DIVERSITY AND RELATIVE ABUNDANCE OF AVIAN FAUNA OF KARRA RIVER, HETAUDA, MAKWANPUR, NEPAL

Kanchan Parajuli

T.U. Registration No: 5-2-19-546-2007

T.U. Examination Roll No: 21656

Batch: 2068/2069

A Dissertation submitted in partial fulfillment of the requirements for the award of the Degree of Master of Science in Zoology with special paper "Ecology and Environment"

Submitted To

Central Department of Zoology
Institute Of Science and Technology
Tribhuvan University
Kirtipur, Kathmandu
Nepal

September, 2016

TRIBHUVAN UNIVERSITY

Central Department of Zoology

Kirtipur, Kathmandu, Nepal

RECOMMENDATION

This is to recommend that the thesis entitled **"DIVERSITY AND RELATIVE ABUNDANCE OF AVIAN FAUNA OF KARRA RIVER, HETAUDA, MAKWANPUR, NEPAL"** has been carried out by Mr. Kanchan Parajuli for the partial fulfillment of Master's Degree of Science in Zoology with special paper Ecology and Environment. This is his original work and has been carried out under my supervision. To the best of my knowledge, this thesis work has not been submitted for any other degree in any institutions.

Date……..…… ……

Supervisor

Prof. Dr. Tej Bahadur Thapa

Central Department of Zoology

Tribhuvan University

Kirtipur, Kathmandu, Nepal.

Tribhuvan University

Central Department of Zoology

Kirtipur, Kathmandu, Nepal

LETTER OF APPROVAL

On the recommendation of supervisor "Prof. Dr.Tej Bahadur Thapa" this thesis submitted by Mr. Kanchan Parajuli entitled **"DIVERSITY AND RELATIVE ABUNDANCE OF AVIAN FAUNA OF KARRA RIVER, HETAUDA, MAKWANPUR, NEPAL"** is approved for the examination and submitted to the Tribhuvan University in Partial fulfillment of the requirements for Master's Degree of Science in Zoology with special paper Ecology and Environment.

Date…… ……

Prof. Dr. Ranjana Gupta

Head of Department

Central Department of Zoology

Tribhuvan University

Kritipur, Kathmandu, Nepal

TRIBHUVAN UNIVERSITY

Central Department of Zoology

Kirtipur, Kathmandu, Nepal

CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Mr. Kanchan Parajuli entitled **"DIVERSITY AND RELATIVE ABUNDANCE OF AVIAN FAUNA OF KARRA RIVER, HETAUDA, MAKWANPUR, 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'.

EVALUATION COMMITTEE

……

Supervisor
Prof. Dr. Tej Bahadur Thapa
Central Department of Zoology
Tribhuvan University
Kirtipur, Kathmandu, Nepal

…..…….

Head of Department
Prof. Dr. Ranjana Gupta
Central Department of Zoology
Tribhuvan University
Kirtipur, Kathmandu, Nepal

……..

External Examiner
Prof. Narendra Bahadur Khadka
Department of Zoology
Trichandra Multiple Campus
Ghantaghar, Kathmandu

…….

Internal Examiner
Dr. Mukesh Kumar Chalise
Associate Professor
Central Department of Zoology
Tribhuvan University
Kirtipur, Kathmandu, Nepal

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).

Date……... ……..…….

Kanchan Parajuli

kanchaanparajulimsc@gmail.com

ACKNOWLEDGEMENTS

I would like to express my deep gratitude to my academic supervisor, Prof. Dr. Tej Bahadur Thapa, Central Department of Zoology for his Continuous guidance and encouragement in carrying out this thesis work.

I am grateful to Prof. Dr. Ranjana Gupta, Head of Central Department of Zoology, T.U, for her kind support and encouragement. I would like to thanks to Small Mammals Conservation and Research Foundation (SMCRF) for partial funding for this project. My sincere thank goes to Idea Wild for granting laptop.

My sincere thank goes Mr. Hem Bahadur Katuwal, Mr. Bimal Shrestha, Mr. Kiran Thapa, Mr. Prakash Gaudel for their kind support and suggestion on this thesis work. I am thankful to Mr. Min Bahadur Gurung for helping in data analysis and map preparation. I am grateful to Mrs. Carol Inskipp for helping in identifying some photograph of birds, Mr. Devendra Dhakal and Mr. Solar Adhikari for accessing in the field work. I am equally thankful to all teaching and non-teaching staff of Central Department of Zoology.

I would like to express my appreciation to the library staffs of CDZ, IUCN, NTNC, TUCL and WWF, for providing valuable information and literatures.

Finally, I would like to express my sincere thanks to my parents, family members and my almighty, for their continuous help and encouragement to produce this thesis work.

ABSTRACT

This study has been carried out with the objective of determining seasonal diversity, relative abundance and ongoing threats to birds and their comparative study on three land use gradient in Karra river belt, Hetauda. Eighteen kilometer of transect of Karra river were surveyed by stratifying it into three blocks on the basis of disturbance. Birds were surveyed within the months of Dec/Jan 2014(winter) and May/June 2015 (summer). Birds were surveyed by using line transect methods and call count methods. Only the bird heard and seen within the band up to 50m on either side of transect were recorded. Altogether 27 hours were spent in each season in the field. All the collected data were enter in a excel sheet and analyzed. Shannon-Wiener diversity index were used to calculate species diversity and Relative abundance of avian species was determined by using encounter rates that give crude ordinal scales of abundance.

A total of 153 bird species were recorded belonging to 15 orders and 38 families. Order Passeriformes was found dominating order comprising 70 species and order Upupiformes was found to be least dominating order comprising only one species. Among 153 species, 98 species were resident, 37 species were winter visitor, 17 species were summer visitor and one species was found vagrant. One way ANOVA revealed that there was significant different ($F = 0.8872$, $df= 2$, $P < 0.0422$) in bird diversity in three different block in two different seasons. 130 species of birds were recorded from winter season and 74 species were recorded from summer season. Shannon winner diversity index shows that winter season ($H=1.86$) was more diverse than summer season ($H=1.62$). Evenness index showed that birds were evenly distributed in winter season ($E=0.8815$) than summer ($E=0.8761$). Karl Pearson's Correlation coefficient showed that there was not any relationship between bird species richness and river width ($r= -0.155$). However, bird species richness was found high in the area where the river width was buffered with good vegetation structure. Bird species richness was found high (126) in moderately disturbed land use type (block 2) than other supporting intermediate disturbance hypothesis. Out of 153 birds recorded, 26 were common in its relative abundance, 49 species were frequent, 73 were uncommon and one species- Common Myna were found most abundant. Habitat destruction, Pollution at the industrial belt, mining, overfishing, poaching and keeping of cage bird and lack of awareness were the major threats to birds around the study area.

CONTENTS

LIST OF FIGURES

Figure Title of figures Pages

LIST OF TABLES

Table Title of tables Pages

LIST OF ABBREVIATIONS

BCN	Bird Conservation Nepal
CITES	Convention on International Trades in Endangered Species of Flora and Fauna
COD CDZ	Chemical Oxygen Demand Central Department of Zoology
DNPWC	Department of National Parks and Wildlife Conservation
DO	Dissolved Oxygen
EMRRP	Ecosystem Management Restoration Research Program
ERRRP	Earthquake Risk Reduction and Recovery Preparedness Programme for Nepal
GPS	Global Positioning System
GIS	Geographic Information System
HID	Hetauda Industrial district
IUCN	World Conservation Union
NTNC	National Trust of Nature Conservation
TU	Tribhuvan University
TUCL	Tribhuvan University Central Library
UNDP	United Nations Development Programs
WWF	World Wildlife Fund

1 INTRODUCTION

1.1 Background

Birds are ecologically important creature and Nepal is remarkably blessed with rich avian diversity. A total of 878 bird species has been recorded in Nepal (Inskipp et al. 2016). The reason for richness in avian diversity is due to amazingly diverse climatic and topographical variations within the country that has provided a variety of forest and ecosystem types. Physiographic features range from the Alpine high Himalayan peaks to the tropical lowlands of the Tarai and also important is Nepal's geographical position, a region of overlap between the Palearctic realm to the north and the Oriental (Indomalayan) realm to the south (Inskipp et al. 2016).

Out of the 878 bird species recorded in Nepal, 19% have been assessed as nationally threatened of which 67 species are Critically Endangered, 38 Endangered, 62 Vulnerable and 22 are Data Deficient (Inskipp et al. 2016). A total of 37 species of Nepal's bird are globally threatened species including two vagrants and three Regionally Extinct species (Inskipp et al. 2016). The major habitat of birds includes forests, wetland and grassland. Over half (53%) of Nepal's nationally threatened birds inhabit in forests, 27% inhabits in wetlands and 15% inhabits in grasslands (BCN and DNPWC 2011). Forest and bushes contribute 77% of Nepalese breeding birds (Grimmet et al. 2000). More than 193 species are dependent on wetlands and among them 187 species are dependent on the wetland of Tarai of Nepal (Bhandari 1998).

Birds occupy an extremely diverse range of niches within riparian systems and are sensitive indicators of environmental conditions (Temple and Wiens 1989, Bryce et al. 2002). Riparian habitat are also called as 'ribbon of life' since they are considered among the most productive habitat (Johnson et al. 1977, Chaney et al. 1990). For a healthy wildlife population in riparian habitat, different ecological conditions are required such as complex vegetation structure that provides birds with nesting sites and feeding sites. The vegetation cover and habitat structure is the key to bird conservation.

Birds are important for ecological functioning of our environment such as indicators of pollution, seed dispersal, scavenging and as predators of insect pests (Shimelis and Afework 2009). They are among the best monitors of environmental changes and have been used to evaluate the environment throughout the history as "bio monitors". Hence

they are the good indicators of ecological status of any given ecosystem and are good indicator for studying the structure and composition of habitat (Bilgrami 1995 and Burel et al. 1998).

Illegal trade, water poisoning, over fishing, food scarcity, over grazing and use of pesticides, pollution from households and industrial discharges and agricultural run-off is seriously degrading the habitat of birds which are posing serious threats to birds of Nepal (Inskipp et al. 2016). Some invasive alien weeds, for instance water hyacinth in wetlands, pose serious threats and recently the climber *Mikania micrantha*, which can rapidly smother all terrestrial habitats. There is generally lack of awareness amongst the poor people on the importance and conservations of birds.

1.2 Rationale

Rivers are the important ecological corridors that play an important role in the life of water dependent species such as water birds, crustaceans, fishes and herpetofauna (Ambrose et al. 2000, Kopij 2001). Flood plain and riparian habitat is very important water bird breeding habitat and a better understanding of this area is an important research priority (Anthony 1997). Research has shown that riverine zone must meet certain minimum width criteria to provide suitable habitat for most bird species (Fischer 2000). That's why study on bird diversity and its relation to river width are very essential for bird conservation.

In Nepal, much of exploration on bird diversities are focused in conservation area and endangered species but the area like Hetauda is not studied well. There is very rare study about the birds from Makawanpur district. Many of the birds now face a wide range of threats in Nepal. Many of them are suffering from food shortage due to over fishing, fish poisoning, water pollution, hunting and trapping, and disturbance and destruction of feeding and nesting sites (Baral and Inskipp 2004). This study area is also not exception from these problems. So, this study was carried out to collect baseline data on the species richness, seasonal diversity, relation of river width on bird diversity and major threats to bird which give important contribution to better understanding of water birds of Karra River and also provide basic information necessary for the conservation of avifauna of this area.

1.3 Research Hypothesis

- Bird species richness is affected by level of disturbance.
- Bird species richness increase with increase in river width.

1.4 Objectives

The main objective was to explore the seasonal diversity and relative abundance of birds in different land use types around Karra River. The specific objectives were:

- To explore the seasonal variation in bird diversity around Karra river
- To compare bird diversity and relative abundance on three different land use type
- To identify major threats and threatened species of Karra river

2 LITERATURE REVIEW

2.1 Seasonal diversity and abundance of birds

Seasonal variation in climatic pattern has direct impact on bird species richness. The structural and functional organization of ecosystem changes as accordance to change in seasons which has direct impact on avian diversity. A seasonal change in species diversity of birds occurs in forests due to their foraging behavior (Robertson and Hack well 1995). Cueto and de Casenave (2000) in the coastal woodlands of the reserve, 'El Destino', Buenos Aires Province, Argentina found more number of birds in spring (pre-monsoon) than in autumn (post-monsoon). Poudel (2005) reported higher bird diversity in winter than in summer in Kirtipur. Basnet et al. (2005) studied the bird diversity and their status at Raja Rani Community forest, Morang. He found the high species richness in winter (71) followed by spring (64) autumn (63) and summer (61). Malla (2006) found higher species richness in winter and spring than other seasons in Nagarjun Forest, Kathmandu. Similarly, Rimal (2006) recorded the highest number of species in spring and lowest in monsoon in Shivapuri National Park. He found more birds in forest than other land use during the summer season. Murgui (2007) studied the effects of seasonality on bird species in urban parks of Valencia (Spain) and found that bird richness became higher during breeding period i.e. in spring and summer than in the winter season due to the unfavorable climatic conditions, shortage of food and predation in winter season. Giri (2008) studied the seasonal diversity of water bird in Fewa Lake, Pokhara. He recorded 31 species of birds in winter and 17 species of birds in summer season. Ghimire (2009) reported higher richness in spring than in autumn in a study done in Barandabhar corridor forest. Harsha and Hosetti (2009) recorded maximum species in Early winter (102) which was followed by summer (96), spring (90), late winter (85) respectively in Lakkavalli range forest of western Ghat, India. Katuwal (2013) recorded the high species richness of birds in post- monsoon season and low in the pre-monsoon season in Manaslu Conservation Area.

Estimation of abundance and density is the foundation for understanding changes in habitat associations and population changes (Norvell et al. 2005). A key element in the study of diversity is the relative abundance of different species at a site (Bennett 1999).

2.2 Bird diversity on different land use type

Many bird species are habitat specific and respond especially to habitat structure (MacArther et al. 1962, MacArthur 1964). Different land use practices influences the habitat, structure and composition of species (Boren et al. 1999, Brawn et al. 2001). Estrada et al. (1997) studied the distribution of birds in different land use types where they found more species in cultivated land, followed by forests, fences and pasture land. Laiolo (2004) analyzed birds on mixed forest, pure juniper forest, dwarf rhododendron shrubbery and cultivations land. He found higher diversity of birds in mixed forest whereas terraced cultivation acts as a prime habitat for the wintering birds. Waltert et al. (2005) observed higher diversity of birds in forest than farm land. Martin and Blackburn (2010) and Khanal (2008) documented higher species richness of birds along cultivated lands than forest. However, Martin and Blackburn found no significant variation of birds between secondary and primary forest type in the tropical forest of Small Island. Fardila and Sjarmidi (2012) said that though the land use and other aspects of environments are interrelated, forest always has higher species richness of birds than other land cover.

Rimal (2006) found many species of birds in disturbed habitats than undisturbed one. Similarly, Basnet (2010) after analyzing the species richness and composition of breeding birds concluded more species richness can be found in moderately disturbed area than in disturbed one. Also, he argued of having higher alpha diversity in moderately disturbed area but higher beta diversity in the disturbed landscape. Katuwal (2013) found higher species richness of birds in exploited forest, followed by natural forest, cultivated land and least in meadow, which accepted the intermediate disturbance hypothesis. Bird diversity is peak at intermediate level of human settlement primarily because of colonization of intermediately disturbed forest by early successional native species (John 2005)

Avian diversity increase with increase in riparian width, riparian vegetation diversity, and patches of riparian habitat are connected to one another and riparian habitats are connected to healthy upland habitats (Mac Arthur and Mac Arthur 1961, Whitmore 1975, Finch 1989, Croonquist and Brooks 1993). According to (Fischer 2000) to encourage a diverse avian community, riparian corridors should be as wide and as long as possible and be relatively free from improved road, human settlement and other potential impacts. Retaining riparian vegetation of proper width not only minimizes the impacts of erosion

and nonprofit source pollution; these areas also provide habitat and movement corridors for wildlife as well as benefits to fish population (Fischer et al. 1999). He said that, if avian habitat is management objective, manager should consider managing the riparian zone that is at least 100m wide. Darveau et al. (1995) compared bird abundance and species composition in riparian forest strip of varying width and founds that that riparian strip at least 60 m wide is needed to sustain forest dwelling birds.

3 MATERIALS AND METHODS

3.1 Study Area

Study area lies in Hetauda Sub-metropolitan city of Makwanpur district which is surrounded by Mahabharata range in the north and Churia range in the south. It is also called Inner Tarai region of Rapti valley and average elevation is 450 m from sea level (UNDP/ERRRP 2009).

Lithologically, the region consists of sandstones, mudstone and conglomerate UNDP/ERRRP (2009) moreover flood plain deposits consist of boulder to sand size sediments of quartzite, gneiss, dolomites and limestone of the lesser Himalayan rocks and sandstone of the Siwalik rocks. It is found along the channel of the major rivers of the area, e.g. the Rapti River, the Karra River and Samari River etc. and Hetauda is regarded as one of the main industrial areas of Nepal.

Karra River is a small sized perennial river originated from North-eastern Siwalik Hill and flows towards west to join with the Rapti River, near Hetuada city. The Karra River flows towards North-west and receives water from several streams. The South bank tributaries of the Karra River are wider and larger compared to the north bank tributaries. The flow of the Karra River during the pre-monsoon months is 0.84m^3/s and minimum flow was reported to vary within 0.65 and 0.75 m^3/s during April-May (Pradhanang 2010). The Karra River drains into the Rapti River to the west of Hetauda town. It is polluted river of Makawanpur district. The study shows that upstream of the Karra River water sample is good but as it enters the industrial belt, it gets loaded with pollutants mainly from industrial effluent (Pradhanang 2010). The study reveals that there is a considerable variation in the concentration of dissolved oxygen, chemical oxygen demand, nitrate and phosphate and heavy metals, in the upstream and industrial and downstream water samples (Pradhanang 2012). These variations may be due to the change in the volume of industrial waste being added to the river at different sampling station. Major industries in the HID are soap, chemical, dairy, bear, slaughterhouse, vegetable ghee, paint, bone, toothpaste and breweries. The river water is mostly used for agriculture, livestock management, washing, and bathing and recreation purposes.

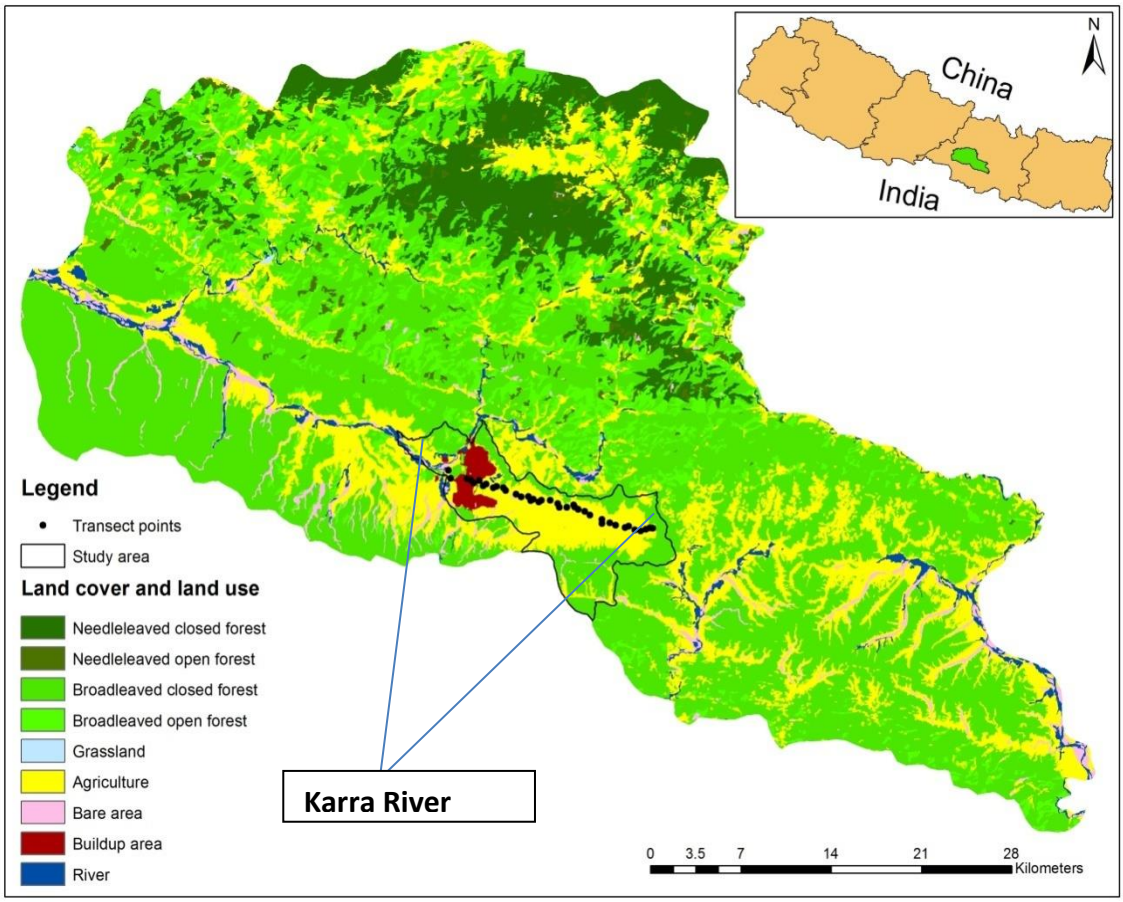


Figure 1: Map showing study area.

3.2 Climate

Climate of Hetauda valley is humid subtropical monsoon. Temperature condition of Hetauda varies from quite hot in summer and warm in winter. Surrounding area of hilly region has relatively cooler temperature condition. The seasonal monthly temperature fluctuates from 7^0C during January to about 35^0C in May (UNDP/ERRRP 2009). As a result, May to September months are the hottest and December to February months are colder. Relative humidity is lowest during winter while in monsoon it climbs up to more than 90% (UNDP/ERRRP 2009).

The average annual precipitation is little more than 2,200 mm of which about 80% falls during the monsoon period in mid-June to October (UNDP/ERRRP 2009). Monsoonal rainfall occurs from prevalent south-westerly monsoonal wind, which occurs normally during mid-June to mid-September. Average monthly precipitation for 37 years (1975-2010) of Hetauda has shown in Fig. 4

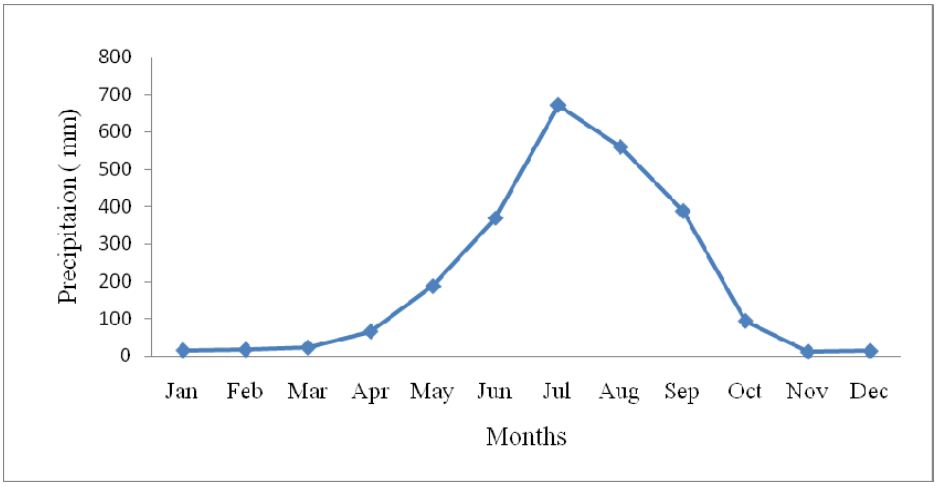


Figure 2 Average monthly precipitation for 37 years (1975-2010) (Source: Department of Hydrology and Meteorology, Nepal)

3.3 Research design

A preliminary field survey was carried out during January 2015 to gather necessary information about study area and research possibilities. Field research design was made using land use map of Hetauda, Google Earth and field preliminary survey. Three blocks (land use gradient) were demarcated on the basis of pollution and river width. Each block was 6 km in length. Width of each block was calculated by averaging the value of river width in each 100 m transects.

Block 1: The eastern upstream belt of river was considered as block one and was far from urban area and had very low disturbance. It was covered by cultivation and some patchy vegetation.

Block 2: Block 2 was the middle belt of river which was close to urban area and had intermediate level of disturbance. It was covered by some cultivated lands and human settlements, some patchy vegetation, ponds; grassland etc.

Block 3: The block 3 was located in the western part of river and situated at the middle of Hetauda city and characterized by high disturbance with heavy load of industrial effluents. It was covered with many industries, urban settlements, some cultivated lands and some patchy vegetation. However the lower section of block 3 around the forestry collage was still good with vegetation cover.

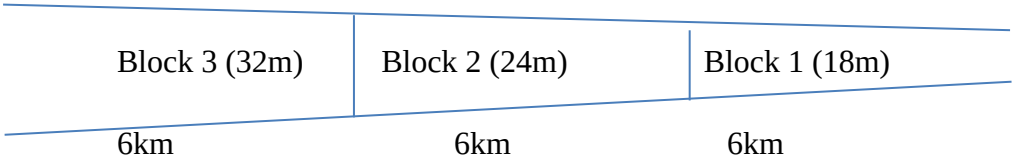


Figure 3: Research design

3.4 Bird survey methods

3.4.1 Line transect methods

line transect methods are highly adaptable and efficient methods for surveying birds of extensive open habitats, e.g. shrub-steppe and moorland, offshore seabirds and water birds (Sutherland 2006). There is less chance of double recording of birds in line transect methods and cover the ground more quickly and records more birds (Bibby et al. 2000). Therefore, line transect methods were used for recording the birds that have seen or hear on either side of river. Only the birds observed on front or either side of observer was recorded, those behind were not. To minimize the disturbance, line transect were walked alone in a constant speed. Care was taken to avoid double counting of mobile species like aerial foragers, raptors etc. In each sharp turn of the river, each new direction was treated as a new start to the next transect.

Birds were observed within the months of December/January 2014 (winter) and May/June 2015 (summer) to assess seasonal variation. Birds were observed from 7:00 am to 10:00 am in the morning. Three days were spent in each block and 27 hours were spent in each season in the field. Only the bird heard and seen within the band up to 50m on either side of transect were recorded. Bird censuses were not carried out on rainy, windy and cloudy day to avoid biases due to change in intensity of bird activities.

Bushnell Binocular of magnification 10×40 were used for confirm identification and Canon camera 50X for photography. Birds were identified by using field guide books of

Birds of Nepal (Grimmet et al. 2003). Unknown photographs and call were recorded and identified it later with the help of bird expert in Kathmandu.

Status of residential and migratory birds, terrestrial and aquatic birds, was assessed with the help of field guide book of birds of Nepal.

Species discovery curve was prepared for bird species. Day was used as a unit of time. Curve was prepared by plotting cumulative total of species detected against number of days.

3.4.2 Threat Assessment

Potential threats of birds were qualitatively judged based on intensive field visit and interaction with local people. Based on preliminary survey, possible threats were categorized into five major types as habitat fragmentation and degradation, industrial and household effluents, poaching, fishing and mining. Extents of threats were identified by counting the total sites where sign of each threats type was observed. Threats like grazing; cutting trees, fire etc. were categorized in title Habitat fragmentation and degradation. Similarly, other threats were also categorized in respective threats titles.

3.5 Data analysis

All the collected data were entered in a excel sheet and analyzed by using appropriate statistical tools. Following statistical tools were used:

3.5.1 Shannon-Wiener's Diversity Index

Shannon Weiner diversity index was used to calculate the species diversity of particular area which is calculated as:

$H' = -\Sigma (ni /N) \log (ni/N)$

Or, if $Pi= ni/N$

Where,

H = Index of species diversity

P_i = the proportion of individuals in the i^{th} species = $\frac{n_i}{N}$

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

N = Total importance value (Total number of individuals)

3.5.2 Evenness index

To calculate whether species were distributed evenly across seasons and across different land use type, evenness index was used. It was determined by the equation

E= H'/ log S

Where, H' = Shannon-Wiener's diversity index.

S= Species richness is the total number of species

3.5.3 Karl Pearson's Correlation

Karl Pearson's Correlation was used to find out the relationship between bird diversity and river width. Mathematical expression of Karl Pearson's correlation is given by:

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[\, n\Sigma x^2 - (\Sigma x)^2 \,][\, n\Sigma y^2 - (\Sigma y)^2 \,]}}$$

Where, r = Coefficient of correlation whose value lie in between -1 and +1

3.5.4 Analysis of Variance (ANOVA)

One way ANOVA was used to see the significant difference in species richness of birds in different land use types in two different seasons. Following null hypothesis was tested:

- Ho: There is no significant difference in the species richness of birds among three land use gradients.
- Ho: There is no significant difference in the species richness of birds between different river widths.

3.5.5 Relative Abundance

Relative abundance of avian species was determined by using encounter rates that give crude ordinal scales of abundance (abundant, common, frequent, uncommon and rare) (Bibby *et al*. 1992, 1998). Encounter rate was calculated for each species by dividing the number of birds recorded by the number of hours spent searching, in order to get a figure of birds per hour for each species. These were categorized in crude ordinal scales of abundance as follows:

Table 1: Using encounter rates to give a crude ordinal scale of abundance (From Lowen et al. 1996)

Abundance category (number of individuals/10 field hours)	Abundance score	Ordinal scale
<0.1	1	Rare
0.1 - 2.0	2	Uncommon
2.1 - 10.0	3	Frequent
10.1 - 40.0	4	Common
40.0 +	5	Abundant

3.5.6 Threats

Threats data were entered in Excel sheet and analyzed. Column chart were prepared to show extent of threats in each block.

Category of threatened bird's status was identified with the help of IUCN and CITES threat categories. It was categorised as critically endangered, endangered, vulnerable, near threatened and to respective CITES appendix.

4 RESULTS

4.1 Seasonal diversity of birds of Karra River

4.1.1 Species richness of birds of Karra River

A total of 153 species of birds were recorded from Karra River belonging to 15 orders and 38 families (Appendices 1). Order Passeriformes has highest diversity (70 species from 11 family) followed by Ciconiformes (23 species and five family), Coraciiformes (ten species and five family), Falconiformes (nine species and three family), Cuculiformes and Anseriformes (eight species in each family), Piciformes (four species and two family), Psittaciformes (four species and one family) Columbiformes (four species and one family), Strigiformes (three species and one family), Gruiformes (three species and one family), Galliformes (two species and one family), Apodiformes (two species and two family), Pelecaniformes (two species and one family) and Upipiformes one species and one family (Appendices 3). Similarly family Corvidae had higher number of bird's species (17).

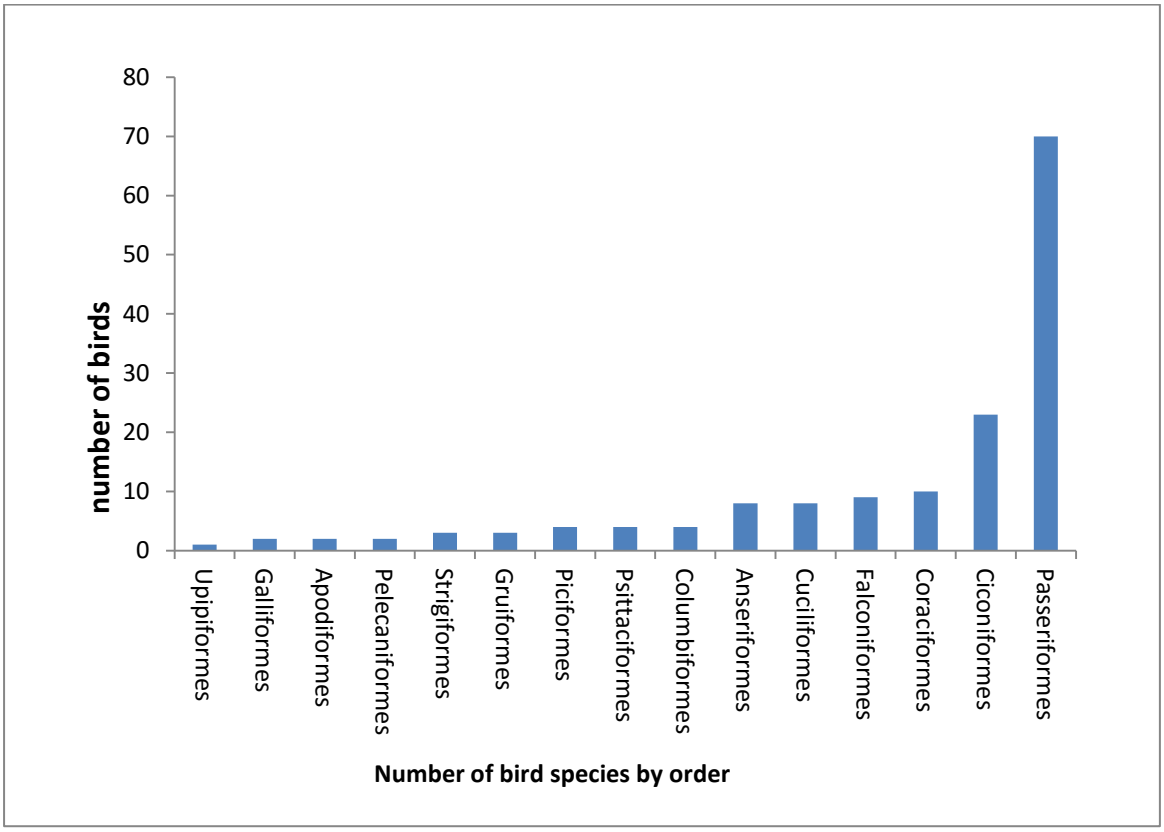


Figure 4: Number of bird species in different orders

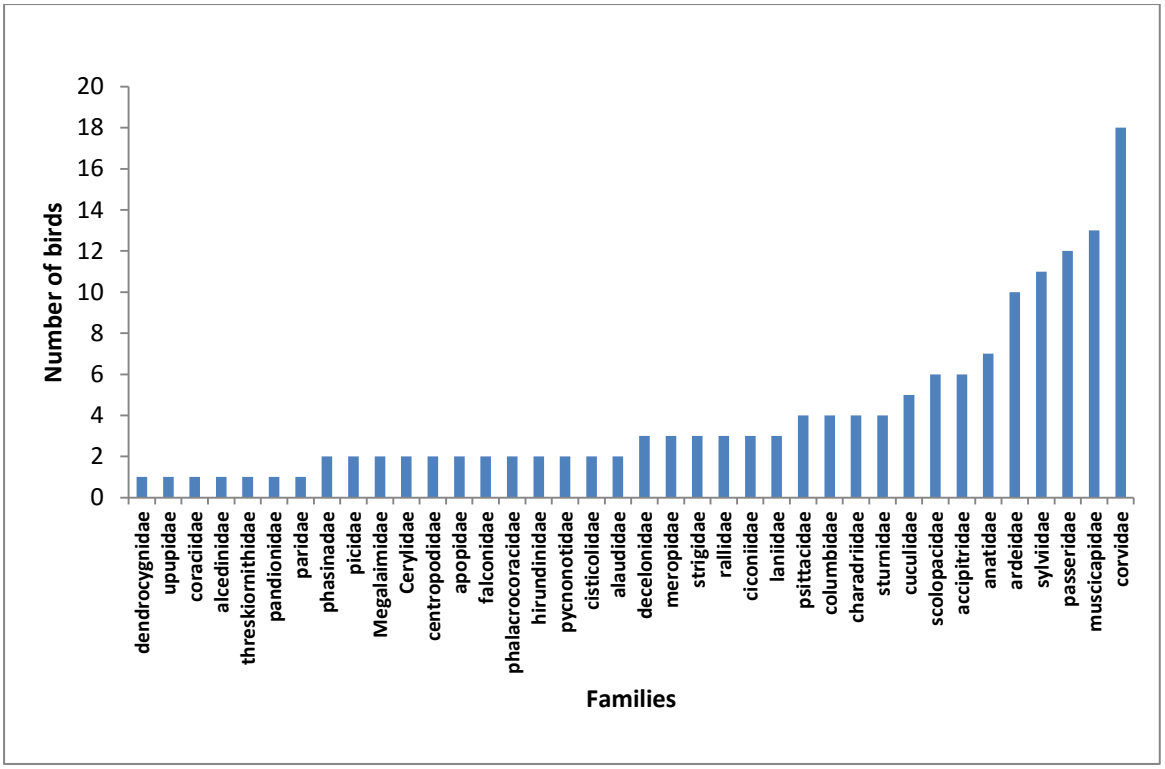


Figure 5: Numbers of bird species in different families

4.1.2 Seasonal variation of bird diversity of Karra River

One hundred thirty species of birds were recorded in winter seasons belonging to 15 orders and 38 families. Seventy-four species of birds were recorded in summer seasons belonging to 14 order and 28 families. Fifty-three bird species were found common in both winter and summer seasons. There were significant difference in seasonal diversity of birds ($F = 0.8429$, $df= 2$, $P < 0.04316$) (Table 3) in Karra River. Shannon winner diversity index showed that winter season ($H=1.86$) had more diverse bird assemblage than summer season ($H=1.62$) (Table: 3). Evenness index also showed that birds were more evenly distributed in winter season ($E=0.8815$) than summer ($E=0.87$).

Among 153 species, 64% species of birds were resident, 24% species were winter visitor, and 10% species were summer visitor and remaining 2% was irregular visitor (Appendice 1). Among resident birds, Common Myna, Plain Martin, Grey-breasted Prinia, Cattle Egret, House Crow, Asian Pied Starling, Red-vented Bulbul, Pied Bushchat, Indian Pond Heron, Common Tailorbird, Spotted Dove, Rose-ringed Parakeet, Plum-headed Parakeet and Blue Rock Pigeon were very common birds in all three blocks in both seasons with more than 100 individuals in each species (Appendice1). Most of the migratory birds were wetland birds like Ruddy Shelduck, Bar-headed Goose, Mallard, Gargany, Common

Merganser, Cotton Pigmy Goose, Eurasian Wigeon, Greater Cormorant, Common Greenshank, Common Sandpiper, Common Snipe, Grey-headed Lapwing, Little-ringed Plover, Common Coot, Common Moorhen, Striated Heron, Cinnamon Bittern, Black Stork, Pallas's Fish Eagle, Osprey, White-capped Water Redstart, Plumbeous Water Redstart, Black-capped Kingfisher etc. Fifty three of total migratory birds were wetlands birds.

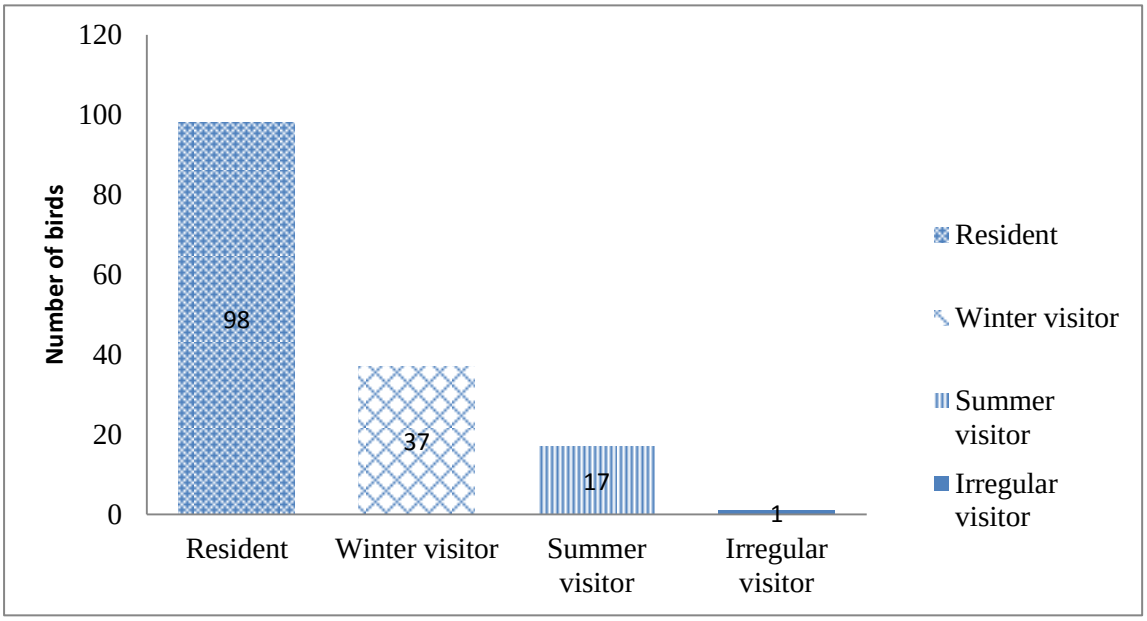


Figure 6: Migration Status of Birds recorded in Karra River, Hetauda

The species discovery curve showed that the frequency of adding new birds to list was more in winter season than summer season (fig 7). Curve show rapid rise in winter season and slow rise in summer season. At the start of the field survey every species recorded was new species and as the time spent increases, fewer and fewer new species were recorded. The curve is not saturated and still rising upward. So there are still chances to record new birds.

Figure 7: Species discovery curve: the graph show cumulative total number of species seen during summer and winter season in the study area

4.2 Bird diversities and relative abundance in different land use types

Out of 153 bird species, 26 were common in its relative abundance with encounter rates 10-40, 49 species were frequent with encounter rates 2-10, 73 species were uncommon with encounter rates 0.1-2 and one species- Common Myna (encounter rate- 47.77) were found abundant.

Bird abundance was higher during winter season than summer season. Out of 130 winter species, 41 species were uncommon, 50 species were frequent, 35 species were common and four species were abundant (Figure 8). Common Stonechat, Pied Bushchat, Common Myna and Grey-breasted Prinia were more abundant during winter season (Appendices 1). Out of 74 summer species, 24 species were uncommon, 24 species were frequent, 25 species were common and one species Plain Martin (43.70) was abundant (Figure 8).

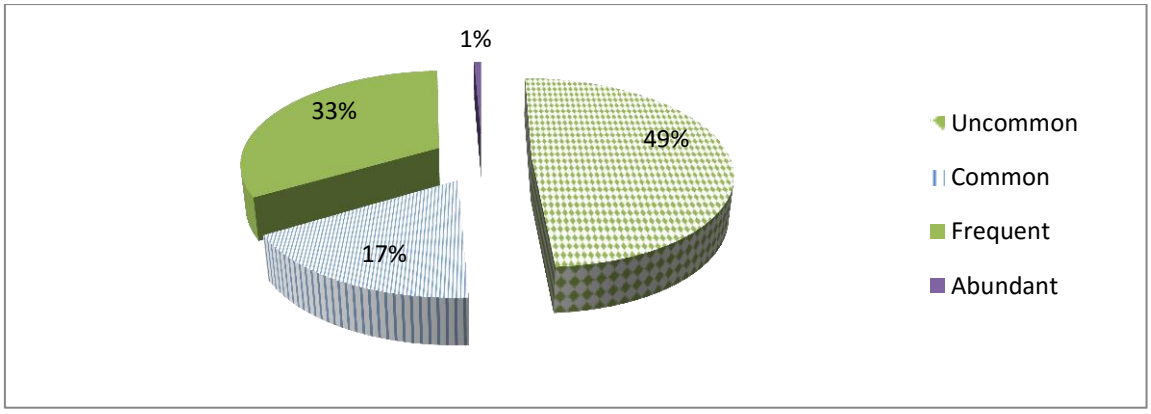


Figure 8: Pie chart showing percentage of Local abundance status of birds

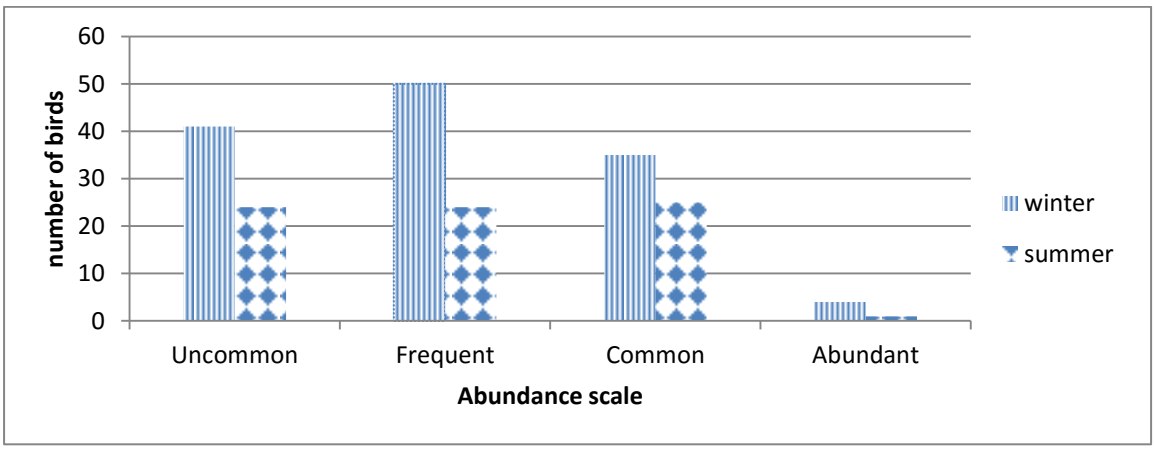


Figure 9: status of local abundant category of bird species between two seasons

Among three different blocks, block 2 was found more diverse and abundance than other blocks (Table 2) which were moderately disturbed land use type with heterogeneous vegetation type.

Table 2: Status of birds in winter and summer season with their diversity index and evenness index

Seasons	Block	Family	Order	Number of species	Number of individuals	Shannon's index	Evenness index
summer	B1	28	14	53	638	1.59	0.929
	B2			63	731	1.62	0.909
	B3			43	624	1.48	0.911
winter	B1	38	15	75	964	1.74	0.931
	B2			100	1186	1.81	0.906
	B3			71	897	1.72	0.920

Forty-eight species (1034 individual) of aquatic and 105 species (4006 individuals) of terrestrial birds were recorded. Shannon winner diversity index showed that terrestrial species were more diverse (H=1.723) than aquatic (H=1.2988). Many aquatic species including winter migratory ducks were observed in block 2 and 3. Some rare aquatic raptor like Pallas's Fish Eagle and Osprey were recorded in block 2 near Fisheries development center, Hetauda (FDCH). Cormorant and whistling duck were found common around the Kampadanda site of Block 2 which was near to FDCH. Single Black Bittern were also observed inside the dense grasslands at the river edge on block 2. Siberian duck like Ruddy Shelduck, Common Merganser, Bar-headed Goose, Mallard, and Eurasian Wigeon were observed in downstream of Block 3 although upstream of block 3 was highly disturbed and less diverse. Some birds like Cotton Pigmy Goose, Black-capped Kingfisher, Red-breasted Parakeet, Black Stork, Lesser Adjutant Stork, Striated Heron, Oriental Honey Buzzard, Collared Falconet, Grey-billed Cuckoo, Common Moorhen and Large Wood Shrike were recorded only from block 1 showing their elusive nature and indicator of good ecosystem.

One way ANOVA revealed that there was significant different (F = 0.84, df= 2, P =0.04316) in bird diversity in three different block in two different seasons (Table 3).

Table 3: ANOVA Table between species richness of birds in three different blocks in two different seasons

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	571.2614	2	285.6307	0.842593	0.043163	3.026678
Within Groups	98985.17	292	338.9903			
Total	99556.43	294				

Karl Pearson's Correlation coefficient showed no any significant relationship (r= -0.155) between river width and bird species diversity.

4.3 Major threats to Karra's birds

Habitat fragmentation and degradation were found as serious threats to avian community in all block. However block three was seriously affected. Industrial and household effluents was high in block three, low in block two and no any effluents were observed in block one. Poaching activities were observed in all blocks however it was high in block two and three. Local ethnic group mainly below the age of twenty were found engaged in poaching by using catapult. Mining were found high in block three than other block. Mining activities includes trade of sand, soil, gravel etc. Many people were found involved in fishing by using net, electricity, dhodiya, etc. fishing were high in block three in comparison to other block.

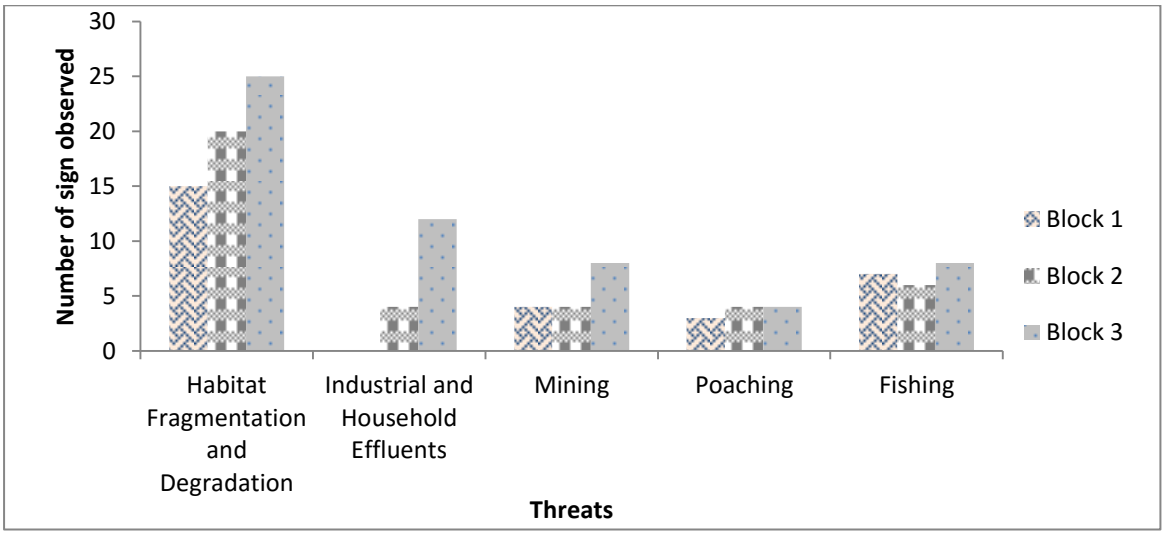


Figure 10: Chart showing extent of threats in each block which show number of sign observed in each threats title in all block

Figure 11: Some threats to Karra's Birds. 1. Plum-headed Parakeet in cage. 2. People fishing in the river 3. Mining of sand and gravel

4.3.1 Threatened bird species of Karra River

Sixteen nationally threatened bird species and sixteen species of birds listed in CITES category II were recorded. Among sixteen species of nationally threatened birds, two were globally threatened (Pallas's fish Eagle and Lesser Adjutant Stork) (Table 4).

Table 4: Status of threatened birds on the basis of National Red list Series 2015 and CITES category

RE	**CR**	**EN**	**VU**	**NT**	**CITES category**
	Pallas's Fish Eagle	Black Bittern	Red-breasted Parakeet	Bar-headed Goose	Common Kestrel II
			Lesser Adjutant	Alexandrine Parakeet	Collared Falconet II
			Gargany	Greater Cormorent	Common Buzzard II
			Cotton-pigmy Goose	Ruddy Shelduck	Creasted Serpent Eagle II
			Black Stork	Collared Falconet	Pallas's Fish Eagle II
			Asian Openbill	Yellow-bellied Prinia	Black Kite II
				Plain Martin	Black-shouldered Kite II
				Baya Weaver	Osprey II
					Spotted Owlet II
					Jungle Owlet II
					Asian Barred Owlet II
					Black Stork II
					Red-breasted Parakeet II
					Plum-headed Parakeet II
					Alexandrine Parakeet II
					Rose-ringed Parakeet II

Regionally Extinct (RE), Threatened (Critically Endangered (CR), Endangered (EN) and Vulnerable (VU)) and Near Threatened (NT).

5 DISCUSSION

This study has been carried out with the objective of determining seasonal diversity, relative abundance and common threats to birds and their comparative study on different land use gradient.

5.1 Species richness and seasonal variation of birds

Although the study area was small and surveys were carried out within short time period, higher species richness was found (H=1.86 and E= 0.85). One hundred fifty-three bird species were recorded within 18 kilometer transect which includes 17% of total birds of Nepal. The high species richness might be attributed to diverse habitat conditions and seasonality in environmental factors like light, temperature, humidity, precipitation, food availability, vegetation, flowering of plants, etc. The bird community of any given habitat changes seasonally (Avery and Riper 1989). Species richness was found higher during winter season than summer. Habitat becomes dry and unproductive in other place during winter season while the riparian habitat is pristine and productive throughout the year which has contributed to have greater diversity during winter. Thus, seasonal variation highly affects the species richness and distribution of birds (Cueto and de Casenave 2000). Harsha and Hosetti (2009) reported flowering in the early winter assure food availability could be contributed for high species richness. Assemblage of many migratory birds in the winter season due to favorable ecological and climatic condition has also contributed for high species richness. However, Aryal (2013) found less species during winter season in Ghunsa valley of Kanchanjunga Conservation Area because landscapes above 3,000m were covered by snow in winter season. .

Seventy-four species of birds were recorded in summer seasons. Fifty-three bird species were found common in both winter and summer seasons. Birds were highly territorial for breeding activity in summer season which had reduced its detection. Thus, fewer species might have observed in this season. Next reason is that during summer season there occurs a heavy rainfall and flooding in the river which destroy the bird's breeding and feeding ground. According to Desgranges et al. (2006) several bird species nest at or near the water surface and are thus vulnerable to nest flooding or stranding.

5.2 Comparison of bird diversity and relative abundance in three land use types

One way ANOVA revealed that there were significant differences in species richness of birds in three blocks in both seasons (Table 3). Species richness was found high in block 2 in both the seasons which was moderately disturbed land use type. The intermediate disturbance hypothesis claims that higher species richness can be found in moderately disturbed land use type (Blair 1996, Vetaas 1997, Chettri et al. 2005, Baniya et al. 2009, Basnet 2010, Panthi 2012, Katuwal 2013). Presence of patchy woody vegetation, grasslands, cultivated lands, fruiting trees around the settlements, bamboo plantation at the edge of river supports large number of birds. The heterogeneous vegetation cover in the disturbed habitat might provide various species of prey insects for insectivorous birds (Grima et al. 2011) and also provide more niches and diverse way of exploiting environmental resources thus increasing species diversity (Bazzaz 1975). Furthermore, change in vegetation community structure could affect the quantity and quality of food, water and cover which in turn alters the diversity, abundance and distribution of birds (Western and Grimsdell, 1979)

Karl Pearson's Correlation coefficient showed that there was not any relationship between bird species richness and river width (r= -0.155). However, bird species richness was found high in the area where the river width is buffered with good vegetation structure. For example, although block 3 was found comparatively less diverse than other blocks, more birds were recorded in its downstream because it is buffered with vegetation structure on both sides. Avian diversity increase with increase in riparian width, riparian vegetation diversity, and patches of riparian habitat are connected to one another and riparian habitats are connected to healthy upland habitats (Mac Arthur and Mac Arthur 1961, Whitmore 1975, Finch 1989, Croonquist and Brooks 1993). Riparian buffer strip protect water quality and provide good habitat for plant and animals and movement corridors for a variety of wildlife species (Fischer 2000).

A significant variation in bird diversity was recorded between aquatic and terrestrial habitat. Shannon winner diversity index show that terrestrial habitat was more diverse (H=1.723) than aquatic habitat (H=1.2988). One hundred five species of terrestrial and 48 species of aquatic birds were recorded. Many terrestrial birds forage in riparian habitat. Brinson et al. (1981) reported that avian diversity in riparian area is often double than that

of adjacent uplands habitat. Riparian habitat provides both feeding, nesting and breeding grounds for many terrestrial birds and most of the resident birds recorded were also terrestrial birds showing greater diversity. Most of the aquatic birds are winter migratory showing less diversity in summer season. Many aquatic birds were recorded from block 2 and block 3 as quantity of water and river width is larger in this site and is attach with water masses like ponds of Fishery Development Centre Hetauda (FDCH) and Rapti River. Throughout riparian areas of the United States, river width is related positively to avian diversity both within and adjacent to riparian zones (Stauffer and Best 1990, Triquet, McPeek and McComb 1990, Keller, Robbins and Hatfield 1993, Kilgo et al. 1998).

5.3 Major Threats to Karra's Birds

Birds in Karra River were seriously threatened by Pollution, habitat fragmentation and degradation, mining, poaching, fishing, etc. Over grazing by domestic cattle, fodder collection, human disturbance, mining, fires were seriously degrading the bird's habitat of Karra. Drainage for conversion to agriculture, livestock grazing, a high degree of disturbance and overfishing are all causing wetland losses and damage (Petersson 1998b, Giri 2002) which causes serious threats to wetlands birds. Poaching of birds either for meat or for pet was common in the study area. Local ethnic groups below the age of 20 were found engaged in poaching activities. Children with catapult were encountered in the study area. Some of the birds like Parakeet, Dove, Cuckoo and myna were found adopted in cage around settlements. Continuous trade of sand and gravel of river was another serious problem for bird's habitat in the study area. Fishing was another important threat to Karra's river birds. Many people found fishing around Karra River. Overfishing leads to mark decline in fishes which poses serious threats to all fish-eating birds such as Pallas's Fish Eagle, Black-bellied Tern, Indian Skimmer, Tawny Fish Owl (BCN and DNPWC 2011).

Water pollution from households and industrial discharges and agricultural run-off were seriously degrading the water quality of Karra River. Water pollution from agricultural chemicals has been identified as particularly serious threats to lowland wetlands (Kafle et al. 2008). The study revealed that the quality of upstream (block 1) of the Karra River water is good but as it enters the industrial belt (block 3), it gets loaded with pollutants mainly from industrial effluent which has degraded its natural quality. Pradhanang (2012)

found that the industrial belt of Karra river was loaded with various pollutants like CO2, Nitrate, Phosphate, sulphide and heavy metals like (Fe, Zn, Cu, Mn etc.) which has degraded the natural quality of water posing serious threats to aquatic birds. She found high COD (450 mg/L) and low DO (0.4 mg/L) in industrial belt. Lack of conservation awareness about the importance of birds and poverty were also found as threats to Karra river birds.

6 CONCLUSION AND RECOMMENDATIONS

Bird species richness, seasonal diversity and relative abundance were compared in three different blocks of Karra River for summer and winter seasons. One way ANOVA revealed that there was significant different ($F = 0.8429$, $df= 2$, $P < 0.04316$) in bird diversity among the blocks in two different seasons. A total of 153 birds species were recorded belonging to 15 orders and 38 families (Appendices 1). Order Passeriformes was found dominating order which comprise 70 species and order Upupiformes was found least dominating order comprising only one species. Among 153 species, 98 species of birds are found resident, 37 species are found winter visitor, 17 species are found summer visitor and one species is found vagrant. One hundred thirty species were recorded during winter season and 74 species during summer season. Shannon winner diversity index revealed more diverse bird assemblage during winter season (H=1.86) than summer season (H=1.62). Evenness index also show that birds were evenly distributed in winter season (E=0.8815) than summer (E=0.8761). Out of 153 bird species recorded in study area, 26(17%) were common in its relative abundance with encounter rates 10-40, 49(32%) species were frequent with encounter rates 2-10, 73(47%) were uncommon with encounter rates 0.1-2 and one species- Common Myna (47.77-abundance number) were found abundant.

Karl Pearson's Correlation coefficient showed that there was not any relationship between bird species richness and river width ($r= -0.155$). However, bird species richness was found high in the area where the river width is buffered with good vegetation structure. Bird species richness was found high (126) in moderately disturbed land use type (block 2) than other supporting intermediate disturbance hypothesis.

Habitat fragmentation and degradation, pollution at the industrial belt, overfishing, poaching, mining and lack of awareness were the major threats to birds around the study area.

Based on this research, following recommendation were made which will be useful for conservation and further study of avian fauna of Karra river belt, Hetauda.

- To encourage a diverse avian community along riparian habitat, buffer strip of vegetation should be maintained on both side of river. Buffer strip should be as wide as possible and relatively free from human land use that potentially impacts on birds.

Landowner /farmer along the edge of the river should be encouraged to replant and protect tree.

- Waste water from industry and household effluents should be treated effectively before discharging out to river. There is an urgent need of Strict policy and monitoring from government sector for effluent discharge from industry and household into the river
- Poaching, keeping of cage birds, overfishing, and use of pesticides should be controlled and awareness program about the importance of birds should be launched for the long term conservation of bird.

7 REFERENCE

Able, K.P. and Noon, B.R. 1976.Avian community structure along elevation gradients in the Northeastern United States. Oecologia 26:275–294**.**

Ambrose, D., Talukdar, S. and Pomela, E.M. 2000. Biological Diversity in Lesotho: A Country Study. Maseru: National Environment Secretariat.

Anthony, S. 1997. Relationship between water bird ecology and river flow in the Murray-Darling Basin. Technical report 5/97. CSIRO Land and Water.

Aryal, Y. 2013. Avian diversity along elevational and land use gradients in the Ghunsa Valley of Kanchenjunga Conservation Area. M.Sc. Thesis submitted to Central Department of Zoology, Tribhuwan University, Kathmandu, Nepal.

Avery, M.L. and Riper, C.V. 1989. Seasonal changes in bird communities of the Chaparral and blue Oak woodlands in central California. The condor **91**(2): 288-295.

Baniya, C. B., Solhoy, T. and Vetaas, O. R. 2009. Temporal changes in species diversity and composition in abandoned fields in a Trans-Himalayan landscape, Nepal. Plant Ecology 201: 383-399.

Baral, H. S. and Inskipp, C. 2004. The State of Nepal's Birds 2004. Department of National Parks and Wildlife Conservation, Bird Conservation Nepal and IUCN-Nepal. Kathmandu.

Basnet, Y., Tamang, B. and Gautam, B. 2005.Birds Diversity and their habitat status at Raja Rani Community forest, Bhogteny, Morang, Nepal. A final report submitted to oriental bird club (UK).

Basnet, T. B. 2010. Distribution pattern of breeding bird species along elevation gradients in Central Nepal, Himalaya. M.Sc. Thesis. Biodiversity and Environmental Management. Kathmandu, Nepal.

Bazzaz, F.A.1975. Plant species diversity in old-field successional ecosystems in southern Illinois. Ecology, 56, 485–488.

BCN and DNPWC. 2011. The State of Nepal's Birds 2010. Bird Conservation Nepal and Department of National Parks and Wildlife Conservation, Kathmandu.

BCN and DNPWC. 2012. Birds of Nepal: An Official checklist, Kathmandu, Nepal.

Bennett, D. 1999. Expedition Field Techniques Reptiles and Amphibians. Royal Geographical Society with IBG 1 Kensington Gore London SW7 2AR.

Bhandari, B. 1998. Avifauna in: An inventory of Nepal's tarai wetlands, IUCN, Nepal: 48-49.

Bibby, C., Jones, M., and Marsden, S. 1998. Expedition Field Technique. Bird surveying manual. Royal Geographical Society of London.

Bibby, C.J., Collar, N.B., Crosby, M.J., Heath, M.F., Imboden, C., Jonston, T.H., Long, A.J., Satterfield, A.J. and Thirgood, S.J. 1992.Putting Biodiversity on the Map: Priority area for Global Conservation Barrington Press, Cambridge 239 pp.

Blair, R.B. 1996. Land use and avian species diversity along an urban gradient. Ecological Applications 62(2): 506-519.

Boren, J.C., Engle, D.M., Palmer, M.W., Masters, R.E. and Criner, T. 1999. Land use change effects on breeding bird community composition. Journal of Range Manage 52: 420-430.

Bryce, S.A.,Hughes, R.M, and Kuffmann, P.R. 2002.Development of bird integrity index: using bird assemblages as indicators of riparian condition. Environmental Management 30(2): 294-310.

Brawn, J.D., Robinson, S.K. and Thompson III, F.R. 2001. Role of Disturbance in the Ecology and Conservation of Birds. Annual Review of Ecology and Systematics 32: 251-276.

Brinson, M.M., Swift, B.L., Plantico R.C., and Barclay, J.S. 1981. "Riparian ecosystem: Their ecology and status," FWS/OBS-81/17, Office of Biological Service, U.S fish and wildlife service, Washington DC.

Chaney, E., Elmore, W. and Platt, S. 1990. Livestock grazing on western riparian areas. U.S. Environmental Protection Agency. Washington, DC, USA.

Chettri, N., Deb, D.C., Sharma, E. and Jackson, R.J. 2005.The Relationship between Bird Communities and Habitat-A Study along a Trekking Corridor in the Sikkim Himalaya. Mountain Research and Development 25(3): 235-243.

Cuthbert, R., Green, R.E., Ranade, S., Saravanan, S., Pain, D.J.,Prakash, V. and Cunningham, A.A. 2006. Rapid population declines of Egyptian vulture (*Neophronpercnopterus*) and Red-headed Vulture (*Sarcogypscalvus*) in India. Animal Conservation 9(3): 249-254.

Cueto, V.R. and deCasenave, J.L. 2000. Seasonal changes in bird assemblages of coastal woodlands in east-central Argentina. Stud Neotrop Fauna and Environment 35: 173-177.

Croonquist, M.J. and Brooks, R.P. 1993. Effects of habitat disturbance on bird communities in riparian corridor. Journal of Soil and Water Conservation 48(1): 65-70.

Darveau, M. et al. 1995. Riparian forest strip as habitat for breeding bird in boreal forest.

Desgranges, J., Ingram, J., Drolet, B., Morin, J., Savage, C. and Borcard, D. 2006. Modelling Wetland Bird Response to Water Level Changes in the Lake Ontario-St. Lawrence River Hydrosystem. Environmental Monitoring and Assessment (2006) 113:329-365

Estrada, A.,Coates-Estrada, R. and Meritt, D.A. 1997. Anthropogenic landscape changes and avian diversity at Los Tuxtlas, Mexico. Biodiversity and Conservation 6: 19-43.

Finch, D.M. 1989. Habitat use and habitat overlap of riparian birds in three elevational zones. Ecology, 70, 866–880.

Fischer, R.A. 2000.Width of riparian zones for birds. EMRRP Technical Notes Collection (TN EMRRP-SI-09), U.S Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/emmrp.

Fischer, R.A., Martin, C.O., Barry, D.Q., Hoffman, K., Dickson, K.L., Zinmmerman, E.G., and Elrod, D.A. 1999. “Corridors and vegetated buffers zones: A preliminary assessment and study design,” Technical Report EL-99-3, US Army Engineer Waterways Experiment Station, Vicksburg, USA.

Fardila, D. and Sjarmidi, A. 2012.Bird distribution along environmental gradients In North Bandung, West Java. Research Journal of Recent Sciences 1: 23-32.

Ghimire, B.C. 2009. Seasonal diversity and habitat utilization of birds in the Bharandabhar Corridor Forest of Chitwan district, Nepal. M.Sc. Thesis submitted to Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Giri, B. and Chalise, M.K. 2008. Seasonal Diversity and Population Status of Waterbirds in Phewa Lake, Pokhara, Nepal. Journal of Wetlands Ecology. 1(1/2):3-7.

Giri, T. and GC, S. 2002. Birds recorded between Prakashpur to Haripur on a boat ride, January 2002. Unpublished.

Grimmet, R., Inskipp, C. and Inskipp, T. 2000. Birds of Nepal, Helm Field Guide. Prakash Books, New Delhi.

Harsha, M.N. and Hosetti, B.B. 2009. Diversity and distribution of avifauna of Lakkavalli range forest, Bhadra wildlife Sanctuary, Western Ghat, India. Ecoprint 16: 21-27.

Inskipp, C., Baral, H.S., Phuyal, S., Bhatt, T.R., Khatiwada, M., Inskipp, T, Khatiwada, A., Gurung, S., Singh, P.B., Murray L., Poudyal L. and Amin R. 2016. The status of Nepal's Birds: The national red list series. Zoological Society of London, UK.

John, M.M. 2005. Island biogeography for an urbanizing world: how extinction and colonization may determine biological diversity in human-dominated landscapes. Journal of Urban ecosystem. Vol. 8, issue 2, Pp 157-177.

Johnson, R.R., Haight, L.T., and Simpson, J.M. 1977. “Endangered Species vs. Endangered habitat: A concept, “importance, preservation and management of riparian habitat: A symposium USDA For. Serv. Gen. Tech. Rep. RM-43, R.R. Johnson and D.A Jones, tech. cords. 68-79.

Kafle, G., Kafle, M., Balla, K. and Paudyal, B.K. 2007. A review of threats to RAMSAR sites and associated biodiversity of Nepal (Part II). Tigerpaper 35(1): 9-11. http://www.fao.org/world/regional/rap/tigerpaper/paper/TP35 1 001.pdf.

Katuwal, H. 2013. Land use gradient and distribution of birds in Manaslu Conservation area, Nepal. M.Sc. Thesis submitted to Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Keller, C.M.E., Robbins, C.S., and Hatfield, J.S. 1993. Avian community in riparian forest of different widths in Maryland and Delaware. Wetlands 13, 137-144.

Khanal, H.R. 2008.Seasonal diversity, status and habitat utilization of bird in the Nawalparasi forest (IBA) of Nawalparasi Nepal. M.Sc. Thesis submitted to Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Kilgo, J.C., Stargent, R.A., Chapman, B.R., and Miller, K.V. 1998. Effect of stand width and adjacent habitat on breeding bird communities in bottomland hardwoods. J.Wildl. Manage. 62, 72-83.

Kopij, G. 2001. "Areas Proposed for Environmental Education and Biodiversity Conservation in Maseru District, Lesotho." In Environmental Education for Sustainable Development: African Perspectives, edited by T. Mokuku, L. Bitso, and A. F. Lana, 150–167. Roma: National University of Lesotho.

Laiolo, P. 2004. Diversity and structure of the bird community overwintering in the Himalayan subalpine zone: is conservation compatible with tourism? Biological Conservation 115: 251-262.

MacArthur, R.H. 1964. Environmental factors affecting bird species diversity. The American Naturalist 98: 387-39742:594-598.

MacArthur, R.H., MacArthur, J.W. and Preer, J. 1962. On Bird Species Diversity II. Prediction of Birds Census from Habitat Measurements. The American Naturalist 96(888): 167-174.

Malla, S. 2006. Seasonal Diversity, Relative Abundance and Status of Avian Fauna in Nagarjun Forest, Kathmandu, Nepal. M.Sc. Thesis. Central Department of Zoology, Tribhuwan University, Kathmandu, Nepal

Murgui, E. 2007. Effects of seasonality on the species–area relationship: a case study with birds in urban parks, Spain. Global Ecology and Biogeography 16: 319– 329

Martin, T.E. and Blackbum, G.A. 2010. Impacts of Tropical Forest Disturbance upon Avifauna on a Small Island with high Endemism: Implications for Conservation. Conservation and Society 8(2): 127-139.

Norvell, R.E., Howe, F.P. and Parrish, J.R. 2005.Riparian bird population monitoring in Utah, 1992-2001.in Bird Conservation Implementation and Integration in the Americas: Volume 1. Pacific Southwest Research Station. General Technical Reports PSW-GTR-191.

Oaks, J.L., Gilbert, M., Virani, M.Z., Watson, R.T., Meteyer, C.U., Rideout, B., Shivaprasad, H.L.,Ahmed, S., Chaudhary, M.J.I., Arshad, M., Mahmood, S., Ali, A. and Khan, A.A. 2004. Diclofenac residues as the cause of vulture population decline in Pakistan. Nature 427:630-633

Panthi, S. 2012. Diversity of Herbaceous Species in Mixed Rhododendron Forests of Kanchanjungha Conservation Area, Eastern Nepal. M.Sc. Thesis submitted to Central Department of Botany, Tribhuvan University, Kathmandu, Nepal.

Paterson, D. 1998. What is happening at Koshi tappu Wild life Reserve? Danphe 7(1/2):6-7

Poudel, A. 2005.Seasonal Diversity of Birds at Kirtipur Municipality, Kathmandu, Nepal. M. Sc. Thesis submitted to Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Pradhanang, S. 2010. Industrial effluents from the Hetauda Industrial District and the impaired water quality of Karra River, Nepal.Ph.D. Dissertation of University of Delhi, India.

Pradhanang, S. 2012. Water Quality Satus of Karra River Hetauda Nepal. Report submitted to Department of Environmental Science Tri-chandra campus, Tribhuvan University, Nepal.

Rimal, R.P. 2006.Community Structure and habitat Association of Birds in Shivapuri National Park of the Central mid-hill of Nepal. M.Sc. Thesis submitted to Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Robertson, H.A. and Hackwell, K.R. 1995. Habitat preferences of birds in seral kahikatea Dacrycarpusdacrydioides (Podocarpaceae) forest of South Westland, New Zealand. Biological Conservation, 71:275-280.

Sutherland, W.J. 2006. Ecological Census Techniques: Hand book 2nd ed. Cambridge University Press, 324 p.

Schimelis, A. and Afework, B. 2009. Species composition, Relative abundance and Habitat Association of the bird fauna of the Montane forest of Zegie peninsula and nearby islnds, Lake Tana, Ethiopia. Ethiop. J. Sci., 32 (1): 45-65, 2009.

Shultz, S., Baral, H.S., Charman, S., Cunningham, A., Das, D., Ghalsasi, G.R., Goudar, M.S., Green, R.E., Jones, A., Nighot, P., Pain, D.J. and Prakash, V. 2004.Diclofenac poisoning is widespread in declining vulture populations the Indian subcontinent. Proceedings of Royal Society of London B (Suppl.) 271: S458-S460

Stauffer, D.F., and Best, L.B. 1980. Habitat selection by birds of riparian communities: Evaluating effects of habitat alternations. J. Wildil. Manage, 44, 1-15.

Temple, S.A, and Wiens, J.A. 1989. Bird populations and environmental changes: can birds be bio-indicators? American Birds 43: 260-270

Thakuri, J.J. 2007.Status, Seasonal Diversity, Habitat Utilization and Distribution of Birds in Satikhel Community Forest and Dallu Community Forest in Seshanarayan VDC. M.Sc. Thesis submitted to Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal

Triquet, A.M., M., McPeek, G.A., and McComb, W.C. 1990. Songbird diversity in clearcuts with and without a riparian buffer strip. J. Soil and Water Conservation. 45, 500-503.

UNDP/ERRRP. 2009. Earthquake Vulnerability Profile and Preparedness Plan of Hetauda Municipality edited by A. Joshi. Kathmandu: United Nations Development Programme/Earthquake Risk Reduction and Recovery Preparedness Programme for Nepal

Vetaas, O. R. 1997. The effect of canopy disturbance on species richness in a central Himalaya oak forest. Plant Ecology 132:29-38.

Waltert, M., Bubo, K.S., Sainge, N.M., Fermon, H. and Muhlenberg, M. 2005. From forest to farmland: habitat effects on Afrotropical forest bird diversity. Ecological Applications 15(4): 1351-1366

Western,D. and Grimsdell, J.J,R. 1979**.** Measuring the distribution of animals in relation to the environment, (2nd edn). A series of handbook on techniques in African wildlife ecology, African Wildlife Foundation, Nairobi

Whitmore, R.C. 1975. Habitat ordination of passerine birds of the Virgin River Valley, Southeastern Utah. Wilson Bulletin. 87:65-74.

8 APPENDICES

1. Checklist of Bird Species Observed

S.N	C.N	Scientific name	No	Abu.	L. Abu.C	WV	SV	CS	M.S	Habitat
	Order: Galliformes									
	Family: Phasinadae									
1	Black Francolin	*Francolinus francolinus*	38	7.037	F	+	+	LC	R	T
2	Red-jungle Fowl	*Gallus gallus*	7	1.296	U	+	+	LC	R	T
	Anseriformes									
	Anatidae									
3	Bar-headed Goose	*Anser indicus*	1	0.185	U	+		NT	WV/PM	A
4	Cotton Pigmy Goose	*Nettapus coromandelianus*	1	0.185	U		+	VU	SV	A
5	Ruddy Shelduck	*Tadorna ferrogenia*	12	2.22	F	+		NT	WV	A
6	Eurasian Wigeon	*Anas penelope*	5	0.925	U	+		LC	WV/PM	A
7	Mallard	*Anas platyrhynchos*	3	0.56	U	+		LC	WV/PM	A
8	Garganey	*Anas querquedula*	4	0.74	U	+	+	VU	PM/RWV	A
9	Common Merganser	*Mergus merganser*	6	1.1	U	+		LC	WV	A
	Dendrosygnidae									

10	Lesser Whistling Duck	*Dendrocygna javanica*	20	3.7	F	+		LC	R	A
	Piciformes									
	Picidae									
11	Rufous Woodpecker	*Celeus brachyurus*	3	0.56	U	+	+	LC	R	T
12	Grey-capped Pigmy Woodpecker	*Dendrocopos canicapillus*	2	0.37	U		+	LC	R	T
	Megalaimidae									
13	Great Barbet	*Megalaima virens*	2	0.37	U	+		LC	R	T
14	Coppersmith Barbet	*Megalaima haemacephala*	13	2.407	F	+	+	LC	R	T
	Upupiformes									
	Upupidae									
15	Common Hoopoe	*Upupa epops*	31	5.74	F	+	+	LC	R	T
	Coraciiformes									
	Coraciidae									
16	Indian Roller	*Coracious benngalensis*	51	9.45	F	+	+	LC	R	T
	Alcedinidae									
17	Common Kingfisher	*Aledo atthis*	23	4.259	F	+		LC	R	A
	Decelonidae									
18	Stork-billed Kingfisher	*Pelargopsis capensis*	2	0.37	U	+		LC	R	A
19	White-throated Kingfisher	*Halcyon smyrnensis*	67	12.41	C	+	+	LC	R	A/T
20	Black-capped Kingfisher	*Halcyon pileata*	2	0.37	U	+	+	LC	IV	A
	Cerylidae									

21	Creasted Kingfisher	*Megaceryle lugubris*	2	0.37	U	+		LC	R	A
22	Pied Kingfisher	*Ceryle rudis*	10	1.851	U	+		LC	R	A
	Meropidae									
23	Green Bee-eater	*Merops orientalis*	53	9.81	F	+	+	LC	R/SV	T
24	Blue-tailed Bee-eater	*Merops philippinus*	47	8.703	F		+	LC	SV	T
25	Chestnut-headed Bee-eater	*Merops leschenaultia*	33	6.11	F		+	LC	SV	T
	Cuculiformes									
	Cuculidae									
26	Pied Cuckoo	*Clamator jacobinus*	2	0.37	U		+	LC	SV	T
27	Common Hawk Cuckoo	*Hierococcyx varius*	10	1.85	U	+	+	LC	R/SV	T
28	Grey-bellied Cuckoo	*Cacomantis passerinus*	1	0.18	U	+		LC	SV	T
29	Banded Bay Cuckoo	*Cacomantis sonneratii*	2	0.3703			+	LC	R/SV	T
30	Oriental Cuckoo	*Cuculus saturatus*	5	0.92	U		+	LC	SV	T
31	Asian Koel	*Eudynamys scolopacea*	15	2.78	F	+	+	LC	R/SV	T
	Centropodidae									
32	Greater Coucal	*Centropus sinensis*	22	4.074	F	+	+	LC	R	T
33	Lesser Coucal	*Centropus bengalensis*	2	0.37	U	+		LC	R/SV	T
	Psittaciformes									
	Psittacidae									
34	Alexandrine Parakeet II	*Psittacula eupatria*	37	6.85	F	+		NT	R	T
35	Rose-ringed Parakeet II	*Psittacula krameri*	114	21.1	C	+	+	LC	R	T
36	Plum-headed Parakeet II	*Psittacula cyanocephala*	112	20.74		+	+	LC	R	T

37	Red-breasted Paakeet II	*Psittacula alexandri*	27	5		+		VU	R	T
	Apodiformes									
	Apodidae			0						
38	House Swift	*Apus affinis*	55	10.18519	C	+	+	LC	R	T
	Hemiprocnidae									
39	Creasted Treeswift	*Hemiprocne coronata*	7	1.296	U	+		LC	R	T
	Strigiformes									
	Strigidae									
40	Asian Barred Owlet II	*Glaucidium cuculoides*	4	0.74	U	+		LC	R	T
41	Jungle Owlet II	*Glaucidium radiatum*	2	0.37	U	+		LC	R	T
42	Spotted Owlet II	*Athene brama*	2	0.37	U	+	+	LC	R	T
	Columbiformes									
	Columbidae									
43	Rock Pigeon	*Columba livia*	112	20.74	C	+	+	LC	R	T
44	Oriental Turtle Dove	*Streptopelia orientalis*	55	10.18	C	+		LC	R/WV	T
45	Spotted Dove	*Streptopelia chinensis*	118	21.85	C	+	+	LC	R	T
46	Eurasian Collared Dove	*Stretopelia decaocto*	16	2.962	F	+		LC	R	T
	Gruiformes									
	Rallidae									
47	White-breasted Waterhen	*Amaurornis phoenicurus*	28	5.185	F	+	+	LC	R	A
48	Common Moorhen	*Gallinula chloropus*	6	1.1	U	+		LC	R/SV	A
49	Common Coot	*Fulica atra*	5	0.925	U	+		LC	WV/PM	A

	Ciconiiformes									
	Scolopacidae									
50	Common Snipe	*Gallinago gallinago*	50	9.259	F	+	+	LC	WV/PM	A
51	Common Greenshank	*Tringa nebularia*	28	5.185	F	+		LC	WV/PM	A
52	Common Sandpiper	*Actitis hypoleucos*	68	12.59	C	+	+	LC	WV/PM	A
53	Common Redshank	*Tringa tetanus*	5	0.92	U	+		LC	WV/PM	A
54	Green Sandpiper	*Tringa ochropus*	3	0.56	U	+		LC	WV/PM	A
55	Little Stint	*Calidris alba*	3	0.56	U		+	LC	WV/PM	A
	Ardeidae									-+
56	Little Egret	*Egretta garzetta*	98	18.148	C	+	+	LC	R	A
57	Cattle Egret	*Bubulcus ibis*	179	33.14	C	+	+	LC	R	T
58	Intermediate Egret	*Mesophoyx intermedia*	8	1.48	F	+		LC	R	A
59	Great Egret	*Casmerodius albus*	3	0.56	U	+		LC	R	A
60	Striated Heron	*Butorides striatus*	1	0.185	U		+	LC	SV/R	A
61	Grey Heron	*Ardea cinerea*	4	0.74	U	+	+	LC	WV/RR	A
62	Indian Pond Heron	*Ardeola grayii*	132	24.45	C	+	+	LC	R	A
63	Cinnamon Bittern	*Ixobrychus cinnamomeus*	1	0.185	U		+	LC	SV/R	A
64	Black Bittern	*Dupetor flavicollis*	1	0.185	U		+	EN	R	A
	Threskiornithidae									
65	Black Ibis	*Pseudibis papillosa*	20	3.7	F	+		LC	R	A
	Ciconiidae									
66	Asian Openbill	*Anastomus oscitans*	41	7.59	F	+		VU	R	A

67	Black Stork	*Ciconia nigra*	2	0.37	U	+		VU	WV/PM	A
68	Lesser Adjutant	*Leptoptilos javanicus*	3	0.56	U	+		VU	R	A
	Charadriidae									
69	Little-ringed Plover	*Charadrius dubius*	32	5.925	F	+		LC	R/WV	A
70	River Lapwing	*Vanellus duvaucelii*	6	1.11	U	+		NT	R	A
71	Grey-headed Lapwing	*Vanellus cinereus*	23	4.25	F	+		LC	WV/PM	A
72	Red-wattled Lapwing	*Vanellus indicus*	32	5.92	F	+		LC	R	A
	Falconiformes									
	Pandionidae									
73	Osprey II	*Pandion haliaetus*	2	0.37	U	+		LC	WV/PM	A
	Accipitridae									
74	Black-shouldered Kite II	*Elanus caeruleus*	5	0.926	U		+	LC	R	T
75	Black Kite II	*Milvus migrans*	28	5.185	F	+	+	LC	R	T
76	Pallas's Fish Eagle II*	*Haliaeetus leucoryphus*	1	0.185	U	+		CR	WV	A
77	Creasted-serpent Eagle	*Spilornis cheela*	10	1.85	U	+		LC	R	T
78	Oriental Honey-buzzard	*Pernis ptilorhyncus*	3	0.56	U	+	+	LC	R/PM	T
79	Common Buzzard II	*Buteo buteo*	13	2.407	F	+		LC	WV/PM	T
	Falconidae									
80	Common Kestrel II	*Falco tinnunculus*	24	4.45	F	+		LC	R/WV/PM	T
81	Collared Falconet II	*Microhierax caerulescens*	1	0.185	U		+	NT	R	T
	Pelecaniformes									
	Phalacrocoracidae									

82	Little Cormorent	*Phalacrocorax niger*	9	1.67	U	+		LC	WV/PM	A
83	Greater Cormorent	*Phalacrocorax carbo*	20	3.703	F	+		NT	WV	A
	Passeriformes									
	Laniidae									
84	Brown Shrike	*Lanius isabellinus*	4	0.74	U	+		LC	WV	T
85	Long-tailed Shrike	*Lanius schach*	54	10	F	+	+	LC	R	T
86	Grey-backed Shrike	*Lanius tephronotus*	24	4.45	F	+		LC	R	T
	Corvidae									
87	Red-billed Blue Magpie	*Urocissa flavirostris*	4	0.74	U	+		LC	R	T
88	Rufous Treepie	*Dendrocitta vagabunda*	6	4.81	F	+	+	LC	R	T
89	House Crow	*Corvus splendens*	172	31.85	C	+	+	LC	R	T
90	Large -billed Crow	*Corvus macrorhynchos*	88	16.29	C	+	+	LC	R	T
91	Ashy Woodswallow	*Artamus fuscus*	15	2.78	F		+	LC	R	T
92	Eurasian Golden Oriole	*Oriolus oriolus*	8	1.481	U		+	LC	SV	T
93	Black-hooded Oriole	*Oriolus xanthornus*	16	2.96	F	+	+	LC	R	T
94	Large Cuckooshrike	*Coracina macei*	25	4.62	F	+	+	LC	R	T
95	Scarlet Minivet	*Pericrocotus flammeus*	5	0.926	U	+		LC	R	T
96	White-throated Fantail	*Rhipidura albicollis*	3	0.56	U	+		LC	R	T
97	Black Drongo	*Dicrurus macrocerus*	115	21.29	C	+	+	LC	R	T
98	Ashy Drongo	*Dicrurus leucophaeus*	21	3.89	F	+	+	LC	R	T
99	White-bellied Drongo	*Dicrurus caerulescens*	15	2.78	F	+	+	LC	R	T
100	Bronzed Drongo	*Dicrurus aeneus*	10	1.852	U	+		LC	R	T

101	Spangled Drongo	*Dicrurus hottentottus*	3	0.56	U	+		LC	R	T
102	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	6	1.11	U	+		LC	R	T
103	Asian Paradise Flycatcher	*Terpsiphone paradise*	8	1.481	U		+	LC	SV	T
104	Large Woodshrike	*Tephrodornis gularis*	3	0.56	U		+	LC	R	T
	Muscicapidae									
105	Orange-headed Thrush	*Zoothera citrine*	2	0.37	U		+	LC	SV	T
106	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	10	1.851	U	+		LC	PM	T
107	Pale-chinned Flycatcher	*Cyornis poligenys*	12	2.22	F	+	+	LC	R	T
108	Blue-throated Flycatcher	*Cyornis rubeculoides*	3	0.56	U		+	LC	SV/PM	T
109	Taiga Flycatcher	*Muscicapidae ficedula*	17	3.148	F	+		LC	WV/PM	T
110	Rufous-gorgetted Flycatcher	*Ficedula strophiata*	5	0.925	U	+		LC	R	T
111	Bluethroat	*Luscinia svecica*	13	2.407	F		+	LC	WV/PM	T
112	White-capped Water Redstart	*Chaimarrornis leucocephalus*	5	0.925	U	+		LC	WV	A
113	Plumbeous Water Redstart	*Rhyacornis fuliginosus*	16	2.962	F	+		LC	WV	A
114	Black-backed Forktail	*Enicurus immaculatus*	3	0.56	U	+		LC	R	T
115	Oriental Magpie Robin	*Copsychus saularis*	47	8.703	F	+	+	LC	R	T
116	Common Stonechat	*Saxicola torquata*	169	31.29	C	+	+	LC	R/WV/PM	T
117	Pied Bushchat	*Saxicola capratta*	142	26.29	C	+	+	LC	R	T
	Sturnidae									
118	Chestnut-tailed Starling	*Sturnus malabaricus*	12	2.22	F	+		LC	R	T
119	Common Myna	*Acridotheres tristis*	258	47.78	A	+	+	LC	R	T
120	Jungle Myna	*Acridotheres fuscus*	93	17.22	C	+	+	LC	R	T

121	Asian Pied Starling	*Sturnus contra*	163	30.185	C	+	+	LC	R	T
	Paridae									
122	Great Tit	*Parus major*	6	1.11	U		+	LC	R	T
	Hirundinidae									
123	Plain Martin	*Riapria paludicola*	195	36.11	C	+	+	NT	R	A
124	Red-rumped Swallow	*Hirundo daurica*	44	8.148	F	+		LC	R	T
	Pycnonotidae									
125	Red-vented Bulbul	*Pycnonotus cafer*	143	26.48	C	+	+	LC	R	T
126	Himalayan Bulbul	*Pycnonotus leucogenys*	7	1.296	U	+		LC	R	T
	Cisticolidae									
127	Grey-breasted Prinia	*Prinia hodgsonii*	180	33.33	C	+	+	LC	R	T
128	Yellow-bellied Prinia	*Prinia flaviventris*	3	0.56	U	+		LC	R	T
	Sylviidae									
129	Common Tailorbird	*Orthotomus sutorius*	120	22.22	C	+	+	LC	R	T
130	Zitting Cisticola	*Cisticola juncidis*	87	16.11	C	+	+	LC	R	T
131	Brownish-flanked Bush Warbler	*Cettia pallidipes*	36	6.67	F	+		LC	R	T
132	Common Chiffchaff	*Phylloscopus collybita*	40	7.407	F	+		LC	WV	T
133	Smoky Warbler	*Phylloscopus fuligiventer*	5	0.925	U	+		LC	R	T
134	Lemon-rumped Warbler	*Phylloscopus chloronotus*	6	1.11	U	+		LC	R	T
135	Dusky Warbler	*Phylloscopus fuscatus*	37	6.85	F	+		LC	WV	T
136	Grey-hooded Warbler	*Seicercus xanthoschistos*	5	0.92	U	+		LC	R	T
137	Striped Tit Babbler	*Macronous gularis*	7	1.296	U	+		LC	R	T

138	Jungle Babbler	*Turdoides striatus*	25	4.629	F	+		LC	R	T
139	Red-billed Leiothrix	*Leiothirx lutea*	4	0.74	U	+		LC	R	T
	Alaudidae									
140	Bengal Bushlark	*Mirafra assamica*	75	13.89	C	+		LC	R	T
141	Ashy-crowned Sparrow Lark	*Eremopterix grisea*	9	1.67	U	+		LC	R	T
	Passeridae									
142	House Sparrow	*Passer domesticus*	55	10.19	C	+	+	LC	R	T
143	Eurasian Tree Sparrow	*Passer montanus*	5	0.925	U	+		LC	R	T
144	White-browed Wagtail	*Motacilla maderaspatensis*	69	12.78	C	+	+	`	R	T
145	Grey Wagtail	*Motacilla cinerea*	21	3.89	F	+		LC	R	A
146	White Wagtail	*Motacilla alba*	4	0.74	U	+		LC	WV/PM	A
147	Rosy Pipit	*Anthus roseatus*	6	1.1	U	+		LC	R/PM	T
148	Olive-backed Pipit	*Anthus hodgsoni*	36	6.67	F	+	+	LC	R/WV	T
149	Paddyfield Pipit	*Anthus rufulus*	64	11.86	C	+		LC	R	T
150	Richards Pipit	*Anthus richardi*	6	1.1	U	+		LC	WV/PM	T
151	White-rumped Munia	*Lonchura striata*	6	1.1	U		+	LC	R	T
152	Scaly-breasted Munia	*Lonchura punctulata*	30	5.56	F	+	+	LC	R	T
153	Baya Weaver	*Ploceus philippinus*	53	9.81	F	+	+	NT	R	T
	Total		5040							

C.S. = Conservation Status, LC= Least Concern, NT= Near Threatened, VU= Vulnerable, M.P. = Migratory pattern, R= Resident, WV= Winter Visitor, SV= Summer Visitor, PM= Partial Migrant, IV= Irregular Visitor, T= Terrestrial, A= Aquatic, L.Abu.C= Local abundance category. I=CITES Appendix I, II= CITES Appendix II, #= Nationally Threatened, *= Globally Threatened.

2. List of birds recorded in different block.

S.N	Common Name	B1	B2	B3	Total
1	Black Francolin	12	11	15	38
2	Red-jungle Fowl		7		7
3	Bar-headed Goose			1	1
4	Cotton Pigmy Goose	1			1
5	Ruddy Shelduck		4	8	12
6	Eurasian Wigeon			5	5
7	Mallard		3		3
8	Garganey		4		4
9	Common Merganser			6	6
10	Lesser Whistling Duck		5	15	20
11	Rufous Woodpecker		1	2	3
12	Grey-capped Pigmy Woodpecker		2		2
13	Great Barbet		2		2
14	Coppersmith Barbet	2	6	5	13
15	Common Hoopoe	16	7	8	31
16	Indian Roller	23	22	6	51
17	Common Kingfisher	7	10	6	23
18	Stork-billed Kingfisher		2		2
19	White-throated Kingfisher	22	24	21	67
20	Black-capped Kingfisher	2			2
21	Creasted Kingfisher		2		2
22	Pied Kingfisher	2		8	10
23	Green Bee-eater	11	14	28	53
24	Blue-tailed Bee-eater	12	20	15	47
25	Chestnut-headed Bee-eater	8	15	10	33
26	Pied Cuckoo			2	2
27	Common Hawk Cuckoo	2	5	3	10
28	Grey-bellied Cuckoo	1			1
29	Banded Bay Cuckoo		2		2
30	Oriental Cuckoo		2	3	5
31	Asian Koel	3	6	6	15
32	Greater Coucal	9	7	6	22
33	Lesser Coucal		2		2

34	Alexandrine Parakeet II	10	12	15	37
35	Rose-ringed Parakeet II	46	43	25	114
36	Plum-headed Parakeet II	40	32	40	112
37	Red-breasted Paakeet II	27			27
38	House Swift		21	34	55
39	Creasted Treeswift		7		7
40	Asian Barred Owlet II	2		2	4
41	Jungle Owlet II			2	2
42	Spotted Owlet II			2	2
43	Rock Pigeon	47	20	45	112
44	Oriental Turtle Dove	14	35	6	55
45	Spotted Dove	40	40	38	118
46	Eurasian Collared Dove	2	12	2	16
47	White-breasted Waterhen	9	19		28
48	Common Moorhen	6			6
49	Common Coot		5		5
50	Common Snipe	22	21	7	50
51	Common Greenshank	20	8		28
52	Common Sandpiper	28	18	22	68
53	Common Redshank		5		5
54	Green Sandpiper		3		3
55	Little Stint		3		3
56	Little Egret	31	25	42	98
57	Cattle Egret	60	59	60	179
58	Intermediate Egret	3	5		8
59	Great Egret		3		3
60	Grey Heron		4		4
61	Indian Pond Heron	40	43	49	132
62	Striated Heron		1		1
63	Cinnamon Bittern		1		1
64	Black Bittern		1		1
65	Black Ibis	8	5	7	20
66	Asian Openbill	5	28	8	41
67	Black Stork	2			2
68	Lesser Adjutant	3			3

69	Little-ringed Plover	8	4	20	32
70	River Lapwing		6		6
71	Grey-headed Lapwing	15	8		23
72	Red-wattled Lapwing	8	14	10	32
73	Osprey II		2		2
74	Black-winged Kite II		5		5
75	Black Kite II	6	10	12	28
76	Pallas's Fish Eagle II*		1		1
77	Creasted-serpent Eagle	6	4		10
78	Oriental Honey-buzzard	2	1		3
79	Common Buzzard II	4	5	4	13
80	Common Kestrel II	7	17		24
81	Collared Falconet	1			1
82	Little Cormorent		9		9
83	Greater Cormorent		2	18	20
84	Brown Shrike		4		4
85	Long-tailed Shrike	22	10	22	54
86	Grey-backed Shrike	9	10	5	24
87	Red-billed Blue Magpie		4		4
88	RufousTreepie	11	9	6	26
89	House Crow	54	43	75	172
90	Large -billed Crow	25	33	30	88
91	Ashy Woodswallow	10	5		15
92	Eurasian Golden Oriole	8			8
93	Black-hooded Oriole	5	6	5	16
94	Large Cuckooshrike	16	6	3	25
95	Scarlet Minivet		5		5
96	White-throated Fantail		3		3
97	Black Drongo	33	35	47	115
98	Ashy Drongo			21	21
99	White-bellied Drongo	5	3	7	15
100	Bronzed Drongo	4	6		10
101	Spangled Drongo		3		3
102	Greater Racket-tailed Drongo		6		6
103	Asian Paradise Flycatcher	5	3		8

104	Large Woodshrike	3			3
105	Orange-headed Thrush	1	1		2
106	Grey-headed Canary Flycatcher			10	10
107	Pale-chinned Flycatcher		5	7	12
108	Blue-throated Flycatcher	1	2		3
109	Taiga Flycatcher	5	12		17
110	Rufous-gorgetted Flycatcher		5		5
111	Bluethroat	8	5		13
112	White-capped Water Redstart			5	5
113	Plumbeous Water Redstart	4	7	5	16
114	Black-backed Forktail		3		3
115	Oriental Magpie Robin	15	20	12	47
116	Common Stonechat	65	73	31	169
117	Pied Bushchat	52	57	33	142
118	Chestnut-tailed Starling			12	12
119	Common Myna	66	105	87	258
120	Jungle Myna	26	44	23	93
121	Asian Pied Starling	24	65	74	163
122	Great Tit		6		6
123	Plain Martin	70	68	57	195
124	Red-rumped Swallow	15	18	11	44
125	Red-vented Bulbul	30	65	48	143
126	Himalayan Bulbul			7	7
127	Grey-breasted Prinia	56	72	52	180
128	Yellow-bellied Prinia		3		3
129	Common Tailorbird	34	52	34	120
130	Zitting Cisticola	46	41		87
131	Brownish-flanked Bush Warbler	22	10	4	36
132	Common Chiffchaff	30		10	40
133	Smoky Warbler		5		5
134	Lemon-rumped Warbler			6	6
135	Dusky Warbler		15	22	37
136	Grey-hooded Warbler			5	5
137	Striped Tit Babbler		7		7

138	Jungle Babbler	8	17		25
139	Red-billed Leiothrix		4		4
140	Bengal Bushlark	20	28	27	75
141	Ashy-crowned Sparrow Lark		3	6	9
142	House Sparrow	6	29	20	55
143	Eurasian Tree Sparrow	5			5
144	White-browed Wagtail	27	20	22	69
145	Grey Wagtail	14	7		21
146	White Wagtail	4			4
147	Rosy Pipit		6		6
148	Olive-backed Pipit	14	8	14	36
149	Paddyfield Pipit	30	26	8	64
150	Richards Pipit		6		6
151	White-rumped Munia		6		6
152	Scaly-breasted Munia	10	20		30
153	Baya Weaver	27	26		53
	Total	1600	1918	1522	5040

3. Total Orders and Families of the Birds Recorded in Study Area

S.N	**Order / No of species**	**Family**	**No of species**
1	**Galliformes**	Phasinadae	2
2	**Anseriformes**	Anatidae	7
		Dendrocygnidae	1
3	**Piciformes**	Picidae	2
		Megalaimidae	2
4	**Upipiformes**	Upupidae	1
5	**Coraciformes**	Coraciidae	1
		Alcedinidae	1
		Decelonidae	3
		Cerylidae	2
		Meropidae	3
6	**Cuciliformes**	Cuculidae	5

		Centropodidae	2
7	**Psittaciformes**	Psittacidae	4
8	**Apodiformes**	Apopidae	2
9	**Strigiformes**	Strigidae	3
10	**Columbiformes**	Columbidae	4
11	**Gruiformes**	Rallidae	3
12	**Ciconiformes**	Scolopacidae	6
		Ardeidae	10
		Threskiornithidae	1
		Ciconiidae	3
		Charadriidae	4
13	**Falconiformes**	Pandionidae	1
		Accipitridae	6
		Falconidae	2
14	**Pelecaniformes**	Phalacrocoracidae	2
15	**Passeriformes**	Laniidae	3
		Corvidae	18
		Muscicapidae	13
		Sturnidae	4
		Paridae	1
		Hirundinidae	2
		Pycnonotidae	2
		Cisticolidae	2
		Sylviidae	11
		Alaudidae	2
		Passeridae	12
			153

4. Bird Survey Data Sheet

Date:		Time start:		Habitat:			Block no:
Weather :		Time off:					
S.N.	Bird Species	No. of Birds	Location	Behaviors	Remark		
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

9 PHOTOPLATES

Black Francolin

Red Jungle Fowl

Lesser Whistling Duck

Black Bittern

Cotton-Pigmy Goose

Garganey

Ruddy Shelduck

Striated Heron

Black-capped Kingfisher

Stork-billed Kingfisher

Creasted Kingfisher

Common Kingfisher

Common Snipe

Grey Lapwing

Little-ringed Plover

Little Egret

Great Egret

Intermediate Egret

Indian Pond Heron

Little Stint

Black Stork

Greater Cormorant

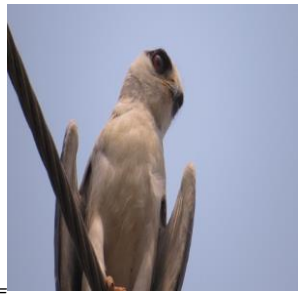
Little Cormorant

Common Buzzard

Osprey

Pallas's Fish Eagle

Creasted-serpent Eagle



Black-shouldered Kite

Pied Cuckoo

Eurasian Cuckoo

Common Hawk Cuckooo

Red-breasted Parakeet

Blue-tailed Bee-eater

Common Hoopoe

Brown Shrike

Red-billed Leiothrix

Pale-chinned Flycatcher

Large Woodshrike

Rufous-winged Bushlark

Ashy-crowned Sparrowlark

Bluethroat

Blue-throated Flycatcher

Scarlet Minivet

Great Barbet

Scaly-breasted Munia

Common Stonechat

Ashy Woodswallow

rosy Pipit

White Wagtail

Eurasian Collared Dove

Black Drong

Bronzed-winged Jacana

Grey Heron

Rufous Treepie

Red-vented Bulbul

Common Myna

Rose-ringed Parakeet

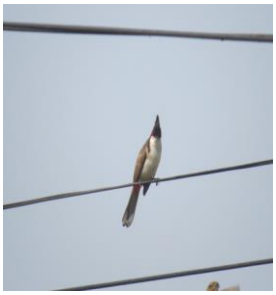
Spotted Owlet

Oriental Turtle Dove

Zitting Cisticola

Black Ibis

Asian Openbil



Himalayan Bulbul

Large Cuckooshrike

Chestnut-tailed Starling

Pied Starling

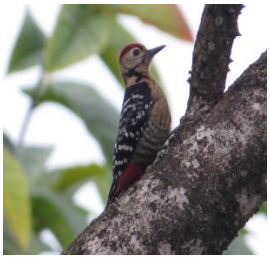
Baya Weaver

Common Greenshank

Orange-headed Thrush

Cattle Egret

Red-breasted Parakeet



Fulvous-breasted Woodpecker

Plain Martin

Common Merganser

People Fishing in the river

Karra river

children playing catapult

researcher observing bird

Thank you !!!