses, herbs, barren lands, ditches, streams etc.
Disturbance Variables	Distance to nearest settlement	Euclidean distance measured from sampling point to the nearest settlements by the help of google earth.
	Number of human trails	Euclidean distance measured from sampling point to the nearest trails or roads used by people by the help of google earth.
	Livestock	Presence or absence of livestock in the sampling points.
	Fodder collection	Presence or absence of fodder collection by people through direct observation within sampling points during point count.

4. RESULTS

4.1 Seasonal Diversity of Birds of Dhaneshwor Baikiwa Community Forest

4.1.1 Species Composition of Birds of Dhaneshwor Baikiwa Community Forest

A total of 1,569 individuals of 108 bird species belonging to 15 orders and 43 families were recorded from the study area (Appendices 1). Out of total birds, Passeriformes was the most dominant order including 26 families and 73 species followed by seven species from Piciformes and five species from Cuculiformes while the least dominant order were Galliformes, Caprimulgiformes, Bucerotiformes, Otidiformes and Accipitroformes represented by single species each (Figure 2). At the family level, the highest number of species was from Muscicapidae represented by 12 species followed by five species each from Cuculidae and Corvidae (Figure 3).

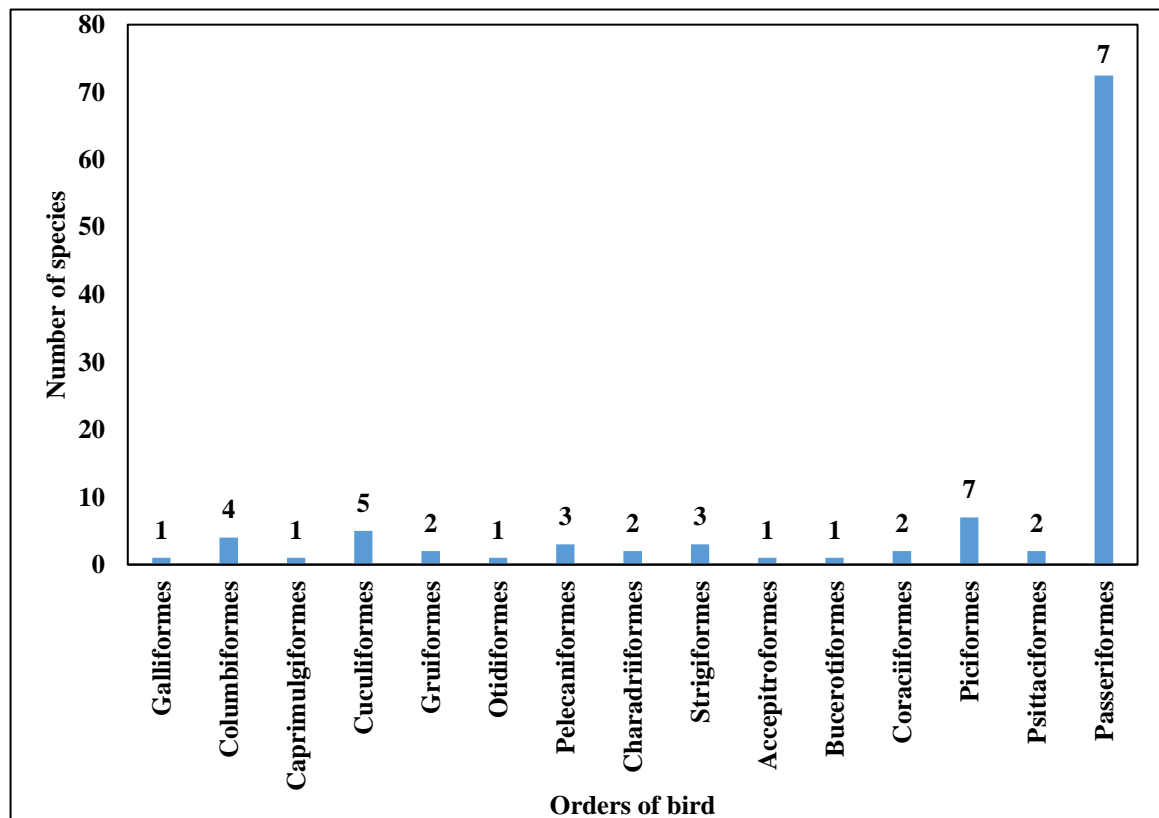


Figure 2: Total Number of Bird Orders Recorded in the Study Area.

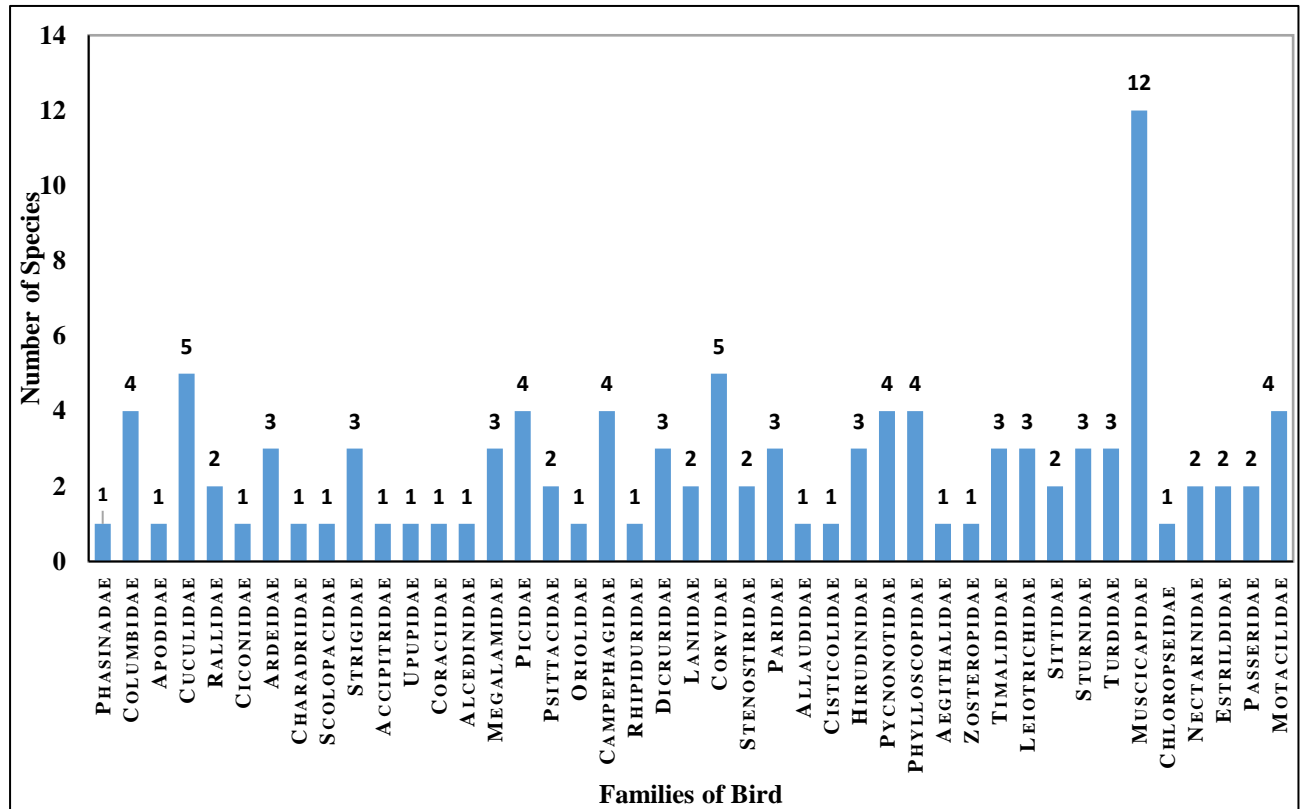


Figure 3: Total Number of Bird Families Recorded in the Study Area.

4.1.2 Seasonal Variation of Birds of Dhaneshwor Baikiwa Community

Forest

From the 108 species of birds identified during the study period, 81 species belonging to 13 orders and 36 families were recorded during winter season producing 13 Mackinnon’s List while 72 species belonging to 11 orders and 35 families were recorded during summer seasons producing 12 Mackinnon’s List. Forty-five species were found common in both summer and winter seasons. The highest bird diversity was observed during winter season ($H= 3.929$) than during summer season ($H=3.808$). There was also seasonal variation of species evenness which showed that birds were more evenly distributed in winter season ($E=0.627$) than summer season ($E=0.625$) (Table 3). However, there was no significant difference in seasonal diversity of birds ($t=0.19$, $df=11$, $P=0.85$).

Table 3: Avian Diversity Index of the Study Area During Summer and Winter Season

Season	No. of species	No. of individuals	H	E
Winter	81	706	3.929	0.627
Summer	72	849	3.808	0.625

The species discovery curve showed the cumulative total number of species seen during summer and winter season in the study area that which revealed that the frequency of adding new birds to list was more in winter season than summer season. The number of species was listed rapidly during winter season than in summer season. Similar number of species were recorded at certain lists. However, the curve was not saturated and still rising upward during both seasons. So, there were still chances to record new birds in the study area (Figure 4).

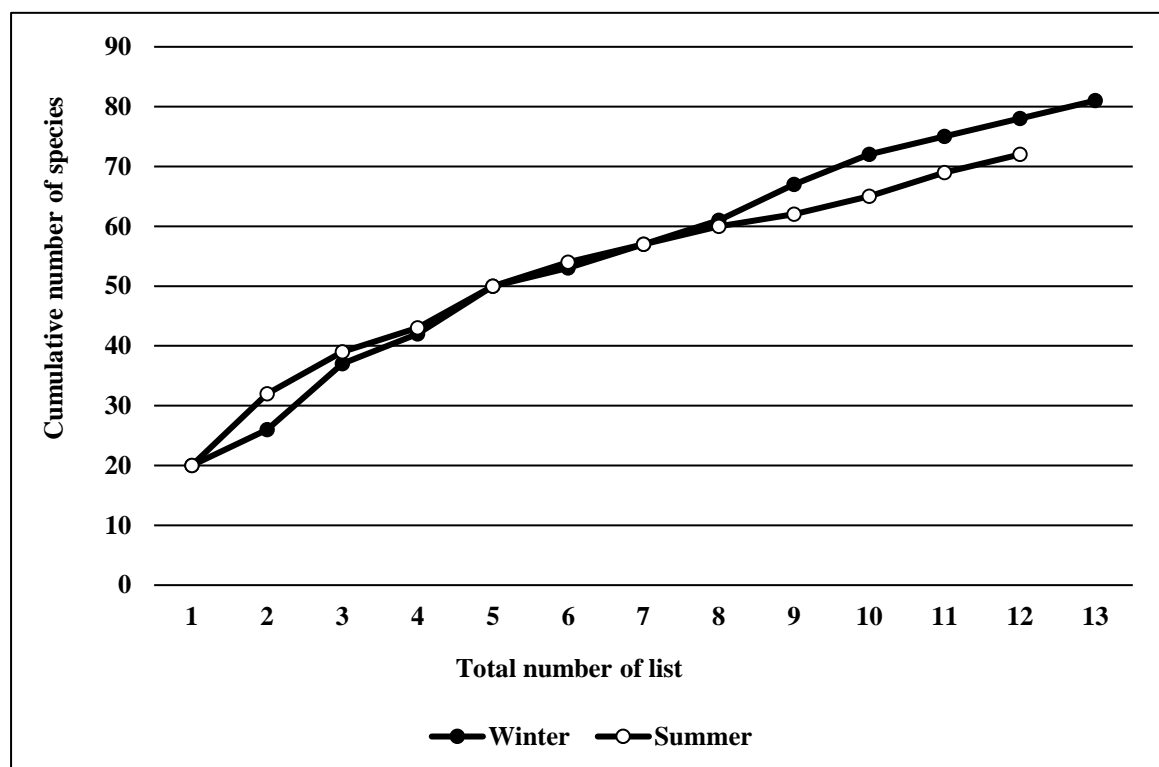


Figure 4: Species Discovery Curve Showing Cumulative Total Number of Species Seen During Summer and Winter Season in the Study Area.

4.2 Local Occurrence, Migratory and Threatened Status of Birds of Dhaneshwor Baikiwa Community Forest

4.2.1 Abundance and Local Occurrence Status

Birds abundance was higher during summer season than in winter season although the species richness was higher during winter season than in summer season. Out of 1,569 recorded individuals, 706 individuals were recorded during winter season while 849 species were recorded during summer season. However, there was no significant difference in seasonal abundance of birds ($t = 1.36$, $df = 11$, $P = 0.19$).

Based on the percent relative abundance computation, Cattle egret (*Bubulcus ibis*) (6.95%) was the most dominant bird species when both summer and winter season was considered together in the study area. When each season was considered separately, Cattle egret (*Bubulcus ibis*) (8.47%) was the most dominant bird species in summer season while Red Vented Bulbul (*Pycnonotus cafer*) (7.65%) was the most dominant bird species in winter season (Table 4).

Table 4: Top Five Ranking of Abundant Species Among Two Seasons Across the Study Area Based on Percent Relative Abundance.

S.N.	Species Name	Across the study Area		Summer Season		Winter Season	
		R.A(%)	Rank	R.A (%)	Rank	R.A(%)	Rank
1.	Cattle egret (<i>Bubulcus ibis</i>)	6.95	1 st	8.47	1 st	5.15	2 nd
2.	Red-vented Bulbul (<i>Pycnonotus cafer</i>)	6.76	2 nd	6.00	2 nd	7.65	1 st
3.	House Crow (<i>Corvus splendens</i>)	4.97	3 rd	4.94	4 th	5.01	3 rd
4.	Red Billed Blue-Magpie (<i>Urocissa flavirostris</i>)	4.27	4 th	5.29	3 rd	3.06	-
5.	Common Myna (<i>Acridotheres tristis</i>)	4.27	4 th	4.24	-	4.31	4 th
6.	Common Pigeon (<i>Columba livia</i>)	3.95	5 th	4.35	5 th	3.48	-
7.	Grey hooded Warbler (<i>Seicercus xanthoschistos</i>)	3.57	-	3.18	-	4.03	5 th

Local occurrence status revealed that seven species were very common, 15 species were common, 41 species were fairly common and 45 species were rare (Figure 5). Very common species were Common Pigeon, (*Columba livia*), Cattle Egret (*Bubulcus ibis*), Red-billed Blue Magpie (*Urocissa flavirostris*), House Crow, (*Corvus splendens*), Common

Myna (*Acridotheres tristis*), Red-vented Bulbul (*Pycnonotus cafer*) and Grey-hooded Warbler (*Seicercus xanthoschistos*). During summer season, two species were very common, seven species were common, 37 species were fairly common and 26 species were rare while during winter season, one species was very common, eight species were common, 39 species were fairly common and 33 species were rare (Figure 6).

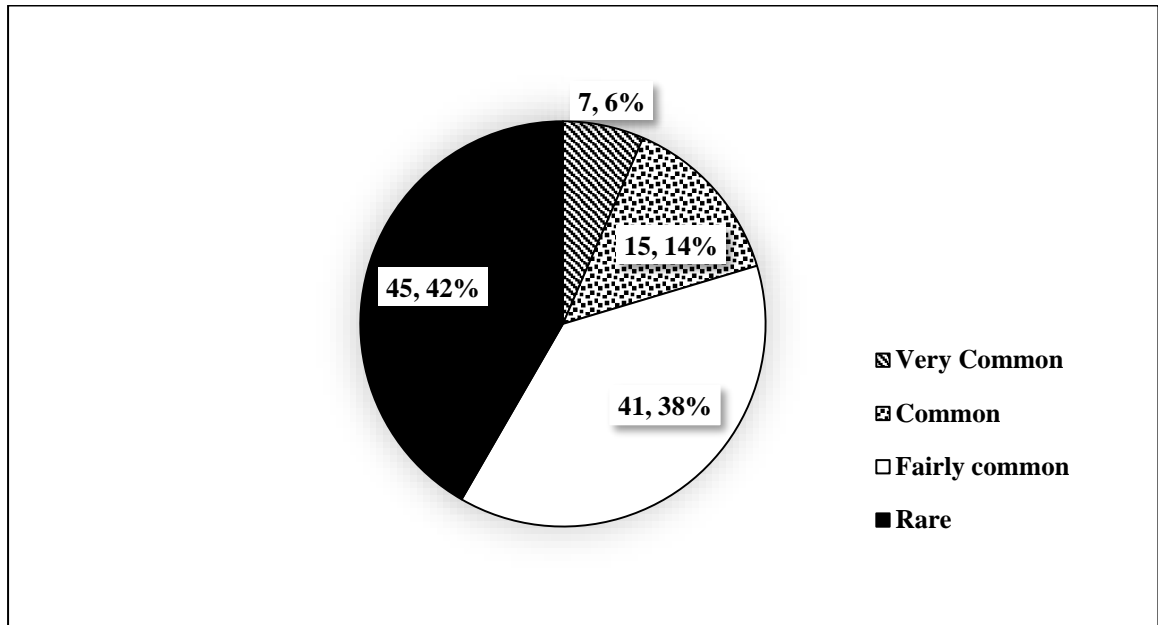


Figure 5: Local Occurrence Status of Recorded Birds in the Study Area.

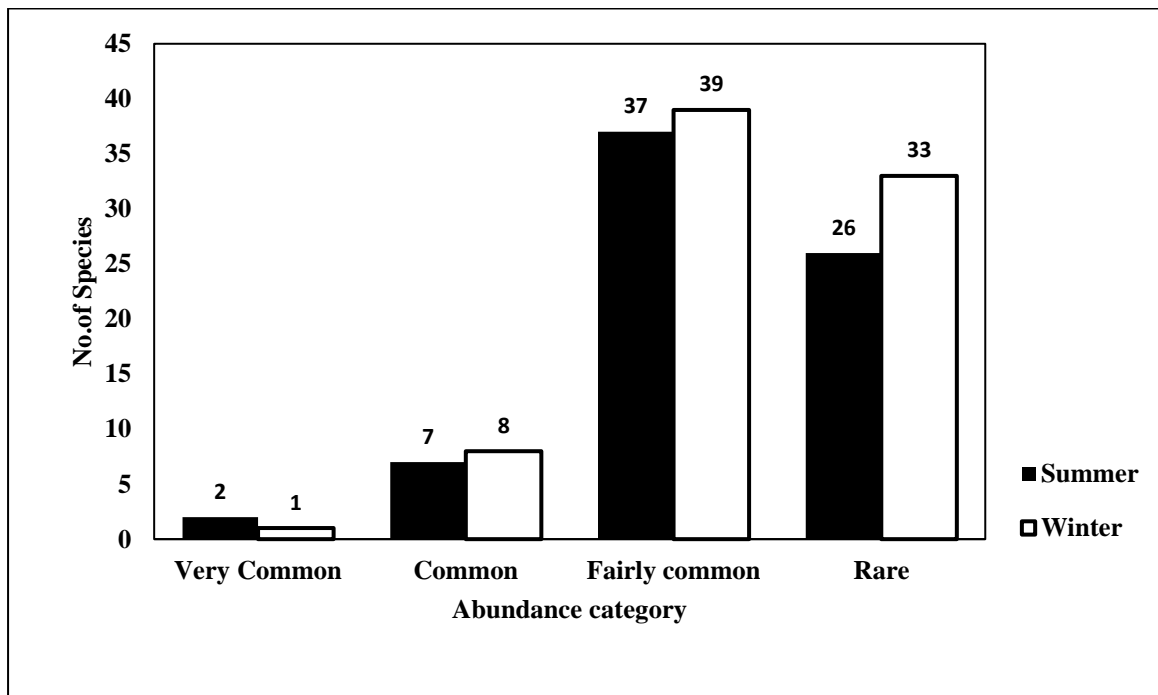


Figure 6: Local Occurrence Status of Recorded Bird Species in the Study Area.

4.2.2 Migratory Status

During the study period, 79 species were residential birds, 12 birds were summer visitors, 13 birds were winter visitors while four birds were passage migrants (Figure 7). During winter season, out of 81 recorded species, 65 species belonged to residential species, 13 species belonged to winter visitors and three species belonged to passage migrants. Similarly, during summer season, out of 72 recorded species, 56 species belonged to residential species, 12 species belonged to summer visitors and four species belonged to passage migrants. Similar number of summer and winter migrants were recorded (Appendix 1).

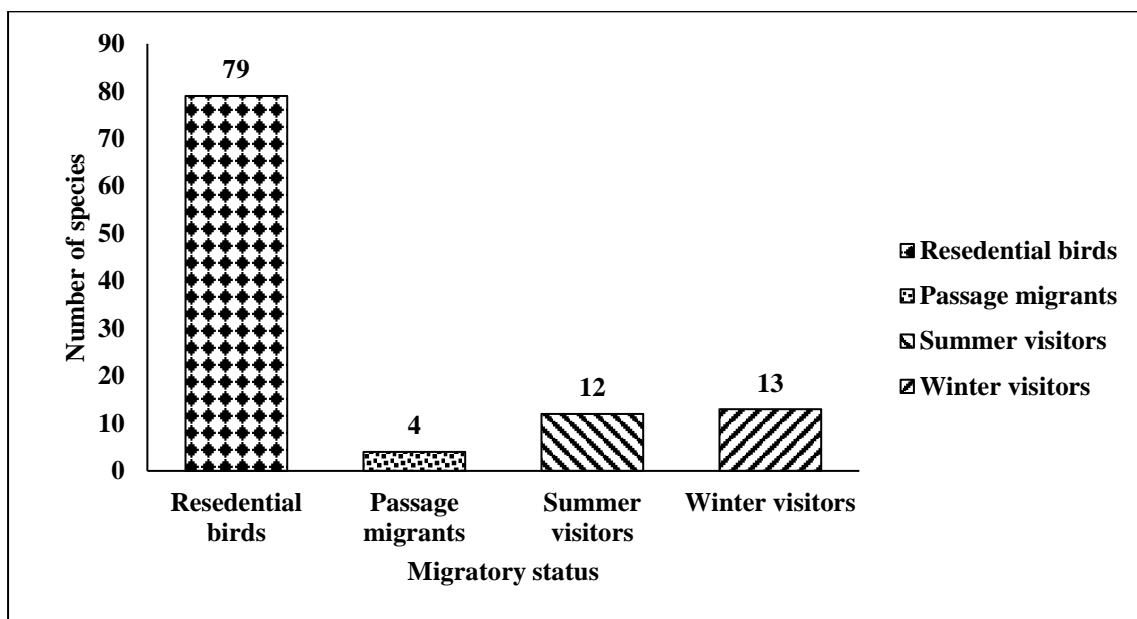


Figure 7: Migratory Status of Birds Recorded in the Study Area.

4.2.3 Threatened Status

Out of 108 species, 106 species were categorized as Least Concern in IUCN Red List and which comprises 98% of the identified species. Only one species i.e. Asian Woollyneck (*Ciconia episcopus*), globally vulnerable was recorded. Similarly, only one species i.e. Alexandrine Parakeet (*Psittacula eupatria*) which was categorized as Near Threatened in IUCN Red List was recorded. Similarly, Kaliz Pheasant (*Lophura leucomelanos*) and five species of birds which included Asian Barred Owlet (*Glaucidium cuculoides*), Collared Owlet (*Glaucidium brodiei*), Spotted Owlet (*Athene brama*), Black Kite (*Milvus migrans*) and Alexandrine Parakeet (*Psittacula eupatria*) are listed in CITES category III and II were recorded; respectively (Table 5).

Table 5: Status of Threatened Birds on the Basis of IUCN Red List 2018 and CITES Category.

IUCN category		CITES category
Vulnerable Species	Near Threatened Species	
Asian Woollyneck	Alexandrine Parakeet	Kaliz Pheasant III
		Asian Barred Owllet II
		Collared Owllet II
		Spotted Owllet II
		Black Kite II
		Alexandrine Parakeet II

4.3 Factors Affecting Bird Diversity

4.3.1 Effect of Habitat on the Bird Diversity

The CCA ordination diagram showed how bird species responded to different habitat types. The result of CCA ordination revealed a strong species-habitat correlation on axes I and II. First two axes were displayed. The first axis and the second axis accounted for 48.6% and 28.8% of the variability respectively. The Monte-Carlo permutation test of significance of all canonical axes showed the significant relationship between the species-habitat variables (Trace = 0.866, F = 1.334, P= 0.002 (with 499 permutations). The maximum abundance of species such as Black Bulbul (*Hypsipetes leucocephalus*), Scaly Thrush (*Zoothera dauma*), Collared owllet (*Glaucidium brodiei*), Black-naped Woodpecker (*Picus guerini*), Yellow-bellied Fairy-Fantail (*Chelidorhynch hypoxantha*), Velvet Fronted Nuthatch (*Sitta frontalis*), Scarlet Minivet (*Pericrocotus lammeus*), etc. were closely associated with forest habitat. The maximum abundance of species such as Indian Pond Heron (*Ardeola grayii*), White Wagtail (*Motacilla alba*), Oriental Turtle Dove (*Streptopelia orientalis*), Spotted Dove (*Streptopelia chinensis*), Common Myna (*Acridotheres tristis*), Long-tailed Shrike (*Lanius schach*) etc. were mainly associated with open habitats while the maximum abundance of species such as Paddy-field Pipit (*Anthus rufulus*), Blyth's Leaf Warbler (*Phylloscopus reguloides*), Blue-throated Barbet (*Megalaima asiatica*) and Common Tailorbird (*Orthotomus sutorius*) were higher at shrub land (Figure 8).

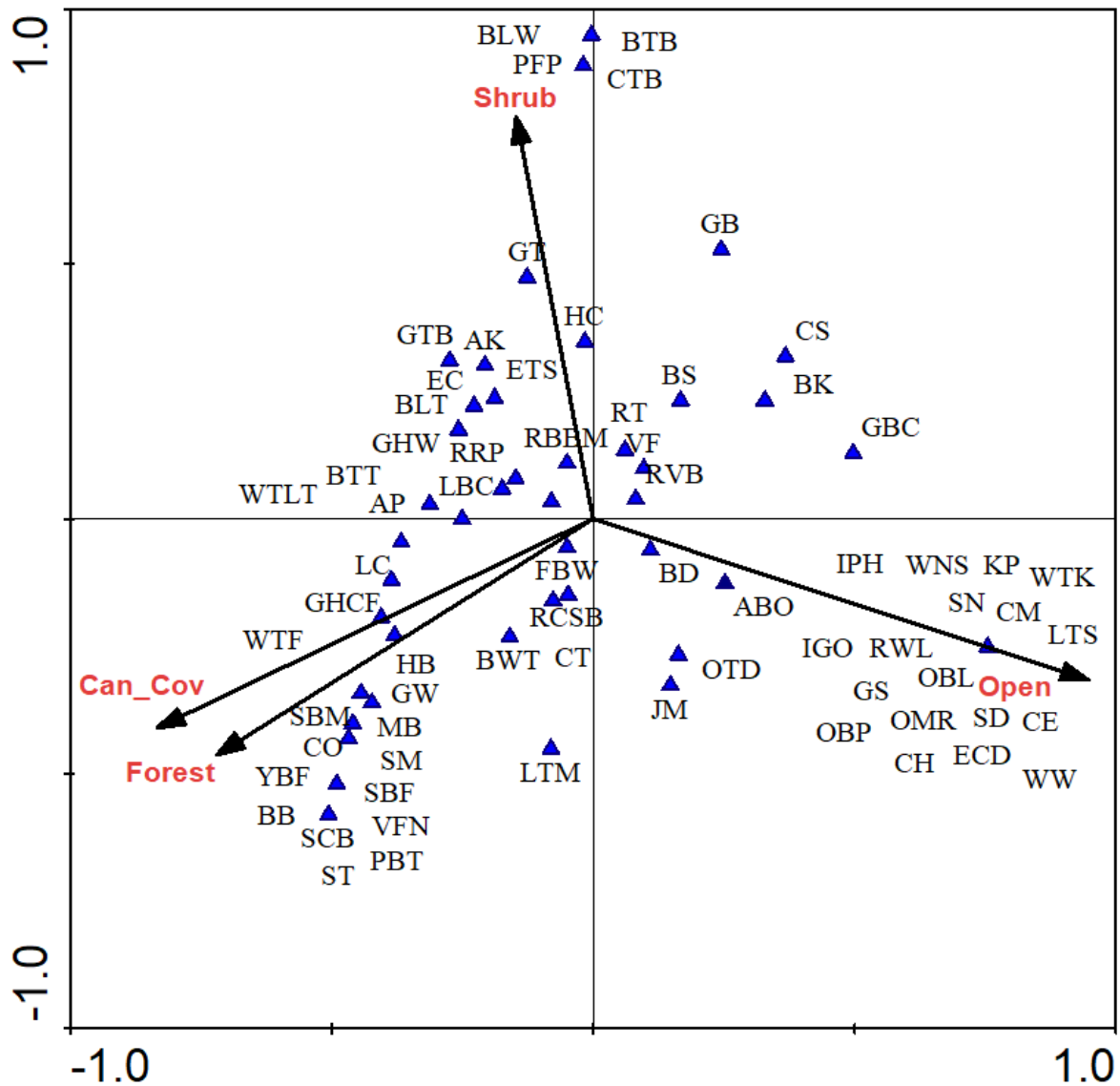


Figure 8: CCA Ordination Diagram (Biplot) Showing Species Response to Different Habitats in the Study Area. Forest along with canopy cover, open area and shrub land are shown. Rest of the term represent the species common name (Appendix 2). The triangle represents the species. The arrows represent each of the disturbance variables plotted pointing in the direction of maximum change of explanatory variables.

4.3.2 Effect of Disturbance Variables on the Bird Diversity

CCA diagram showed that the bird diversity was generally influenced by fodder collection, distance to nearest settlement, number of human trails and livestock grazing. There was strong correlation between the species-disturbance variables in axis I and axis II. The first axis and the second axis accounted for 34.3% and 25.3% of the variability respectively. The Monte-Carlo permutation test of significance of all canonical axes showed the significant relation between species-disturbance variables (Trace = 1.075, F = 1.236, P= 0.020 (with 499 permutations). The maximum abundance of species such as Slaty-backed Forktail (*Enicurus schistaceus*), Black Bulbul (*Ardeola grayii*), Velvet-Fronted Nuthatch (*Sitta frontalis*), Streak-breasted Schimitar Babbler (*Pomatorhinus ruficollis*) showed more tolerant to distance to nearest settlement but less tolerant towards fodder collection. The maximum abundance of species such as Cattle Egret (*Bubulcus ibis*), Grey Bushchat (*Saxicola ferreus*), Indian Pond Heron (*Ardeola grayii*), Olive-backed Pipit (*Anthus hodgsoni*), White-breasted Kingfisher (*Halcyon smyrnensis*), Common Hoopie (*Upupa epops*) showed more tolerant to the number of Human trails while the species such as Oriental-Magpie Robin (*Copsychus saularis*), Crimson Sunbird (*Aethopyga siparaja*), Eurasian-collared Dove (*Streptopelia decaocto*), Kaliz Pheasant (*Lophura leucomelanos*) showed more tolerant to fodder collection conditions. Among all the variables, the association of maximum abundance of species was higher with distance to the nearest settlements (Figure 9).

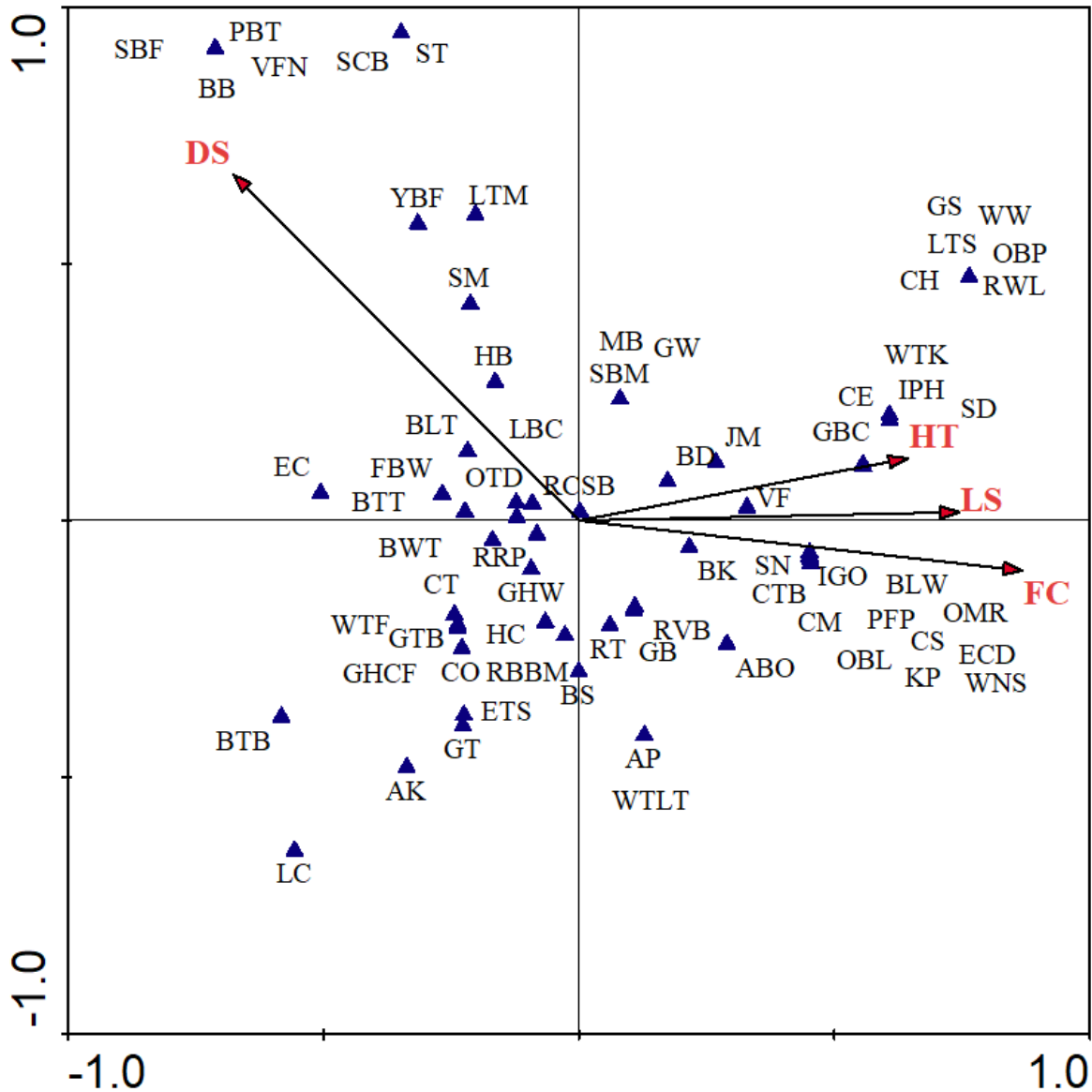


Figure 9: CCA ordination diagram (biplot) showing species response to disturbance variables in study area. (DS = Distance to nearest settlement, HT = Human Trail, LS = Livestock and FC = Fodder Collection). Rest of the term represent the species common name (Appendix 2). The triangle represents the species. The arrows represent each of the disturbance variables plotted pointing in the direction of maximum change of explanatory variables.

5. DISCUSSION

5.1 Species Composition and Seasonal Variation of Birds of Dhaneshwor Baikiwa Community Forest

In the present study, higher number of bird diversity was found higher within the small area. Relatively high species diversity of avian fauna in the area could be attributed to the various habitat types (vegetation types) that constitute the area and these could provide them different arrays of foraging opportunities and nesting sites (Girma et al. 2016). The highest number of species was recorded from the Passeriformes order of the total identified species. Passeriformes was also numerically the dominant order in the study carried out by (Chaudhary et al. 2009) in Khata corridor Forest, Nepal. The study conducted by (Husein et al. 2019) also recorded the highest number of species from Passeriformes order in Nansebo Forest, Southern Ethiopia. Similarly, the present study found the highest number of species from Muscicapidae family followed by Corvidae and Cuculidae. (Kandel et al. 2018, Thakuri et al. 2018) also found the Muscicapidae as the most common and diversely represented family during the study conducted in Kanchanjunga landscape of Eastern Himalayas and Western Nepal respectively. Singh (2015) also found the Muscicapidae as the most dominating family recording highest number of species followed by Corvidae.

The result of the present study revealed the higher bird diversity during winter season than during summer season. This might be due to increase in local movement of birds in search of food resources and easy detection of birds as in this season defoliation of the plants occur which made birds to be detected easily. The result was in agreement with the study conducted by (Katuwal et al. 2018, Tzortzakaki, et al. 2018) where the higher number of species was recorded in winter season than in summer season. When there was defoliation of the most of the plants, some species can probably move spatially to optimize their search for resources (Almazan-Nunez et al. 2015) and open habitats could favor the foraging activity (Otieno et al. 2011). Hailu (2008) stated that open areas could make easy sighting of avian fauna clear for identification and classification as well as counting. During the study conducted in Bardiya National Park, the diversity of bird was found higher in winter season as the flowering in early winter assured food availability (Acharya 2013). Assemblage of many migratory birds in the winter season due to favorable ecological and climatic conditions also contributed to high species richness (Parajuli 2016). Birds were unable to tolerate the high temperature in summer season which might lead to recording

low species in summer (Pokherel 2015). However, similar study conducted at Kanchanjunga Conservation Area, higher number of species were recorded in the spring season than in winter season (Aryal 2013). 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 counting summer migrants (Katuwal et al. 2018).

5.2 Local Occurrence, Migratory and Threatened Status of Birds of Dhaneshwor Baikiwa Community Forest

Although the diversity of bird was higher in winter season, the higher abundance of the birds during summer season than during winter season might be due to the availability of food resources such as seeds of Chilaune (*Schima wallichii*), Peepal (*Ficus religiosa*) which would provide diverse food resources to birds and breeding season of birds. In this season, breeding of most of the birds occurred which might lead to the increase in the number of the species. This is similar with the finding of (Abie et al. 2019) where the species abundance was higher in summer season as wet season created conducive environmental condition for bird species in terms of food, cover and other habitat requirements to had high distribution in the study area. The seasonal movement patterns, local and regional habitat changes, large-scale population would change and climatic conditions could cause the variation in species abundance between different seasons (Gaston et al. 2000, Aynalem and Bekele 2008). However, the study conducted by (Gomes et al. 2017) found the lower species abundance during the breeding season. Herzog et al. (2003) also found minimum abundance of birds in winter season in a study in central Bolivia.

In the present study, Cattle Egret (*Bubulcus ibis*) was the most dominating species when both seasons were considered together and was most dominating species in summer when both seasons were considered separately. This might be due to the adaptation of the species in diverse habitat conditions. Cattle Egret are gregarious birds that feed in flocks, breed colonially and establish large roosting places in permanent and temporary swamps or trees (de La Pena 1992). The abundance of Cattle Egret was higher in summer season in comparison to the winter season which might be due to the availability of the food resources and the breeding during summer season. The study conducted by (Ducommun et al. 2008) also found the feeding efficiency of the species varied seasonally with the increase in density of the insect during summer season. However, the study conducted by (Sharma and Soni 2014) found the higher abundance of Cattle Egret in rainy season than during summer and winter season due to the higher prey availability. Relative abundance values did not

necessarily reflect true abundances of species, but might be influenced by interspecific differences and seasonal changes in detectability (Herzog et al. 2003).

In the present study, Common Pigeon, (*Columba livia*), Cattle Egret (*Bubulcus ibis*), Red-billed Blue Magpie (*Urocissa flavirostris*), House Crow, (*Corvus splendens*), Common Myna (*Acridotheres tristis*), Red-vented Bulbul (*Pycnonotus cafer*) and Grey-hooded Warbler (*Seicercus xanthoschistos*) were very commonly seen species. The feeding behavior and adaptation of these species in diverse habitat structure rather than climatic condition might results in their maximum sighting of these species in both seasons. The species such as White-breasted Waterhen (*Vanellus indicus*), Ruddy brested Crake (*Porzana fusca*), Indian Pond Heron (*Ardeola grayii*), Little egret (*Egretta garzetta*), and the passage migrants Green Sandpiper (*Tringa ochropus*) and Red-wattled Lapwing (*Vanellus indicus*) were observed near the water resources which provide the variety of food resources to those species. Similar study conducted by (Basnet et al. 2005) also reported White-breasted Waterhen (*Amaurornis phoenicurus*) and Little Cormorant (*Phalacrocorax niger*) mainly from aquatic habitat and seven species such as Cattle Egret (*Bubulcus ibis*), White-throated Kingfisher (*Halcyon smyrnensis*), Red-wattled Lapwing (*Vanellus indicus*) and Indian Pond Heron (*Ardeola grayii*) from aquatic as well as agricultural habitat in Rajarani Community Forest of Morang. Although the nocturnal birds were excluded from the study, the three species of owlet i.e. Asian Barred Owlet, Collared Owlet and Spotted Owlet were sighted during day time as they were resting in their shelter and hence recorded in the study.

In the present study, out of 108 species, 79 species were residential birds, 12 birds were summer visitors, 13 birds were winter visitors while four birds were passage migrants. Study conducted by (Pokherel 2015) recorded 44 residential species, five species of winter visitors and six species of summer visitors out of 55 species. One globally vulnerable species Asian Woollyneck (*Ciconia episcopus*) and one Near Threatened Species Alexandrine Parakeet (*Psittacula eupatria*), categorized in IUCN Red List (IUCN 2018). was recorded including one and four species categorized in CITES appendix I and III respectively in the present study. Woolly-necked Stork was sighted only during winter season while Alexandrine Parakeet was sighted in both summer and winter season. Thakuri (2013) reported globally threatened Red-headed Vulture (critically endangered), Satyr Tragopan (near threatened), River Lapwing (near threatened) and nationally threatened Ibis bill (endangered), Lammergeier (vulnerable) and Himalayan Griffon (vulnerable) in

Manaslu Conservation Area. There were all species in least concern category of IUCN Red data book except lesser adjutant stork which was in vulnerable category and four species were listed in CITES appendix II (Subba and Chhetri 2005). Katuwal et al. (2015) reported two nationally threatened species Barn Owl (*Tyto alba*) and Pied Thrush (*Zoothera wardii*) from Chandragiri Hill. Baral et al., 2013 reported nine globally threatened and 13 nationally threatened species in Koshi Tappu Wildlife reserve and its adjoining areas. There were four, 20 and one species of birds recorded in Sagarmatha National Park and its Buffer Zone included in CITES Appendix I, II and III respectively (SNP 2016).

5.3 Factors Affecting Bird Diversity

In the present study, birds were observed in forest, shrub land and open areas whereas the maximum abundance of species was associated towards shrub land followed by forest and open areas. This might be due to the easy accessibility of ecological requirement such as vegetation cover, availability of food in respective habitat. Similar pattern was observed in the study conducted by (Kiros et al. 2018) where the higher number of species in shrub land were found which might be due to the vegetation composition that could create variations in food sources, nesting and protection opportunities based up on the bird's habitat preference and feeding habits. Flowering plants support wide variety of birds as they feed on nectars, berry, fruits and seeds (Brook and Berkead 1991). Similar study conducted by (Nsor et al. 2018) found the higher number of species in abundance and richness in woodland and shrub land which might be due to less predation accessibility, availability of food and vegetation cover for nestling or sheltering. Within shrub and forest habitats the degree of seasonal variation in avian community composition could change with stratum (Karr 1976) whereas vegetation classification based on structural features of habitat was important in the study of birds in open habitats (Bibby et al. 1998). The variation in species dominance among different habitats could be attributed to the presence food availability, suitable cover and nesting sites, adaptation or tolerance level of the species and the degree of the threats presented in the habitats (Girma et al. 2017).

There is variation in tolerance of bird to different disturbance variables resulting in different bird assemblage as depicted in the current study. The selected variables show positive relationship on the species diversity as revealed by CCA. Nsor et al. (2014) reported farming activities, grazing pressure, and bushfires as the factors affecting bird diversity. Human settlement at some levels might limit avian productivity by diminishing resources,

increasing nest predation, competition for resources, and brood parasitism (Marzluff et al. 2001). However informal settlements that are surrounded by a mosaic of vegetation types could offer many opportunities for bird foraging and nesting (Jokimaki et al. 2012). The study conducted by (Gillespie et al. 2000) in Central America asserted that cattle reduce the capacity of seeds to germinate and that intensive grazing can generate spiny and unpalatable forests. Stern et al. (2002) found that the diversity and structure of the forests had been significantly influenced by cattle grazing in two protected areas in Costa Rica. Allowing large and repetitive livestock population in to unprotected area will also lead to loss of grassland specialist bird species (Asefa et al. 2015).

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The exploration of bird diversity was done in Dhaneshwor Baikiwa Community Forest for the first time. Passeriformes and Muscicapidae was found most dominating order and family respectively. Bird diversity and evenness was higher during winter season than during summer season as shown by Shannon winner diversity index which revealed that birds were more diverse and evenly distributed during winter season than during summer season however was not statistically significant.

Although the diversity of birds was higher in the winter season, the abundance of bird was higher in summer season. Higher number of birds were residential out of total recorded birds however, almost similar number of summer visitors and winter visitors were recorded. Asian Woollyneck and Alexandrine Parakeet which are categorized as Vulnerable and Nearly Threatened in IUCN Red List were recorded. Similarly, five species categorized in CITES appendix II and III were recorded.

Various factors that can influence the bird diversity were habitat types, distance to nearest settlements, livestock, fodder collection and number of human trails. In overall, all these factors were found to be significant as shown by CCA. The maximum abundance of species was highly associated with shrub land followed by forest and open areas. There was positive association between the disturbance variables and the diversity of birds.

Thus, the results of this study indicate that the area despite its small size is a home to large number of bird species. The occurrence of globally Vulnerable and Nearly Threatened species as well as the species which are categorized in Appendix I and II of CITES also revealed the importance of the area to conserve these species. Birds can be affected by the ecological requirements that are found in different habitats as well as different disturbances regimes can be influential in determining bird diversity.

6.2 Recommendations

Based on the research findings, following recommendations could be made:

1. Since the study was conducted during two seasons only, complete seasonal variation of bird diversity could not be explored. So, future research should be conducted in autumn, summer, spring and winter season to understand seasonal variation of birds in detail.
2. Since there are still chance of recording new bird species as shown by species discovery curve, the further research should be conducted to explore new bird species as well as to know the actual status of the birds in the study area.

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8. APPENDICES

1. Checklist of birds of Dhaneshwor Baikwa Community Forest

S.N.	Common Name	Scientific Name	Summer	Winter	Total	Abundance	L.A.C.	M.S	C.S.
A.	GALLIFORMES								
i.	Phasianidae								
1.	Kaliz pheasant	<i>Lophura leucomelanos</i>	0	6	6	0.38	FC	R	LC, III
B.	COLUMBIFORMES								
ii.	Columbidae								
2.	Common Pigeon	<i>Columba livia</i>	37	25	62	3.95	VC	R	LC
3.	Oriental Turtle Dove	<i>Streptopelia orientalis</i>	13	17	30	1.91	C	R	LC
4.	Eurasian Collared Dove	<i>Streptopelia decaocto</i>	10	6	16	1.02	FC	R	LC
5.	Spotted Dove	<i>Streptopelia chinensis</i>	9	11	20	1.27	FC	R	LC
C.	CAPRIMULGIFORMES								
iii.	Apodidae								
6.	House Swift	<i>Apus affinis</i>	0	21	21	1.34	C	R	LC
D.	CUCULIFORMES								
iv.	Cuculidae								
7.	Indian Cuckoo	<i>Cuculus micropterus</i>	4	0	4	0.25	R	SV	LC
8.	Common Cuckoo	<i>Cuculus canorus</i>	15	0	15	0.96	FC		

9.	Asian Koel	<i>Eudynamus scolopaceus</i>	11	0	11	0.70	FC	SV	LC
10.	Green-billed Malkoha	<i>Phaenicophaeus tristis</i>	7	0	7	0.45	FC	SV	LC
11.	Himalayan Cuckoo	<i>Cuculus saturates</i>	5	0	5	0.32	FC	SV	LC
E.	GRUIFORMES								
v.	Rallidae								
12.	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	1	0	1	0.06	R	R	LC
13.	Ruddy- breasted Crake	<i>Porzana fusca</i>	3	0	3	0.19	R	SV	LC
F.	OTIDIFORMES								
vi.	Ciconiidae								
14.	Asian Woollyneck	<i>Ciconia episcopus</i>	0	1	1	0.06	R	R	VU
G.	PELECANIFORMES								
vii.	Ardeidae								
15.	Cattle Egret	<i>Bubulcus ibis</i>	72	37	109	6.95	VC	R	LC
16.	Little Egret	<i>Egretta garzetta</i>	1	0	1	0.06	R	R	LC
17.	Indian Pond Heron	<i>Ardeola grayii</i>	8	5	13	0.83	FC	R	LC
H.	CHARADIFORMES								
viii.	Charadriidae								
18.	Red-wattled Lapwing	<i>Vanellus indicus</i>	9	6	15	0.96	FC	PM	LC
ix.	Scolopacidae								
19.	Green Sandpiper	<i>Tringa ochropus</i>	9	8	17	1.08	FC	PM	LC

I.	STRIGIFORMES								
x.	Strigidae								
20.	Asian Barred Owlet	<i>Glaucidium cuculoides</i>	2	4	6	0.38	FC	R	LC, II
21.	Collared Owlet	<i>Glaucidium brodiei</i>	0	1	1	0.06	R	R	LC, II
22.	Spotted Owlet	<i>Athene brama</i>	1	1	2	0.13	R	R	LC, II
J.	ACCEPITROFORMES								
xi.	Acciptridae								
23.	Black Kite	<i>Milvus migrans</i>	10	21	31	1.98	C	PM	LC, II
K.	BUCEROTIFORMES								
xii.	Upupidae								
24.	Common Hoopoe	<i>Upupa epops</i>	0	3	3	0.19	R	R	LC
L.	CORACIIFORMES								
xiii.	Coraciidae								
25.	Indian Roller	<i>Coracias benghalensis</i>	1	0	1	0.06	R	PM	LC
xiv.	Alcedinidae								
26.	White-breasted Kingfisher	<i>Halcyon smyrnensis</i>	12	10	22	1.40	C	R	LC
M.	PICIFORMES								
xv.	Megalaimidae								
27.	Great Barbet	<i>Megalaima virens</i>	20	12	32	2.04	C	R	LC
28.	Blue-throated Barbet	<i>Megalaima asiatica</i>	3	5	8	0.51	FC	R	LC

29.	Golden-throated Barbet	<i>Megalaima lineata</i>	3	0	3	0.19	R	R	LC
xvi.	Picidae								
30.	Black-naped Woodpecker	<i>Picus guerini</i>	4	0	4	0.25	R	R	LC
31.	Fulvous-breasted Woodpecker	<i>Dendrocopos macei</i>	1	4	5	0.32	FC	R	LC
32.	Speckled Piculet	<i>Picumnus innominatus</i>	0	1	1	0.06	R	R	LC
33.	Lesser Yellownape	<i>Picus chlorolophus</i>	2	0	2	0.13	R	R	LC
N.	PSITTACIFORMES								
xvii.	Psittacidae								
34.	Alexandrine Parakeet	<i>Psittacula eupatria</i>	10	6	16	1.02	FC	R	NT, II
35.	Rose-ringed Parakeet	<i>Psittacula krameri</i>	18	15	33	2.10	C	R	LC
O.	PASSERIFORMES								
Xviii	Oriolidae								
36.	Indian Golden oriole	<i>Oriolus kundoo</i>	14	0	14	0.89	FC	SV	LC
xix.	Campephagidae								
37.	Large Cuckooshrike	<i>Coracina macei</i>	0	3	3	0.19	R	R	
38.	Black-winged Cuckooshrike	<i>Coracina melanoptera</i>	4	0	4	0.25	R	R	LC
39.	Long-tailed Minivet	<i>Pericrocotus thologus</i>	14	0	14	0.89	FC	SV	LC
40.	Scarlet Minivet	<i>Pericrocotus lammeus</i>	6	10	16	1.02	FC	R	LC
xx.	Rhipiduridae								

41.	White-throated Fantail	<i>Rhipidura albicollis</i>	4	6	10	0.64	FC	R	LC
xxi.	Dicruridae								
42.	Black Drongo	<i>Dicrurus macrocerus</i>	18	10	28	1.78	C	R	LC
43.	Ashy Drongo	<i>Dicrurus leucophaeus</i>	0	6	6	0.38	FC	WV	LC
44.	Bronzed Drongo	<i>Dicrurus aeneus</i>	5	6	11	0.70	FC	R	LC
xxii.	Laniidae								
45.	Long-tailed Shrike	<i>Lanius schach</i>	21	11	32	2.04	C	R	LC
46.	Grey-backed Shrike	<i>Lanius tephronotus</i>	0	9	9	0.57	FC	WV	LC
xxiii.	Corvidae								
47.	Red-billed Blue Magpie	<i>Urocissa flavirostris</i>	45	22	67	4.27	VC	R	LC
48.	House Crow	<i>Corvus splendens</i>	42	36	78	4.97	VC	R	LC
49.	Large -billed Crow	<i>Corvus macrorhynchos</i>	9	11	20	1.27	FC	R	LC
50.	Rufous Treepie	<i>Dendrocitta vagabunda</i>	19	7	26	1.66	C	R	LC
51.	Grey Treepie	<i>Dendrocitta formosae</i>	7	5	12	0.76	FC	R	LC
xxiv.	Stenostiridae								
52.	Yellow-bellied Fairy-fantail	<i>Chelidorhynch hypoxantha</i>	0	7	7	0.45	FC	WV	LC
53.	Grey-headed Canary Flycatcher	<i>Culicicapa ceylonensis</i>	0	5	5	0.32	FC	WV	LC
xxv.	Paridae								
54.	Black-lored Tit	<i>Parus xanthogenys</i>	18	15	33	2.10	C	R	LC

55.	Green-backed Tit	<i>Parus monticolus</i>	4	7	11	0.70	FC	R	LC
56.	Cinereous Tit	<i>Parus major</i>	0	6	6	0.38	FC	R	LC
xxvi.	Alaudidae								
57.	Oriental Skylark	<i>Alauda gulgula</i>	0	1	1	0.06	R	WV	LC
xxvii.	Cisticollidae								
58.	Common Tailorbird	<i>Orthotomus sutorius</i>	2	6	8	0.51	FC	R	LC
xxviii.	Hirudinidae								
59.	Red-rumped Swallow	<i>Hirundo daurica</i>	6	0	6	0.38	FC	SV	LC
60.	Nepal House Martin	<i>Delichon nipalense</i>	12	0	12	0.76	FC	R	LC
61.	Barn Swallow	<i>Hirundo rustica</i>	10	0	10	0.64	FC	SV	LC
xxix.	Pycnonotidae								
62.	Red-vented Bulbul	<i>Pycnonotus cafer</i>	51	55	106	6.76	VC	R	LC
63.	Himalayan Bulbul	<i>Pycnonotus leucogenys</i>	12	30	42	2.68	C	R	LC
64.	Black Bulbul	<i>Hypsipetes leucocephalus</i>	16	0	16	1.02	FC	R	LC
65.	Mountain Bulbul	<i>Ixos mccllellandii</i>	0	3	3	0.19	R	R	LC
xxx.	Phylloscopidae								
66.	Grey-hooded Warbler	<i>Seicercus xanthoschistos</i>	27	29	56	3.57	VC	R	LC
67.	Blyth's Leaf Warbler	<i>Phylloscopus reguloides</i>	0	4	4	0.25	R	WV	LC
68.	Hume's Leaf Warbler	<i>Phylloscopus humei</i>	0	3	3	0.19	R	WV	LC
69.	Black-faced Warbler	<i>Abroscopus schisticeps</i>	1	2	3	0.19	R	R	LC

xxxi.	Aegithalidae								
70.	Black-throated Tit	<i>Aegithalus concinnus</i>	10	14	24	1.53	C	R	LC
xxxii.	Zosteropidae								
71.	Oriental White-eye	<i>Zosterops palpebrosus</i>	3	5	8	0.51	FC	R	LC
xxxiii.	Timalididae								
72.	Streak-breasted Scimitar Babbler	<i>Pomatorhinus ruficollis</i>	0	2	2	0.13	R	R	LC
73.	Rusty-cheeked Scimitar Babbler	<i>Pomatorhinus erythrogenys</i>	5	2	7	0.45	FC	R	LC
74.	Black-chinned Babbler	<i>Stachyridopsis pyrrhops</i>	2	0	2	0.13	R	R	LC
xxxiv.	Leiotrichidae								
75.	Nepal Fulvetta	<i>Alcippe nipalensis</i>	2	0	2	0.45	FC	R	LC
76.	White-throated Laughing Thrush	<i>Garrulax albogularis</i>	0	3	3	0.19	R	R	LC
77.	Streaked LaughingThrush	<i>Garrulax lineatus</i>	0	2	2	0.13	R	R	LC
xxxv.	Sittidae								
78.	Chestnut-bellied Nuthatch	<i>Sitta cinnamoventris</i>	3	0	3	0.19	R	R	LC
79.	Velvet-fronted Nuthatch	<i>Sitta frontalis</i>	2	3	5	0.32	FC	R	LC
xxxvi.	Sturnidae								
80.	Chestnut-tailed Starling	<i>Sturnus malabaricus</i>	17	0	17	1.08	FC	SV	LC

81.	Common Myna	<i>Acridotheres tristis</i>	36	31	67	4.27	VC	R	LC
82.	Jungle Myna	<i>Acridotheres fuscus</i>	16	13	29	1.85	C	R	LC
xxxvii.	Turdidae								
83.	Scaly Thrush	<i>Zoothera dauma</i>	0	2	2	0.13	R	R	LC
84.	Black-throated Thrush	<i>Turdus atrogularis</i>	0	1	1	0.06	R	WV	LC
85.	Plain-backed Thrush	<i>Zoothera mollissima</i>	1	0	1	0.06	R	R	LC
xxxviii.	Muscicapidae								
86.	Blue Whistling Thrush	<i>Myophonus caeruleus</i>	9	7	16	1.02	FC	R	LC
87.	Blue-capped Redstart	<i>Phoenicurus coerulenocephala</i>	0	1	1	0.06	R	WV	LC
88.	Plumbeous Water Redstart	<i>Rhyacornis fuliginosus</i>	0	1	1	0.06	R	R	LC
89.	Little Forktail	<i>Enicurus scouleri</i>	0	2	2	0.13	R	R	LC
90.	Slaty-backed Forktail	<i>Enicurus schistaceus</i>	0	4	4	0.25	R	R	LC
91.	Oriental Magpie Robin	<i>Copsychus saularis</i>	9	11	20	1.27	FC	R	LC
92.	Common Stonechat	<i>Saxicola torquata</i>	0	9	9	0.57	FC	R	LC
93.	Pied Bushchat	<i>Saxicola caprata</i>	0	1	1	0.06	R	R	LC
94.	Grey Buschat	<i>Saxicola ferreus</i>	0	4	4	0.25	R	R	LC
95.	Chestnut-bellied Rock Thrush	<i>Monticola solitaries</i>	0	1	1	0.06	R	R	LC
96.	Small Niltava	<i>Niltava macgrigoriae</i>	0	4	4	0.25	R	R	LC

97.	Verditer Flycatcher	<i>Eumyias thalassinus</i>	12	0	12	0.76	FC	SV	LC
xxxix.	Chloropseidae								
98.	Orange-bellied Leafbird	<i>Chloropsis hardwickii</i>		2	2	0.13	R	R	LC
xl.	Nectarinidae								
99.	Black-throated Sunbird	<i>Aethopyga saturate</i>	0	1	1	0.06	R	R	LC
100.	Crimson Sunbird	<i>Aethopyga siparaja</i>	1	3	4	0.25	R	R	LC
xli.	Estrildidae								
101.	White-rumped Munia	<i>Lonchura striata</i>	2	0	2	0.13	R	SV	LC
102.	Scaly-breasted Munia	<i>Lonchura punctulata</i>	1	0	1	0.06	R	R	LC
xlii.	Passeridae								
103.	House Sparrow	<i>Passer domesticus</i>	27	22	49	3.12	C	R	LC
104.	Eurasian Tree Sparrow	<i>Passer montanus</i>	24	12	36	2.29	C	R	LC
xliii.	Motacilidae								
105.	Grey Wagtail	<i>Motacilla cinerea</i>	0	1	1	0.06	R	WV	LC
106.	White Wagtail	<i>Motacilla alba</i>	0	8	8	0.51	FC	WV	LC
107.	Olive-backed Pipit	<i>Anthus hodgsoni</i>	0	4	4	0.25	R	WV	LC
108.	Paddyfield Pipit	<i>Anthus rufulus</i>	0	2	2	0.13	R	R	LC
		TOTAL	850	719	1569				

C.S. = Conservation Status, LC= Least Concern, NT= Near Threatened, VU= Vulnerable, M.S. = Migratory Status, R= Resident, WV= Winter Visitor, SV= Summer Visitor, PM= Partial Migrant, L.A.C= Local abundance category

Abundance Score:

CITES Appendices

51-200= Very Common (VC)

II. =Appendix II

21-50= Common (C)

III. = Appendix III

5-20 = Fairly Common (FC)

1-4 = Rare (R)

2. Species and their codes

S.N.	SPECIES	CODE	S.N.	SPECIES	CODE
1	Blue Whistling Thrush	BWT	28	Oriental Turtle Dove	OTD
2	Grey-hooded Warbler	GHW	29	Spotted Dove	SD
3	Grey-headed Canary Flycatcher	GHCF	30	Rusty-cheeked Scimitar Babbler	RCSB
4	Black Drongo	BD	31	Common Myna	CM
5	Yellow-bellied Fairy- fantail	YBF	32	Cattel Egret	CE
6	White-throated Fantail	WTF	33	Orange-bellied Leafbird	OBL
7	Mountain Bulbul	MB	34	Long-tailed Minivet	LTM
8	Red-vented Bulbul	RVB	35	Scaly Thrush	ST
9	Fulvous-breasted Woodpecker	FBW	36	Scarlet Minivet	SM
10	Blue-throated Barbet	BTB	37	Eurasian Tree Sparrow	ETS
11	Barn Swallow	BS	38	Crimson Sunbird	CS
12	Rufous Treepie	RT	39	Small Niltava	SN
13	Large-billed Crow	LBC	40	Oriental Magpie Robin	OMR
14	House Crow	HC	41	Kaliz Pheasant	KP
15	Black Kite	BK	42	Eurasian Collared Dove	ECD
16	Black-throated Tit	BTT	43	Rose-ringed Parakeet	RRP
17	Blyth's Leaf Warbler	BLW	44	White-breasted Kingfisher	WTK
18	Great Barbet	GB	45	Woolly necked Stork	WNS
19	Black-lored Tit	BLT	46	Red-wattled Lapwing	RWL

20	Red-billed Blue Magpie	RBBM	47	Long-tailed Shrike	LTS
21	Paddyfield Pipit	PFP	48	White Wagtail	WW
22	Common Tailorbird	CTB	49	Jungle Myna	JM
23	Grey Bushchat	GBC	50	Common Hoopoe	CH
24	Large Cuckooshrike	LC	51	Green Sandpiper	GS
25	Cinereous Tit	CT	52	Olive-backed Pipit	OBP
26	Asian Barred Owlet	ABO	53	Indian Pond Heron	IPH
27	White-throated Laughing Thrush	WTLT	54	Streak-breasted Scimitar Babbler	SCB
55	Collared Owlet	CO	63	Grey Treepie	GT
56	Slaty-backed Forktail	SBF	64	Alexandrine Parakeet	AP
57	Velvet-fronted Nuthatch	VFN	65	Indian Golden Oriole	IGO
58	Black-naped Woodpecker	GW	66	Golden-throated Barbet	GTB
59	Himalyan Bulbul	HB	67	Eurasian Cuckoo	EC
60	Verditer Flycatcher	VF	68	Black Bulbul	BB
61	Scaly-breasted Munia	SBM	69	Plain-backed Thrush	PBT
62	Asian Koel	AK			

3. Total Orders and family of recorded birds in the study area

S.N.	Order	Family	No. of species
1	Galliformes	Phasinadae	1
2	Piciformes	Picidae	4
		Magalaimidae	3
3	Bucerotiformes	Upupidae	1
4	Coraciiformes	Coraciidae	1
		Alcedinidae	1
5	Cuculiformes	Cuculidae	5
6	Psittaciformes	Psittacidae	2
7	Apodiformes	Apodidae	1
8	Strigiformes	Strigidae	3
9	Columbiformes	Columbidae	4
10	Gruiformes	Rallidae	2
11	Ciconiformes	Scolopacidae	1
		Ardeidae	3
		Ciconiidae	1
		Haematopodidae	1
12	Accipitroformes	Accipitridae	1
13	Passerioformes	Laniidae	2
		Corvidae	5
		Oriolidae	1
		Dicruridae	3
		Rhipiduridae	2
		Campephagidae	4
		Muscicapidae	13
		Sturnidae	3
		Sittidae	2
		Paridae	4
		Hirudinidae	3
		Pycnonotidae	4
Cisticolidae	1		

		Sylviidae	4
		Allaudidae	1
		Zosteropidae	1
		Passeridae	2
		Timalididae	6
		Turdidae	3
		Chloropseidae	1
		Nectarinidae	2
		Estrildidae	2
		Motacilidae	4
	Total		108

9. PHOTO PLATES



Black-throated Tit



Crimson Sunbird (♂)



Green Sandpiper



White Wagtail



Small Niltava (♂)



Spotted Owlet



Rusty Cheeked Schimitar Babler



Common Hoppie



Kaliz Pheasant (♀), (♂)



Oriental White-eye



Jungle Myna



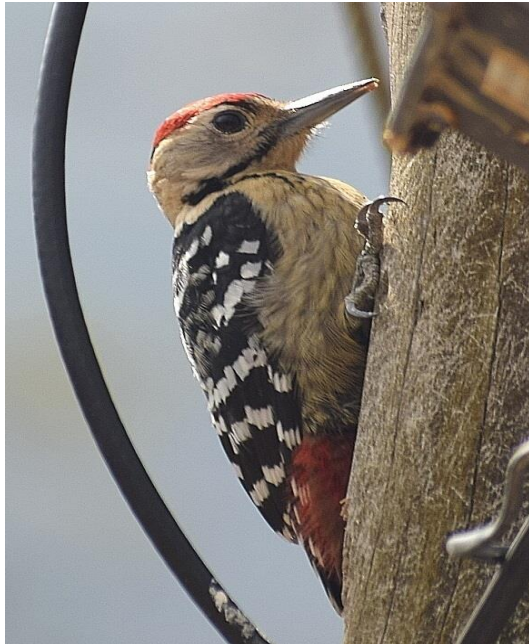
Asian Woollyneck



Eurasian Collared Dove



Chestnut-tailed Starling



Fulvous-breasted Woodpecker (♂)



Verditer Flycatcher



Plain-backed Thrush



Grey Bushchat (♀)