# 1. INTRODUCTION

## 1.1 Background

Birds occupy almost all habitat types and diversity of birds often serves as a good indicator of overall diversity of a given area (Furness and Greenwood 1993).In any ecosystem, birds serve as an important component as they have the ability to fly away and avoid any obnoxious conditions (Desai and Shanbhag 2007). Bird species richness is an indicator of all habitat quality of an ecosystem (Bilgrami 1995). The species richness and community structure of birds vary from region to region and it depends on habitat conditions (Recher 1969, Pearson 1977). Seasonal climatic change, landscape patterns, vegetation types and community structures are influencing the avian communities (Karr 1976, Blake and Loiselle 1991). Biogeographically, diverse habitats are the major factors for high species richness of bird as well as other faunal communities, which ranges from lush moist forests and sparse alpine deserts to luxuries grasslands in lowland Terai (BCN and DNPWC 2011).

Major habitat for Nepal's bird consists of forest, wetland and grassland. Forest and bushes holds 77% of Nepal's breeding birds (Grimmet et al. 2000). Over half (53%) of Nepal's nationally threatened birds inhabits in forests, 27% in wetlands, 15% in grasslands, eight percent in cultivated land, five percent in shrub, nine percent in open canopy, three percent near human habitation, and one percent in semi-desert areas (Inskipp et al. 2013). Habitat structure and floristic composition are known to have a significant role in determining the occurrence of bird species (Wiens and Rotenberry 1991, Rice et al. 1984).

The major threats of birds of Nepal are poaching and illegal trade, habitat loss and destruction due to agricultural activities, overgrazing, overharvesting for fodder and poisoning. Habitat loss is the major threat, about 86% of the birds at risk under habitat loss (Birdlife Nepal 2013). Out of 871 species of Bird species of Nepal, about 36 species recorded in Nepal are listed in IUCN Red List of globally threatened birds (BirdLife International 2012). Sixteen orders and 61 families of birds have been recorded in Nepal forming more than nine percent of the world's known bird species (BCN and DNPWC 2011). Spiny Babbler *Turdoides nipalensis* is the only endemic bird of Nepal (Grimmet et al. 2003). In 2010, the alarming number of 149 bird species, 17% of Nepal's birds is

considered nationally threatened, 61 species are thought to be Critically Endangered, 38 are endangered and 50 are Vulnerable (BCN and DNPWC 2011). A total of 35 globally threatened species, 19 near threatened species and 15 restricted-range species of birds are recorded in Nepal (Birdlife Nepal 2013).

The information on the complexity of bird community is usually increased with the increase of habitat complexity (MacArthur and MacArthur 1961). In the Himalaya range, many birds migrate to downhill during snowing seasons and migrate uphill when the snow melts. In the lowland Terai, many species of birds migrates from Himalayas, Tibet of China and Siberia of Russia during the winter season and show the high species richness (Recher 1969, Pearson 1977).

Declines in populations of many grassland birds have been linked to agricultural land use and increasing intensification. Establishing patches of non-crop, native herbaceous vegetation in agricultural landscapes may help reverse these declines by providing suitable breeding habitat. To optimize the balance between habitat benefits and agronomics, we need to understand bird community responses to a variety of patch designs, its species diversity and conservation threats in those areas. Patterns of worldwide avian species composition and distribution have been investigated for many decades, yet ecologists' understanding of these patterns and the underlying processes which create them remain incomplete (DNPWC 2011). Early studies of bird communities attempted to estimate the relationship between species diversity and habitat, specifically vegetation structure and composition (MacArthur and MacArthur 1961, MacArthur et al. 1966, Recher 1969, Karr and Roth 1971) and were mostly conducted in temperate regions of some countries of North American and Europe.

### 1.2 Rationale

Information on birds of the eastern Nepal is lacking even the study site are near to Koshi Tappu Wildlife Reserve. It is an important recreational destination with great potential of wildlife including bird diversity. Now this area has been established as a picnic spot and other recreational activities that have created lots of problem on habitat, breeding and feeding activities of bird. Firewood collection, grazing are the prominent human induced disturbances of this area. Data on avifauna of this area is not adequate to assess conservation needs. Only little information from records of bird watchers, nature guides

etc. are available (Subba and Chhetri 2005). Baseline survey and data are necessary for the proper conservation and management initiatives. Hence, this study was essential to provide baseline data on seasonal diversity and habitat association of birds of that area.

### 1.3 Objectives

The main objective of the study was to explore the Diversity and Conservation Status of bird in Betana wetland area, Belbari, Morang, Nepal.

The specific objectives were:

- To explore the species richness of birds.
- To explore the seasonal variation in bird species richness and
- To compare the species richness of birds between the different habitats.

# 2. LITERATURE REVIEW

The study and conservation programs of bird are high in Nepal compared to small mammals, invertebrates and herpetofauna (BCN 2011). Patterns of bird diversity are driven by fundamental biogeographic factors, with tropical and sub-tropical countries supporting the highest species richness of bird (MacAuthur and MacArthur 1961). By understanding the factors that influence the distribution of organisms, it becomes possible to use conservation tools necessary for the survival of endangered species of the geographical areas (Guisan and Zimmermann 2000). Availability of food, detectability and capture, location of nesting sites, availability of nesting materials, presence of predators and competitors are the major factors known to influence the population of birds (Wiens 1989). Majority of the studies on bird community were focused on the understanding of the structure of a community based on the population (MacArthur and MacArthur 1961, Cody 1974 and Wiens 1989). Population studies have been traditionally used to monitor long term changes in avian population and to assess both habitat quality and the responses of birds to both natural and human caused environmental changes (Wiens 1989, Sharma 2004, Ghimire 2009). A total of 871 bird species have been recorded in Nepal (BCN and DNPWC 2012). Basnet et al. (2006) recorded a total of 110 species of bird at Raja Rani Community forest Bhogteny, Morang.

Rimal (2006), Thakuri (2007), Khanal (2008), Basnet (2010), Aryal (2012, 2013), Katuwal (2013) and Chapagain (2014) studied on relationship between species richness and factors influencing the distribution of birds in different parts of Nepal. Seasonal changes often correspond to different life-style requirements and migratory strategies of birds (Katuwal2013). Requirements can differ by stages within a season, such as during nesting and fledging periods, or between seasons such as breeding and non-breeding. The climatic condition varies to the species diversity and richness of birds. Seasonal differences in habitat can range from shifts in tree-species used by resident species to the use of drastically different areas by migrant birds (Conner 1981, Hutto 1985, Morrison et al. 1985, Terborgh 1989, Block 1991).

Ghimire (2009) reported higher richness in spring than in autumn in a study done in Barandabhar corridor forest of Chitwan National Park. Khanal (2008) also documented the

higher diversity of birds in agricultural land than forest and grassland during winter season while studying on Nawalparasi forest due to the suitable climate during winter season. Poudel (2005) observed higher number and diversity of birds in Kirtipur during winter season due to the suitable climatic condition in winter. Malla (2006) recorded higher species richness in winter and spring than other seasons in Nagarjun Forest, Kathmandu. Furthermore, Rimal (2006) found the highest number of species in spring and lowest in monsoon in Sivapuri National Park. Thakuri (2007) mentioned higher species richness in summer followed by autumn and spring season in a research in Northern part of Kathmandu Valley. Research done in Godavari forest concluded that species richness was the highest in winter and lowest in autumn due to the easy availability of food material and favourable climatic condition (Basnet 2010). Katuwal (2013) recorded the high species richness of birds in post- monsoon season and low in the pre-monsoon season in Manaslu Conservation Area. Similarly, Aryal (2013) found higher species richness in spring than in the winter in Kanchenjunga Conservation Area. Levey (1988) concluded that bird richness and abundance was maximum in rainy season in Costa Rica. A research on coastal woodlands in east-central Argentina shows higher density of bird recorded during spring and lower one during autumn, but species richness did not show changes during the annual cycle (Cueto and De Casenave 2000). Herzog et al. (2003) also found minimum abundance of birds in winter season in a study in central Bolivia. Murgui (2007) studied on effects of seasonality on bird species in urban parks of Valencia (Spain). He concluded that in the breeding period i.e., in spring and summer bird richness became higher than in the winter season.

Khanal (2008) concluded that species richness of birds was higher in agricultural farmland with wetland and lower in forest habitat while studying on Seasonal diversity, status and habitat utilization of birds in a Nawalparasi forest (IBA) of in Nepal.Most of the studies in Nepal are broad area landscape approaches (Fleming et al. 1984, Inskipp 1989, Grimmet et al. 2003, DNPWC 2011 and BES 2013) but some studies were done focusing on species richness and habitat types. Ghimire (2009) reported the highest bird richness in Sal forest and the lowest in mix forest in a study on seasonal diversity and habitat utilization of birds in the BCF of Chitwan. Thakuri (2007) also concluded that majority of the birds were found within forested areas than in riverine, agricultural land, marshes , urban and human settlement areas while studying in Satikhel and Dallu community forests of Seshnarayan VDC on Seasonal Diversity and Community Composition of Birds. Malla (2006) recorded

higher species richness along the forest edge than in an interior forest. Rimal (2006) examined community structure and habitat association of birds in Shivapuri National Parks of the central mid-hill of Nepal. On his study bird species richness was higher in the disturbed habitat condition. Basnet (2010) concluded that more species richness was found in moderately disturbed forest area than in highly disturbed one after analyzing the species richness and composition of breeding bird species along elevation gradients in central Nepal. Aryal (2013) studied on avian diversity along elevation and land use gradient in Ghunsa Valley of Kanchenjunga Conservation Area and concluded that the species richness was higher in natural forest followed by exploited forest, cultivated land and meadows. Katuwal (2013) studied the species richness of birds in different habitats of Manaslu Conservation Area and concluded that there was a significant difference in species richness of birds among habitat types. Many studies related to the species richness of birds with different habitats have been conducted in other countries too. Avian richness peaked at moderately disturbed sites (Robert 1996, Chettri et al. 2005). In contrast, species richness was relatively higher for natural forest than for other land use types (Palomino and Carrascal 2006, Waltert et al. 2004)

Raman (2001) studied the community of birds in different altitudes and the impact of fragmentation and plantations on rainforest birds in the Western Ghats. The relationships between habitat and diversity in avian communities in Panama, Illionis, Texas and Bahamas were examined by Karr (1968), Karr and Roth (1971). Karr (1976) reported on seasonality, resource availability and community diversity in the tropical bird communities in Panama during the period 1968 and 1969. The species richness in an oak woodland avifauna was studied by (Landres and MacMahon1980). Wiens and Rotenberry (1981) studied the relationship between the distribution of birds, their abundance and habitat characteristics at a regional scale, using surveys conducted over three consecutive years in the shrub steppe of the northwestern Great Basin of North America. Ambuel and Temple (1983) studied the avian biogeography and habitat selection in forests of southern Wisconsin.

# 3. MATERIALS AND METHODS

## 3.1 Study area

Betana wetland is located at newly established Belbari Municipality of Morang district. It is one kilometer far from the Belbari Bazar in the east lying on the north side of the highway. Its southern border touches the East –West highway (Figure1). The study site nearly covers 4.6 $Km^2$with forest and lake. The wetland services is own natural water from per catchment area and really rich in water resources over the year. The pond is situated at the eastern side of the Betana Wetland and covers 8 hectors, where as the next pond of Betana Wetland of western side covers 22 hectors (Subba and Chhetri 2005).

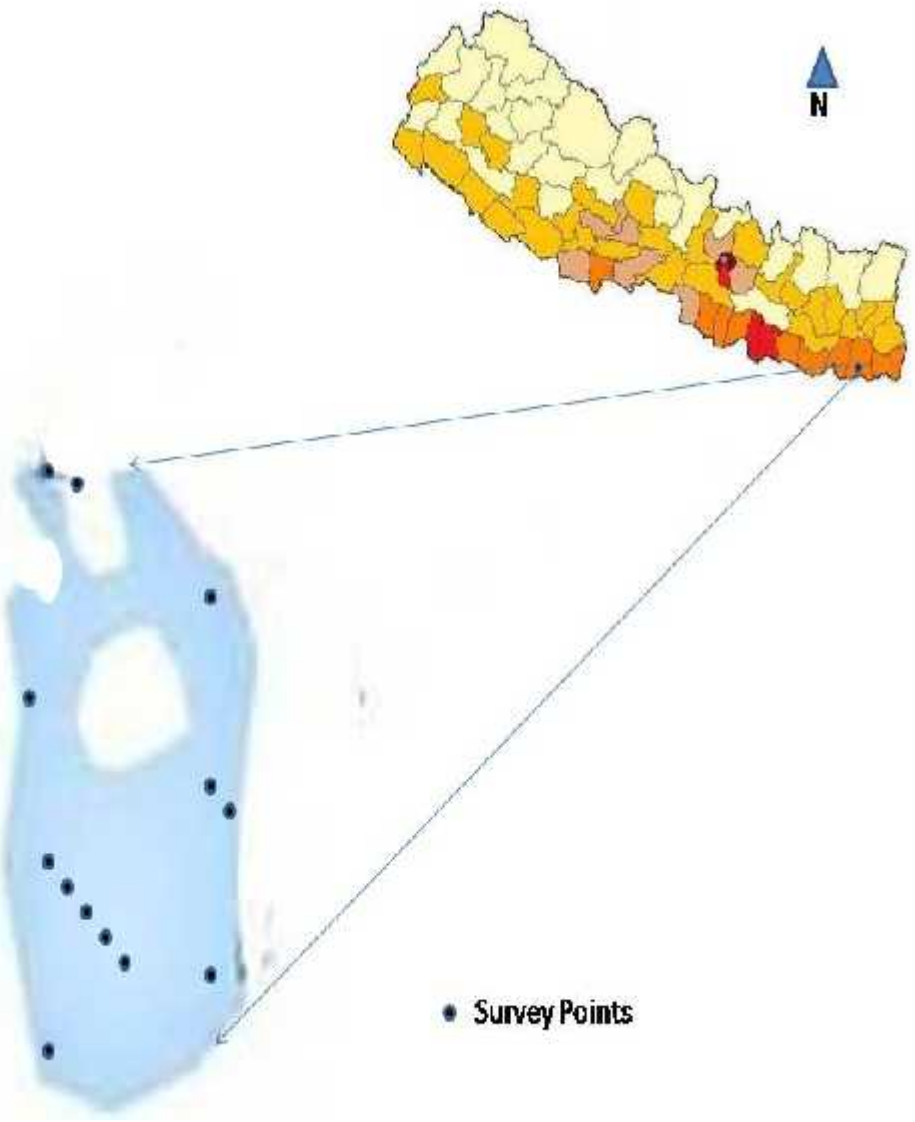


Figure1: Map showing study area and sampling point


Figure 2: Google map Showing Betana wetland area.

### 3.2 Climate

The climate of study site is tropical with four distinct seasons, Pre-monsoon (March-May), Monsoon (June-August), Post Monsoon (September-November) and winter (December-February) seasons. Winter season is with relatively high humidity. The minimum relative humidity is 89% and highest is 98% (Figure 5). The average rainfall is 3250 mm per year and about 90% of rainfall occurs within three months of monsoon seasons (June-August) (Figure 4). The monsoon rain causes dramatic floods and changes in the character and course of rivers and is one of the important and dramatic factors in terms of ecosystem dynamics. Winter season is marked as the coldest season and temperature can drop to 8˚C. Summer season is marked as pre-monsoon season and temperature may rise up to 37˚C (Figure 3)

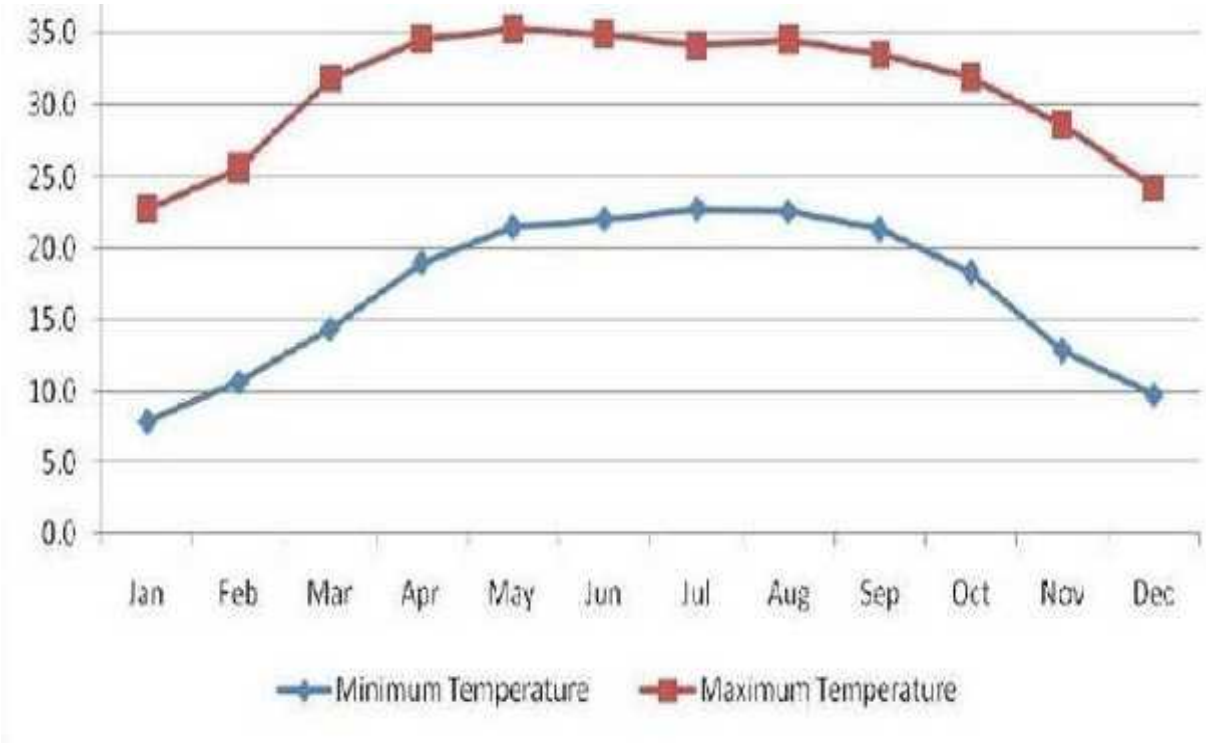


Figure 3: Monthly average of minimum and maximum temperature of Morang station recorded from 2000- 2014 (Source: Department of Hydrology and Metrology).

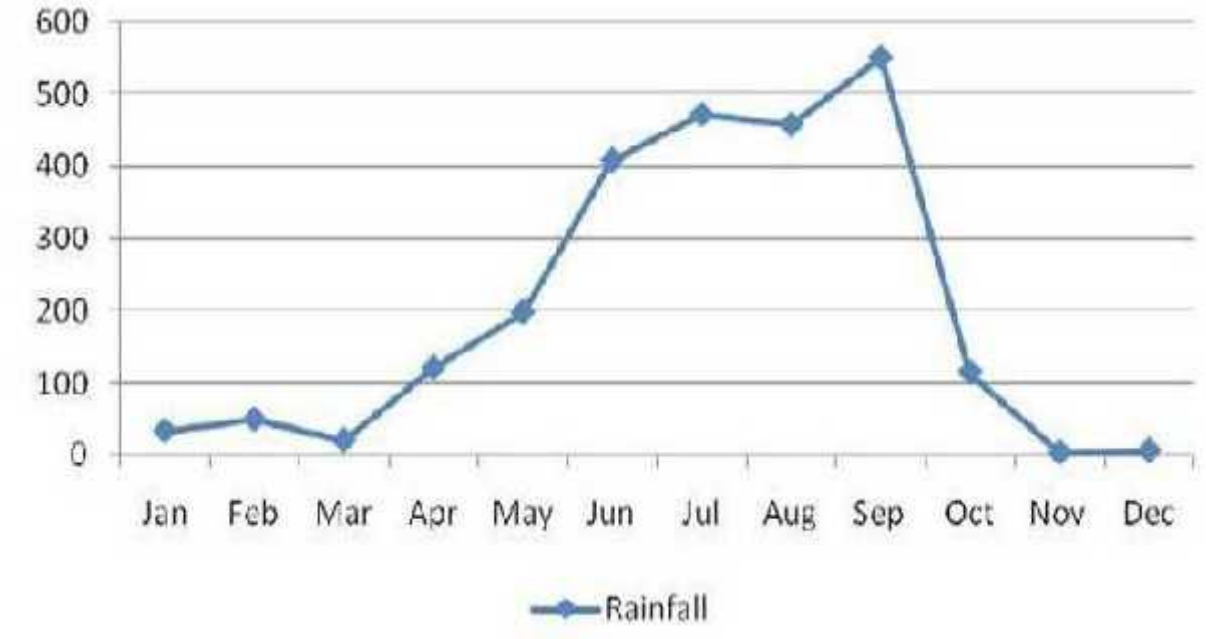


Figure 4: Monthly average of rainfall (mm) of Morang station recorded from 2000-2014(Source: Department of Hydrology and Metrology).

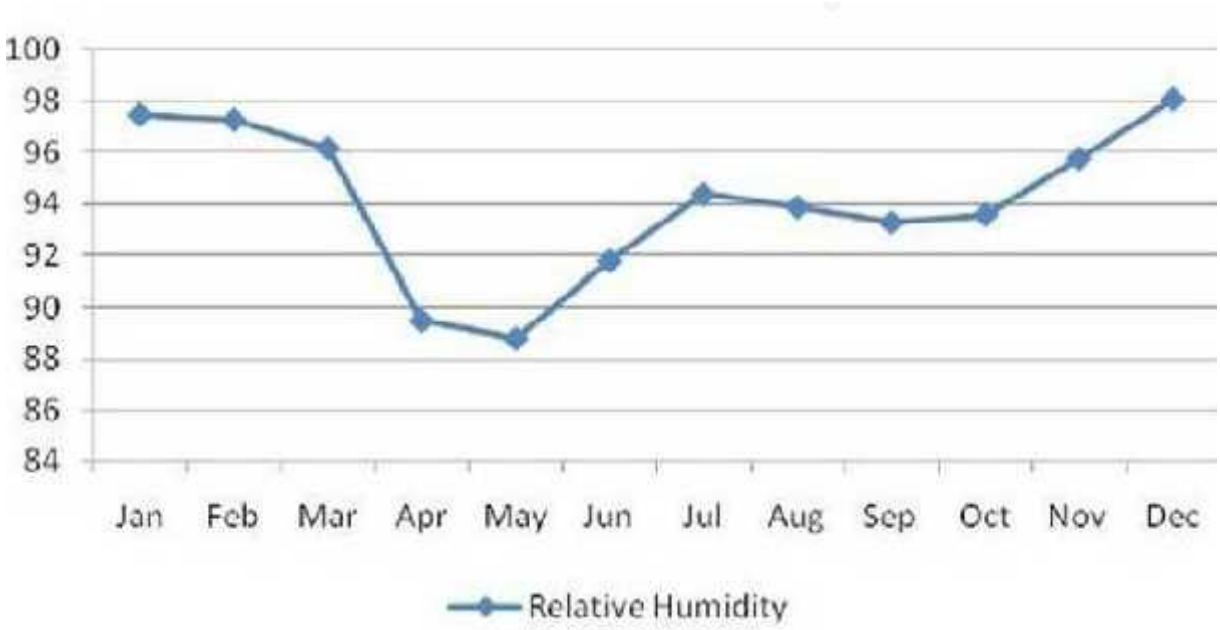


Figure 5: Monthly average of Relative humidity of Morang recorded from 2000- 2014 (Source: Department of Hydrology and Metrology).

## 3.3 Biodiversity

### *3.3.1 Flora*

The forest area of wetland dominated by Sal (*Shorea robusta*) followed by Khair-Sissoo (*Acacia catechu- Dalbergia sissoo*) and mixed forest. More than 13 grassland areas, ranging from 10-50 ha in size, cover approximately four percent of the wetland. Grassland flora consisted of a combination of wetland herbs and moist grass species which are commonly composed of *Imperata cylindrica, Cyperus papyrus, Digitariya ciliaris, Bulbostylis barabata, Erasgrostis tentella, Cyperus totundus, Polygonum spp.*etc. (Subba and Chhetri 2005).

### *3.3.2 Fauna*

Fifteen species of mammals, excluding those belonging to the Rodentia and Chiroptera, were recorded in the forest and associated habitats during the field survey (Annex 1). The area also supports 96 species of bird species including two vulnerable species such as Cinereous Vulture (*Aegypius monachus*) and Darter (*Anhinga melanogaster*), one endangered Egyptian Vulture (*Neophron percnopterus*) and one critically endangered White-rumped vulture (*Gyps bengalensis*) (Basnet 2006).

### *3.3.3 Culture and Ethnicity*

The study area is surrounded by villages inhabited by Brahman and Chhetri along with other ethnic groups such as Rai, Limbu, Gurung, Magar, Dhimal, etc. Majority of villagers near the forest area depend on the forest around theBetana wetland for their livelihood. Main occupation of villagers is agriculture and animal husbandry. Rice (*Oryza sativa),*Wheat (*Triticum spp.*), Corn (*Zea Mays*) and Millet (*Eleusine coracana*) are major crops in the area, whereas Mustard (*Brassica campestris),* Potato (*Solanum tuberosum),* and legumes are grown as minor crops. Livestock is the major component of the agricultural system in the area. The main livestock groups are cattle, buffalo, goat, pig and poultry etc.

## 3.4 Research design

Bird sampling was done at three different habitats such as the forest, corridor (between forest and settlement area) and settlement of Betana wetland area. Three line transects were set along the forest, corridor and settlement areas. Each transect was used as the reference points for the plots setting. Observations of birds were carried out on each 300m interval of transect and the distance between the two transects were designed 500m apart from each other (Figure 6)**.** Altogether 36 plots were established for the observation of birds in the study area.

## 3.5 Bird Survey Techniques

**Fixed Point Count Method** was used for the survey of birds within the radius of 50m. Point count method is widely used approach for surveying birds in different land use types (Hutto et al. 1986, Schulze et al. 2004, Waltert et al. 2005, Fardila and Sjarmidi 2012) andto study the species-habitat relationships (Alldredge et al. 2007).Birds were scanned from 6:30 AM to 11:00 AM in the morning and 4:00 PM to 6:00 PM in the evening. In each plot, 15 minutes was spentbut repeated observation of the same species was not counted. A Bushnell binocular (magnification 8x40) and Canon camera (50X) was used for the effective survey of bird. A field guidebook Birds of Nepal (Grimmet et al. 2003) was used for the identification of birds and GPS (e-trex 10) used to mark the location of the plots. Photograph of unidentified species were identified with the help of bird expert in Kathmandu. Call Count Method was employed within the plots for the identification of

shy birds that could not be observed directly. Unfamiliar calls were recorded with the help of a recorder and identified them with the help of bird experts of Friends of Birds.

Group discussion was made with the local people, forest user group and wetland personal to gather information about status and conservation threats of birds in this area.

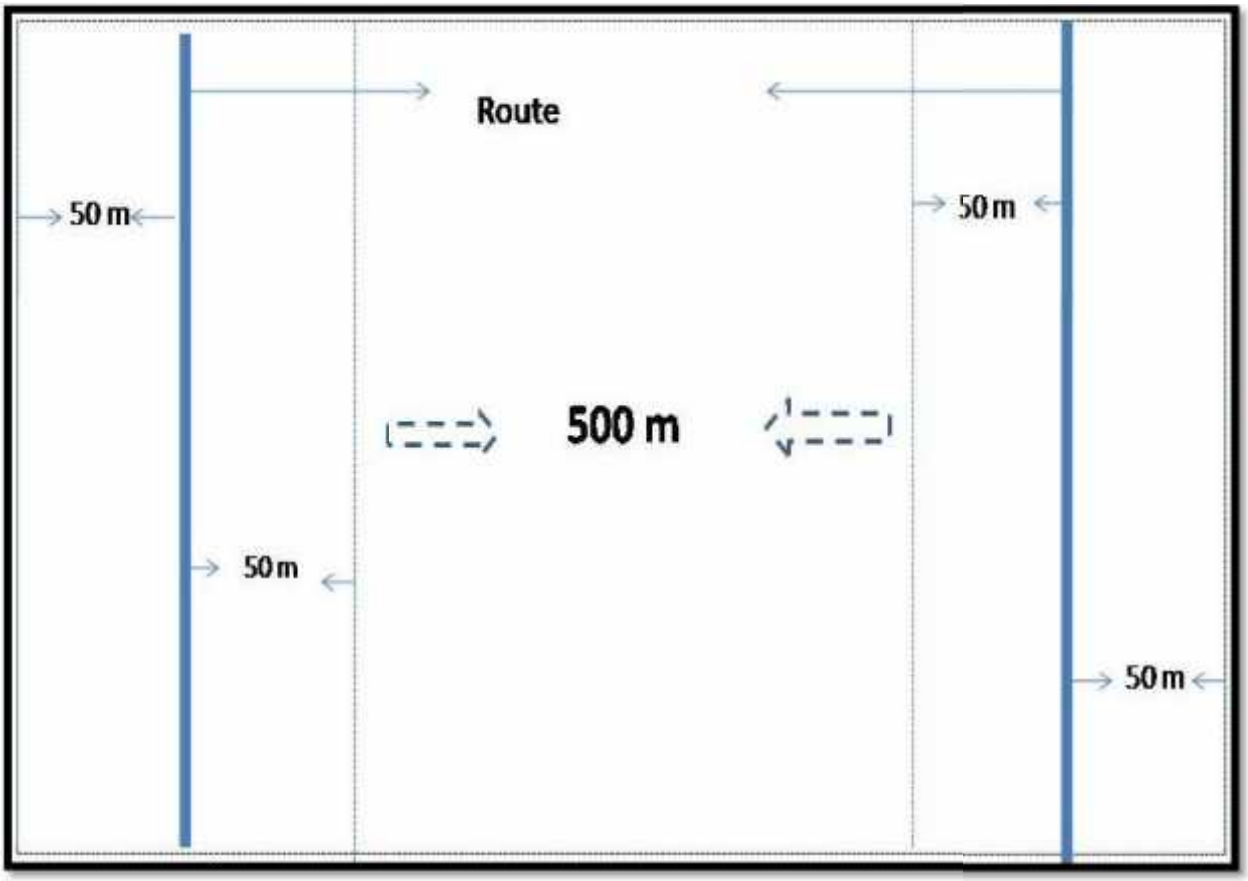


Figure 6: Line Transect Sampling design in the study site.

### 3.6 Data Analysis

The computer based Microsoft Excel was used to represent the collected data in tabulated form. Species richness of the birds was calculated by using SPSS- software and Chi Square test was used to calculate the seasonal variation of species richness between the two seasons. The Kruskal-Wallis rank sum test used to test the significant difference in species richness of birds between different habitats.

Shannon Weiner diversity index was used to calculate the bird diversity between the two seasons designated as H',

Which is calculated as: $H' = -\Sigma (ni /N) \log_e (ni/N)$

Or, if $Pi = ni/N$

$H' = -\Sigma Pi \log_e Pi$

Where,

ni =Importance values for each species.

N =Total Importance value.

**Evenness index**

To calculate whether species are distributed evenly across seasons and across landscapes, evenness index was determined by the equation:

$E = H'/ \log S$

Where,

H' = Shannon-Wiener's diversity index.

S= Species richness is the number of species and is the simply a count of the number of different species in a given area.

All recorded birds species were categorized into different status based on IUCN Red list (Grimmet et al. 2003) as per their migratory status such as resident, winter migrant and summer visitor etc.

# 4. RESULTS

## 4.1 Species richness of birds

A total of 55species of bird belonging to 10 orders and 26 families were recorded during summer and winter seasons. The highest numbers of species (18) were represented in the order Passeriformes along with 6families. Other major orders in terms of species richness were Ciconiformes (7 families and 16 species),Coraciformes (3 families and 5 species), Piciformes (2 families and 4 species), Cuculiformes (2 family and 3 species), Columbiformes (1 family and 3 species), Ansariformes (2 families 2 species), Strigiformes (1 family and 2 species)and other orders representing 1 family and 1 species were Psittaciformes and Galliformes .

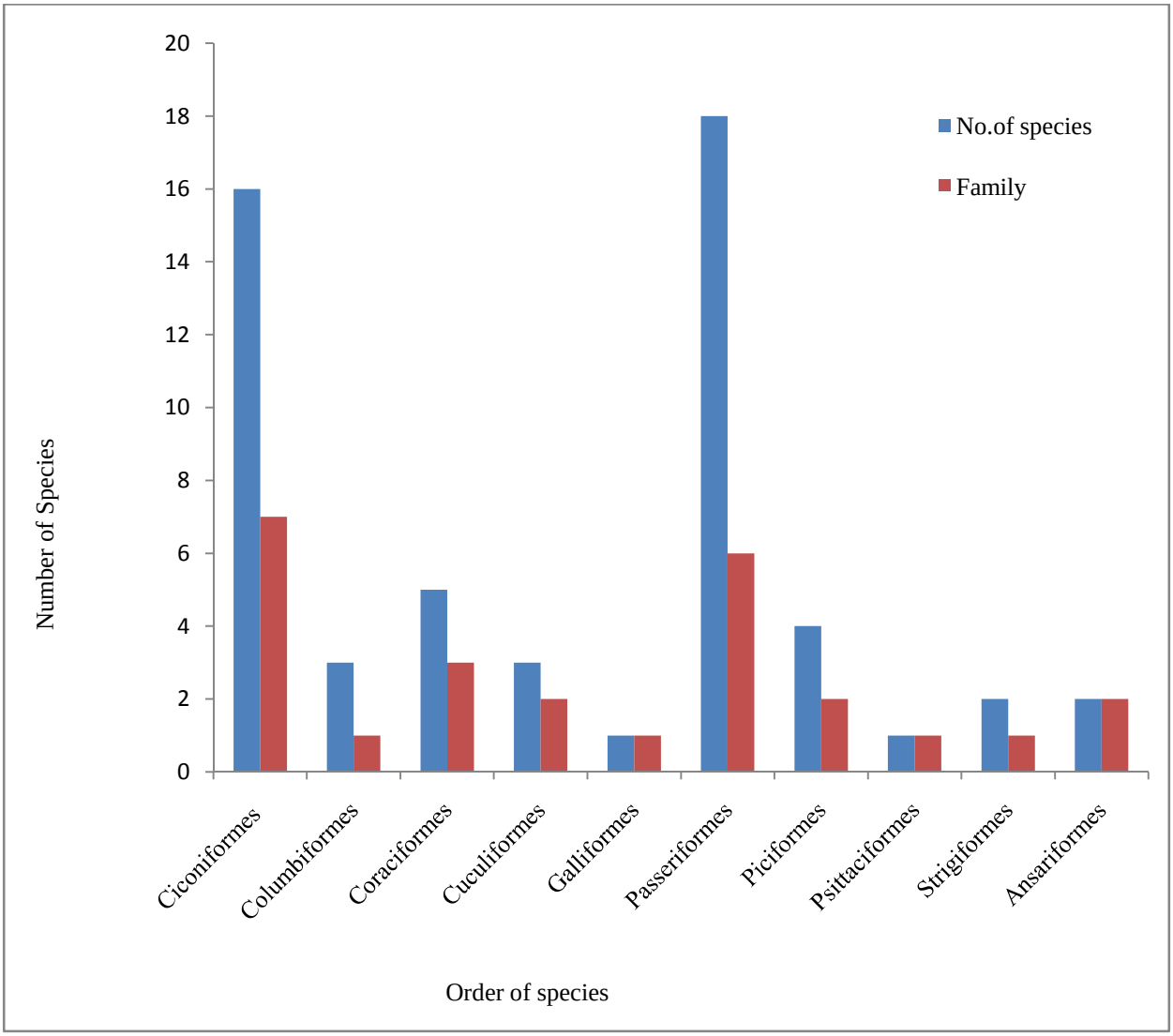


Figure 7: Orders and Families of bird species recorded in Betana wetland area.

## 4.2 Seasonal variation in species richness of bird

Species richness and population size of birds was found higher in the winter season then in summer. There were 46 bird species recorded in winter season and 36 species were recorded during the summer season and 26 species were common to both seasons (Table 1). Both Shannon wiener index and Evenness index was found higher in winter season than in summer (Table 1).

Species such as Bronze-winged Jacana *(Metopidius indicus),* Intermediate Egret *(Mesophoyx intermedia),* Brown Hawk Owl *(Ninoxs cutulata),* Black Kite *(Milvus migran),* Black Ibis *(Pseudibis papillosa),* Lesser Whistling Duck (*Dendrocygna javanica*) etc. were seen during Winter season. Ashy Wood swallow *(Artamus fuscus),* Crow-billed Drongo *(Dicrurus annectans),* Dollar Bird *(Eurystomus orientalis),* Indian Cuckoo *(Cuculus micropterus),* Eurasian Golden Oriole (*Oriolus oriolus)* etc. were seen during summer season. Similarly, Black Drongo (*Dicrurus macrocercus),* Black-hooded Oriole (*Oriolus xanthornus),* Jungle Babbler (*Turdoides striatus),* Common Myna (*Acridothere stristis),* House Crow (*Corvus splendens),*Spotted Dove (*Streptopelia chinensis),* Greater Racket- tailed Drongo *(Dicrurus paradiseus),* Red-vented Bubul (*Pycnonotus cafer)* and Jungle Myna (*Acridotheres fuscus)* were seen on both seasons (Table 2).
Out of 55 species, 44 species were resident, 5 species were winter visitor and 6 species were summer visitor.

Table 1: Comparison of species richness and diversity of bird recorded during winter and summer seasons in Betana wetland area.

| Seasons | Number of species | Number of individuals | Shannon wiener index | Evenness index |
|---|---|---|---|---|
| Winter | 46 | 356 | 1.45 | 0.87 |
| Summer | 36 | 225 | 1.27 | 0.82 |

### 4.3 Bird Species in different habitats

The higher species richness of birds was recorded in corridor (32 species) followed by forest (23 species) and cultivated area (17 species) (Figure 9). The Kruskal-Wallis rank sum test revealed that there was significant difference in species richness of birds between different habitats (P-value = 0.016, df =2, $\chi^2$=8). Occurrence of birds like Common Tailor Bird (*Orthotonus sutorius*), Lesser Coucal (*Megalaima lineata*), Common Hoopoe (*Upupa*

*epops*), Greater Racket-tailed Drongo (*Dicruru sparadiseus*), Stork-billed Kingfisher (*Halcyon capensis*) etc. were seen in the forest. Among the 52 species of birds Black Drongo (*Dicrurus macrocercus),* Black-hooded Oriole (*Oriolus xanthornus),* House Crow (*Corvus splendens*), Jungle Myna (*Acridotheres fuscus*), Red-vented Bulbul (*Pycnonotus cafer*), Rufous Treepie (*Dendrocitta formosae*) etc. were common in all habitats. Birds like Rose-ringed Parakeet (*Psittacula krameri),* Black-hooded Oriole (*Oriolus xanthornus),* Black Drongo (*Dicrurus macrocercus*) etc. were highly territorial. The diversity of aquatic bird is less than terrestrial birds, the terrestrial showed 70 % and aquatic showed 30 % respectively (Figure 10). Some important aquatic birds were Indian Pond Heron (*Ardeola grayii),* Common Teal *(Anas crecca),* Intermediate Egret *(Mesophoyx intermedia),* Little Cormorant *(Phalacrocorax niger),* Lesser Adjutant *(Leptoptilos javanicus)* etc.

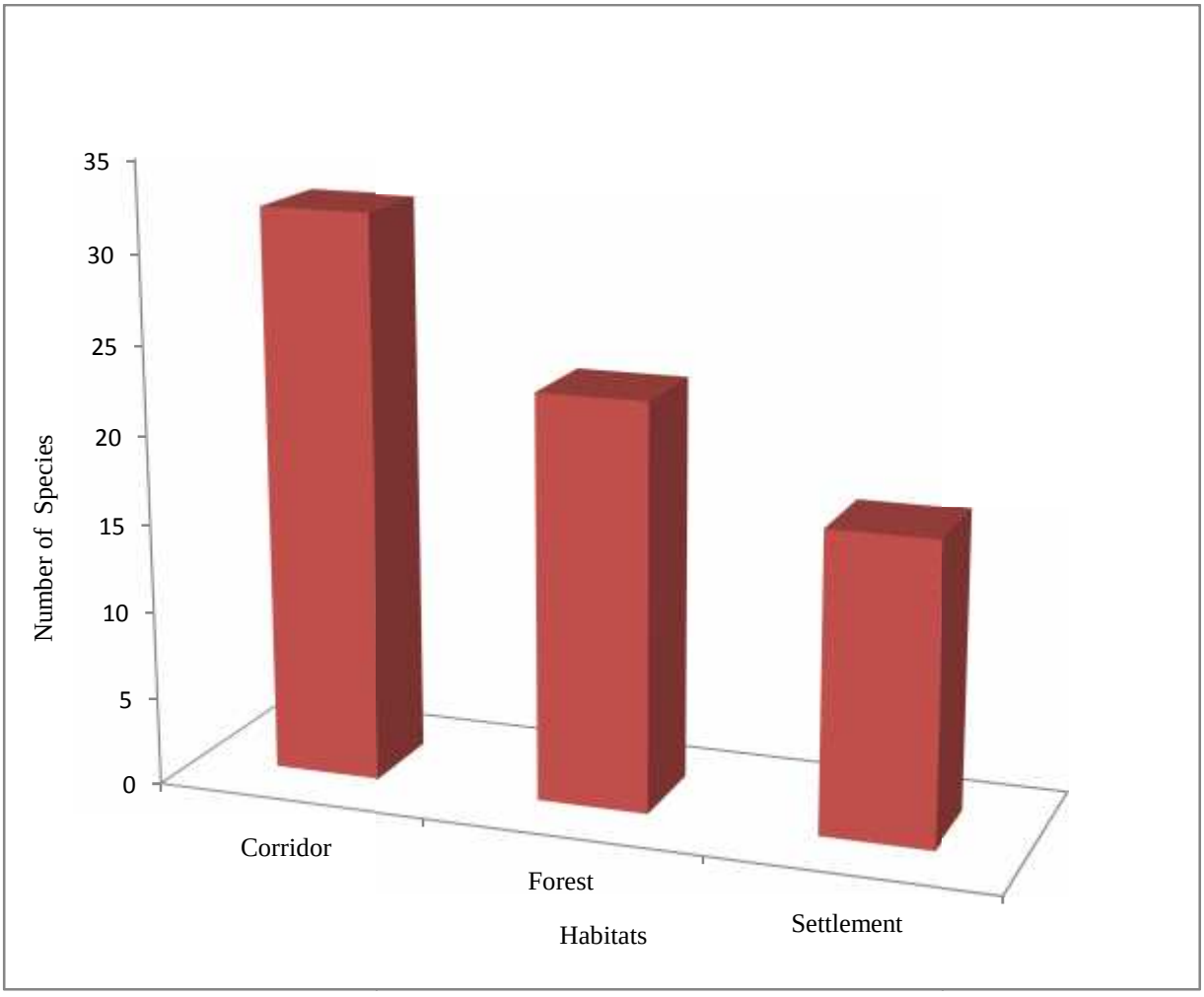


Figure 8: Bird Species richness in different habitats of Betana wetland area.

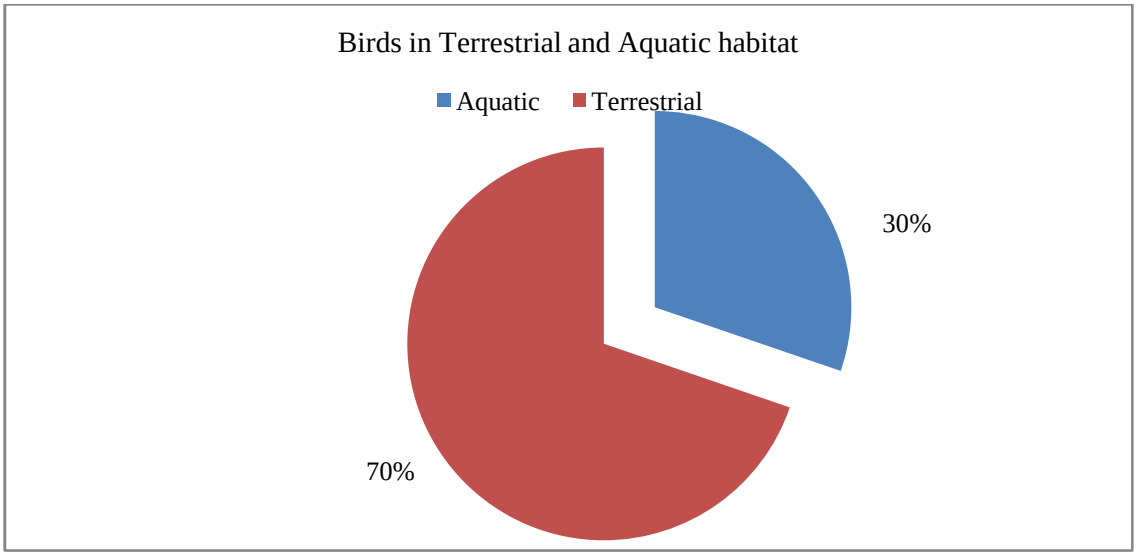

Figure 9: Birds in different (terrestrial and aquatic) habitat in Betana wetland area

### 4.4 Threats to Birds

**Threats from Human:** There were not reported a big poaching for game bird like Red Jungle fowl and other water birds for the purpose of meat. The local people used catapult to kill water birds and jungle fowl. These birds were selling in local market and small hotels of East – West highway.

**Human Activities around the Wetland:** Different types of recreational activities of human such as picnic, boating inside the wetland area has created disturbances to the bird. Likewise bottles of water, covers of biscuits, noodles and other types of plastics and garbage were seen around the wetland. Firewood collection was also high. Many religious flags of Buddhist were seen around the forest.

**Cattle Grazing**: There are no any rules and regulation to the locals to enter their livestock for grazing in and around the Betana wetland area. Therefore, many bird's habitat are destroying due to the over disturbances by the human beings in and around the wetland area.

### 4.5 Threatened species

Out of 55 species of birds, 54 Species were belongs to the Least Concern categories. However, Lesser Adjutant Stork has been categorized as a Near Threatened category of IUCN Red list and 7 species are under the categories of Least Concern. Least of bird recorded in Betana as showing below table 2.

| Families | No. of species | S.N | Name of Species | Scientific Name | Wi | Su | CITES | IUCN | MP | H.P |
|---|---|---|---|---|---|---|---|---|---|---|
| Corvidae | 18 | 1 | Large-billed Crow | *Corvus macrorhynchos (Wagler, 1827)* | + | + | | LC | R | S |
| | | 2 | Black Drongo | *Dicrurus macrocercus(Vieillot, 1817)* | + | + | | LC | R | C |
| | | 3 | Greater Racket-tailed Drongo | *Dicrurus paradiseus(Linnaeus, 1766* | + | - | | LC | R | F |
| | | 4 | Spangled Drongo | *Dicrurus bracteatus(Gould, 1842)* | + | + | | LC | R | F |
| | | 5 | Ashy Drongo | *Dicrurus leucophaeus(Vieillot, 1817)* | - | + | | LC | R | C |
| | | 6 | Crow -billed Drongo | *Dicrurus annectans( Hodgson, 1838* | + | - | | LC | S | F |
| | | 7 | Red Billed Blue Magpie | *Urocissa erythroryncha(Boddaert, 1783)* | + | - | | LC | R | C |
| | | 8 | Eurasian Golden Oriole | *Oriolus oriolus(Linnaeus, 1758)* | - | + | | LC | S | C |
| | | 9 | Large Woodshrike | *Tephrodomis gularis(Temminck, 1824)* | - | + | | LC | R | F |
| | | 10 | Large Cuckooshrike | *Coracina macei(Lesson, 1831)* | + | + | | LC | R | F |
| | | 11 | Black-hooded Oriole | *Oriolus xanthornus(Linnaeus, 1758)* | + | + | | LC | R | S |
| | | 12 | RufousTreepie | *Dendrocitta vagabunda (Latham,1790)* | + | + | | LC | R | S |
| Sturnidae | | 13 | Jungle Myna | *Acridotheres fuscus(Wagler,1827)* | + | + | | LC | S | C |
| | | 14 | Common Myna | *Acridotheres tristis(Linnaeus, 1766)* | + | + | | LC | R | S |
| Laniidae | | 15 | Long-tailed Shrike | *Lanius schach(Linnaeus, 1758)* | + | + | | LC | R | C |
| Pycnonotidae | | 16 | Red-vented Bulbul | *Pycnonotus cafer(Berger, 1972)* | + | + | | LC | R | C |
| Sylviidae | | 17 | Jungle Babbler | *Turdoides striata(Dumont, 1823)* | + | + | | LC | R | F |
| Muscicapidae | | 18 | Oriental Magpie Robin | *Copsychus saularis(Linnaeus, 1758)* | + | + | | LC | R | S |
| Accipitridae | 16 | 19 | Black Kite | *Milvus migrans(Boddaert, 1783)* | + | - | II | LC | W | S |
| | | 20 | Shikra | *Accipiter badius(Gmelin,JF, 1788)* | + | - | II | LC | R | C |
| | | 21 | Lesser Fish Eagle | *Icthyophaga humilis(Muller,S&Schlegel, 1841)* | + | - | II | LC | R | C |
| | | 22 | Crested Serpent Eagle | *Spilornis cheela(Latham, 1790)* | + | + | II | LC | R | F |
| | | 23 | Osprey | *Pandion haliaetus(Linnaeus,1758)* | + | - | II | LC | W | C |
| Ardeidae | | 24 | Indian Pond Heron | *Ardeola grayii(Sykes, 1832)* | + | - | | LC | R | S |
| | | 25 | Great Egret | *Ardea alba(Linnaeus,1758)* | + | - | | LC | R | F |
| | | 26 | Cattle Egret | *Bubulcus ibis(Linnaeus,1758)* | + | + | | LC | R | S |
| | | 27 | Cinnamon Bittern | *Ixobrychus cinnamomeus(Gmelin,JF, 1789)* | + | - | | LC | R | F |
| | | 28 | Intermediate Egret | *Ardea intermedia(Wagler, 1827)* | + | - | | LC | R | C |
| Ciconiidae | | 29 | Lesser Adjutant | *Leptoptilos javanicus(Horsfield, 1821)* | + | - | | VU | R | C |
| | | 30 | Asian Openbill | *Anastomus oscitans(Boddaert,1783)* | + | - | | LC | S | C |
| Jacanidae | | 31 | Bronze-winged Jancana | *Metopidius indicus(Latham, 1790)* | + | - | | LC | R | F |
| Charadriidae | | 32 | Red-wattled Lapwing | *Vanellus indicus(Boddaert, 1783)* | + | - | | LC | R | F |
| Phalacrocoracidae | | 33 | Little Cormorent | *Microcarbo niger(Vieillot,1817)* | + | + | | LC | W | F |
| Threskiornithidae | | 34 | Black Ibis | *Pseudibis papillosa(Temminck, 1824)* | + | - | | LC | R | C |
| Coraciidae | 5 | 35 | Dollar Bird | *Eurystomus orientalis(Linnaeus, 1766)* | - | + | | LC | S | F |
| | | 36 | Indian Roller | *Coracias banghalensis(Linnaeus,1758)* | + | + | | LC | R | S |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dacelonidae | | 37 | Stork-billed Kingfisher | *Coracias banghalensis(Linnaeus,1758)* | + | - | | LC | S | C |
| | | 38 | White-throated Kingfisher | *Halcyon capinsis(Linnaeus,1766)* | + | + | | LC | R | C |
| Meropidae | | 39 | Chestnut-headed Bee-eater | *Halcyon symmensis(Linnaeus, 1758)* | - | + | | LC | S | C |
| Megalaimidae | 4 | 40 | Blue-throated Barbet | *Merops leschenaulti(Vieillot, 1817)* | - | + | | LC | R | S |
| Indicatoridae | | 42 | Grey-headed Woodpecker | *Megalaima asiatica(Latham, 1790)* | + | + | | LC | R | F |
| | | 43 | Himalayan Flameback | *Picus canus(Gmelin, JF, 1788)* | + | + | | LC | R | F |
| | | 44 | Fulvus-breasted Woodpecker | *Dinopium shorii(Vigors, 1831)* | + | + | | LC | R | C |
| Columbidae | 3 | 45 | Rock Pigeon | *Dendrocopos macei(Vieillot, 1818)* | + | + | | LC | R | S |
| | | 46 | Spotted Dove | *Columba livia(Gmelin, 1789)* | + | + | | LC | R | C |
| | | 47 | Eurasian Collared Dove | *Streptopelia chinensis(Scopoli, 1786)* | - | + | | LC | R | S |
| Cuculidae | 3 | 48 | Indian Cuckoo | *Streptopelia decaocto(Frivaldszky, 1838)* | - | + | | LC | S | C |
| | | 49 | Large Hawk Cuckoo | *Cuculus micropterus(Gould, 1838)* | + | + | | LC | R | C |
| Centropodidae | | 41 | Lesser Coucal | *Cuculus sparverioides(Vigors, 1832)* | + | + | | LC | R | S |
| Dendrocygnidae | 2 | 50 | Lesser Whistling Duck | *Centropus bengalensis(Gmelin, JF, 1788)* | + | - | | LC | W | F |
| Anatidae | | 51 | Common Teal | *Dendrocygna javanica(Horsfield, 1821)* | + | - | | LC | W | F |
| Strigidae | 2 | 52 | Asian Barred Owlet | *Anas crecca(Linnaeus, 1758)* | - | + | II | LC | R | F |
| | | 53 | Brown Hawk Owl | *Glaucidium cuculoids(Vigors, 1830)* | + | - | II | LC | R | C |
| Pisittacidae | 1 | 54 | Rose-ringed Parakeet | *Ninox scutulata(Raffles, 1822)* | + | + | | LC | R | F |
| Phasianidae | 1 | 55 | Red Junglefowl | *Psittacula krameri(Scopoli, 1769)* | + | + | | LC | R | F |

1. LC= Least Concern, VU=Vulnerable 2. M.P. =Migration Pattern, R= Resident, W= winter visitor, S= summer Visitor 3.H.P. = Habitat Preference, F= Forest, S= Settlement, C= Corridor

Table 2: List of birds recorded in Betana wetland area with their family, scientific name and conservation status.

# 5. DISCUSSIONS

This study was done to determine the diversity and species richness of birds with reference to habitat types and to analyze their habitat association. Bird diversity in those areas wasn't so good in Betana and its associated area compared to Barandabhar corridor forest of Chitwan (Chapagain 2014). This investigation revealed that only 5% for the total avian species of the Nepal (DNPWC and BCN 2012) found in the Betana wetland. Basnet et al. (2006) recorded a total of 110 species of bird at Raja Rani Community forest Bhogteny, Morang. The study was restricted only in the Betana Wetland and its small fragmented areas, which might be the reason for low species richness.

Species richness was higher in winter season than summer. Easy availability of food, suitable climate, and temperature and migration of species might be the reason for high species richness in winter season. Birds are unable to tolerate the high temperature in summer season so that low species were recorded in summer. During the winter season the rate of migration of bird species found high i.e. most of the foreign bird species were migrated during winter season. Bird migration also changes the number of bird species in different seasons and habitats (Baniya et al. 2009).This result was also supported by Khanal (2008) and Thapa (2015) while conducting the research in the forest of Nawalparasi and Chitwan district respectively. The climatic condition as well as vegetation pattern of Betana wetland seen similar with Chitwan and Nawalparasi, so got similar types of result. Bird distribution can be fluctuated by temporal and climatic factors (Shoo et al. 2005) due to seasonal change. Environmental factors may also alter the variations which directly cause impact on bird diversity and their individual number (Lennon et al. 2000).Different studies such as Aryal (2013), Chapagain (2014). Ghimire (2009), Levey (1988) and Murgui (2007) have shown that species richness was highest during monsoon season and lowest during winter season. Some birds with their juvenile were also detected for example Red-billed Blue Magpie (*Urociss aerythrorhyncha*), Black-hooded Oriole (*Oriolus xanthornus*), Common Myna (*Acridotherestristis*), Black Kite (*Milvus migrans*) etc. The pattern of terraced cultivation, flowering of plants varied with seasons, availability of food, humidity and temperature also vary according to seasons. According to Chapagain (2014) flowering period of many plant species attract a large number of bird species. Some residential birds like Great Egret (*casmerodius albus),* Spotted Dove (*Streptopelia chinensis),* Common Myna (*Acridotheres tristis)* etc. were

recorded as high population. In winter season, some birds such a Red-vented Bulbul (*Pycnonotus cafer*), Common Myna (*Acridotheres tristis*), House Sparrow (*Passer domesticus*), Rock Pigeon (*Columba livia*) were very high in the corridor and settlement areas. Thus, seasonal variation strongly influences the species richness and distribution pattern of the birds.

The present study showed the highest diversity index in winter (1.45) followed by summer season (1.27) and evenness index was also found higher in winter season (0.87) than in summer season (0.82). This result indicated that winter season was more favourable for birds than summer season. Diversity value of winter and summer was 1.71 and 1.64 respectively of the bird surveyed in the Someshwor range of Madi, Chitwan and evenness index value of winter and summer was 0.88 and 0.86 respectively (Thapa 2015). Diversity index values (H= 2.75) higher during summer and lower during monsoon at silent valley and Mukkali which was attributed to the availability of more fruits (Jayson and Mathew 2000a). There was an increase in the diversity and number of bird in December (Jayson and Mathew 2000b) in the silent valley of Kerala.

Species richness and population of bird species were found different in forests, corridors and settlements. Species richness of birds was found higher in corridor (32) followed by forest (23)and settlement area (17). There was significant difference (P value = 0.016, df= 2, $\chi 2$= 8)in species richness of bird in forest, corridor and settlement area. Most of the birds were utilized corridor as the prime habitat because of the easy assessment of food materials and edge effect. Birds are habitat specific (MacArthur et al. 1962 and MacArthur 1964) as habitat type represents the number of bird species. Studies show that complexity of bird community is usually increased with the increase of habitat complexity (MacArthur and MacArthur 1961). The grassland with some forests and wetland habitat are which support significantly high population of avian fauna in Nepal (Baral and Inskipp 2005).Moreover, some other factors like structure, slope, canopy of tree, heterogeneity (Manel et al. 2000), edge effect (Turner 1997) and in overall, the availability of food and disturbances (Brawn et al. 2001, Lee et al. 2004, Fardila and Sjarmidi 2012) were the important factor for occurrence and distribution pattern of birds in different habitats. Various studies such as Inskipp (1989), Daily et al. (2001), Grimmet et al. (2003),Waltert et al.(2004, 2005), DNPWC (2011), Fardila and Sjarmidi (2012),Aryal (2013) and Chapagain (2014) have shown that species richness decreases from natural forest to

agricultural land in different protected and unprotected areas of Nepal. Forests, especially corridor site with the human settlements support a higher numbers of avifaunal diversity (BirdLife International 2008). Corridor taken as prime habitat for most birds and also breeding birds (Grimmet et al. 2003). More than 50% of threatened bird species depends upon thoseforests (Baral and Inskipp 2004). Rimal (2006) also found higher species richness in undisturbed forests than in disturbed one. Inskipp (1989) also suggested that forests are the important habitats for wintering birds and passage migrants.

Red-vented Bulbul (*Pycnonotus cafer*), Rufous Treepie (*Dendrocittava gabunda)*, Rose-ringed Parakeet (*Psittacula krameri)*, Indian Roller (*Coracius benghalensis)*, Black Drongo (*Dicrurus macrocercus)*, Greater Racked-tailed Drongo (*Dicrurus paradiseus)*, Oriental Magpie Robin (*Copsychuss aularis)*, White-throated Kingfisher (*Halcyon smyrnensis)*, etc. were very common in Corridor area. Similarly, Black Drongo (*Dicrurus macrocercus*), Black Kite (*Milvus migrans*) etc. were also very common in the corridor and settlement areas. Corridor and settlement areas were highly fragmented and deforested therefore the birds were easily seen. Cattle grazing, pollution and road construction were major threats to birds in the corridors. Bird diversity and species composition significantly differ among the disturbed and undisturbed habitat.

In general bird species richness and diversity were higher in disturbed habitat. 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 CITIS appendix II (Subba and Chhetri 2005).

# 6. CONCLUSION AND RECOMMENDATION

The species richness of birds in different habitat types of Betana wetland area during two different seasons (winter and summer) showed that there were altogether 55 species of birds belonging to 10 orders and 26 families during the study period. Out of 55 species, 44 species were resident, 5 species were winter visitor and 6 species were summer visitor.

The highest number of bird species was recorded during winter season than summer showing the seasonal variation in species richness of avifauna. Different factors such as Climate, temperature and availability of food influence the distribution of species in this area.

Similarly, there was a significant difference (P value = 0.016, df= 2, $\chi 2$= 8) in species richness of birds among the three habitats. Species richness was higher in corridor followed by forest and settlement area due to the easy accessibility of food, low chances of predation, diverse habitat and edge effect. This showed the direct influence of habitats on the composition of bird. The Lesser Adjutant (*Leptoptilos javanicus*) found as vulnerable species according to IUCN red data list.

Habitat destruction and fragmentation, cattle grazing inside the forest, deforestation, pollution and growing urbanization were the major threats of bird community in Betana wetland area.

Based on my study some major recommendations are as follows:

- A frequent research should be encouraged to understand biodiversity, physical impact, cultural impact and other impact of human activities.
- Immediate measures are to be taken to reduce from grazing, firewood, fodder and medicinal plants collection and illegal felling of trees.
- Awareness program should be launched( some people were found to used catapult and deforestation was found) through bird watching program and by establishment of nature clubs

# 7. REFERENCES


Alldredge, M.W., Simons, T.R. and Pollock, K.H. 2007. Factors Affecting Aural Detections of Songbirds. Ecological Applications **17**(3): 948-955.

Ambuel, B. and Temple, S.A. 1983. Area dependent changes in the bird communities and vegetation of southern Wisconsin forests. USA. Ecology **64**:1057-1068.

Aryal, A., Brunton, D. Pandit, R., Shrestha, T.K., Lord, J., Koirala, R.K., Thapa, T.B., Adhikari, B. and Raubenheimer, D. 2012. Biological diversity and management regimes of the Northern Barandabhar Forest Corridor: an essential habitat for ecological connectivity in Nepal. Tropical Conservation Science **5** (1): 38-49.

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

Baniya, C.B., Solhoy, Gauslaa, T.Y. and Palmer, M.W. 2010. The elevation gradient of lichen species richness in Nepal. The Lichenologist **42** (1): 83-96.

Baral, H.S. and Inskipp, C. 2005. Important Birds Areas in Nepal: key sites for conservation. Bird Conservation Nepal and Birdlife International, Kathmandu and Cambridge.

Basnet, Y.R., Tamang, B. and Gautam, B. 2006. Bird diversity and habitat status at Raja Rani Community Forest, Bhogteny, Morang, Nepal.

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.

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.

BES. 2013. Bird Checklist Chitwan. Bird Education Society. Pages 44.

Bhuju, U.R., Shakya, P.R., Basnet, T. and Shrestha, S. 2007. Nepal Biodiversity Research Book Protected Areas, Ramsar Sites and World Heritage Sites. First Edition. ICIMOD, Kathmandu.

Bilgrami, K.S. 1995. Concept and Conservation of Biodiversity. CBS Publishers and distributors, Delhi.

BirdLife International.2008. State of the world's birds: indicators for our changing world. Cambridge, UK: Bird Life International.

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

Birdlife Nepal, 2013.http://www.birdlifenepal.org/status-of-birds.php accessed on 5th march 2012.

Blake, J.O. and Loiselle, B.A. 1991. Variation in resource abundance affects capture rates of birds in three low land habitats in Costa Rica. Auk **108**: 114-130.

Block, W.M. 1991. Foraging ecology of Nuttall's Woodpecker, Auk **108**: 303-317.

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

Chapagain, N. 2014. Habitat Association of Bird in Barandabhar Corridor Forest, Bharatpur,Chitwan,Nepal. M.Sc. Thesis. Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Chettri, N., Debes, D.C., Sharma, E. and Jackson, R. 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.

Cody, M.L. 1974. Competition and the structure of bird's communities. Belknap Press of Harvard University Press, Cambridge, M.A.

Conner, R.N. 1981. Seasonal changes in woodpecker foraging patterns, Auk **98**: 562-570.

Cueto V.R. and De Casenave J.L. 2000. Seasonal changes in bird assemblages of coastal woodlands in east-central Argentina. Study on Neotropical Fanna& Environment **35**: 173-177.

Daily, G.C., Ehrlich, P.R. and Sanchez-Azofeifa, G.A. 2001. Countryside biogeography: use of human dominated habitats by the avifauna of southern Costa Rica. Ecological Applications **11**(1): 1-13.

Desai, M. and Shanbhag, A. 2007. Birds breeding in unmanaged Monoculture plantations in Goa, India. Indian Forester **133**:1367-1372.

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

Fleming, R.L.S., Fleming, R.L.J. and Bangdel, L.S. 1984. Birds of Nepal. Third edition. Nature Himalayas, Kathmandu, Nepal.

Furness, R.W. and Greenwood, J.J.D. 1993. Birds as monitors of environmental change. Champman and Hall, London.

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

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

Grimmet, R., Inskipp, C., Inskipp, T. and Baral, H.S. 2003. Birds of Nepal (Nepali Version). Helm Field Guide. Prakash Books, New Delhi.

Guisan, A. and Zimmermann, N.E. 2000. Predictive habitat distribution models in ecology. Ecological Modelling **135**: 147–186.

Herzog, S.K., Soria, R. and Matthysen, E. 2003. Seasonal variation in avian community composition in a high-andean*Polylepis*(rosaceae) forest fragment, Central Bolivia. Wilson Bulletin **115**(4): 438–447.

Hutto, R.L., Pletscher, S.M. and Hendricks, P. 1986. A fixed- radius point count method for nonbreeding and breeding season use. Auk **103**: 593-602.

Inskipp, C. 1989. Nepal's Forest Birds: Their Status and Conservation. International Council for Birds Preservation Monograph No.4. Cambridge, U.K.

Jayson, E.A. and Mathew, D.N. 200a. Vertical stratification and its relation to foliage in tropical forest birds in Western Ghats, India. ActaOrnitologica**38**(2): 111-116.

Jayson, E.A. and Mathew, D.N. 200b. seasonal changes of tropical forest birds in the southern Weatern Ghats. Journal of Bombay Natural History Society **97**(1): 52-62.

Karr, J.R. 1968. Habitat and Avian diversity on strip-mined land in east-central Illionis, Chicago, USA. Condor **70**: 348-357.

Karr, J.R. and Roth, R.R. 1971. Vegetation structure and avian diversity in several New World areas. American Naturalist **105**: 423-435.

Katuwal, H.B. 2013. Land use gradients and distribution of birds in Manaslu Conservation Area, Nepal. M.Sc. Thesis. Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

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

Lamichhane, B., Pokhrel, K.P. and Anderson, A. 2013. Bird monitoring in Barandabhar Corridor Forest, Internal report to the National Trust For Nature Conservation Biodiversity, Conservation Centre, Sauraha, Nepal.

Landres, P.B. and MacMahon, J.A. 1980. Guilds and community organization analysis of an oak woodland avifauna in Sonora, Mexico. Auk **97**: 351-365.

Lee, P.F., Ding, T.S., Hsu, F.H. and Geng, S. 2004. Breeding bird species richness in Taiwan: distribution on gradients of elevation, primary productivity and urbanization. Journal of Biogeography **31**: 307-314.

Levey, D.J. 1988. Spatial and temporal variation in Costa Rican Fruit and fruit-eating bird abundance. Ecological Monographs **58**(4): 251-269.

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.

MacArthur, R. H. and MacArthur, J.W. 1961. On bird species diversity. Ecology **42**:594 - 598.

MacArthur, R.H. 1964. Environmental Factors Affecting Bird Species Diversity. The American Naturalist **98**: 387-397.

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

Manel, S., Buckton, S.T. and Ormerod, S.J. 2000. Testing large-scale hypotheses using surveys: the effects of land use on the habitats, invertebrates and birds of Himalayan Rivers. Journal of Applied Ecology **37**: 756-770.

Morrison, M.L., Timossi, I.C. With, K A. and Manley, N. 1985. Use of tree species by forest birds during winter and summer, Journal of Wildlife Management **49**: 1098-1102.

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.

Odum, E.P. 1971. Fundamentals of Ecology, Third edition, Nataraj Publication, Dharadun, India.

Palomino, D and Carrascal, L.M. 2006. Urban influence on birds at a regional scale: A case study with the avifauna of northern Madrid province, *Landscape and Urban Planning***77**: 276-290.

Pearson, D.L. 1977. A pantropical comparison of bird community structure on six low land forest sites. Condor **79**: 232-244.

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

Raman, T.R.S. 2001. Community ecology and conservation of tropical rain forest birds in the southern Western Ghats, India Ph.D. thesis, Indian Institute of Science, Bangalore.

Recher, H.F.1969. Bird species diversity and habitat diversity in Australia and North America. American naturalist **103**: 75-80.

Rice, J., Anderson, B.W. and Ohman, R.D. 1984. Comparision of the importance of different habitat attributes to avian community organization, J. Wildl. Manag.**48**: 895-911.

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. Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Robert B.B. 1996. Land Use and Avian Species Diversity Along an Urban Gradient .*Ecological* Applications **6**(2): 506-519.

Rotenberry, J.T. 1981. Why measure bird habitat? In: The Use of Multivariate Statistics in Studies of Wildlife Habitat (D. E. Capen, ed.), General Technical Report RM-87. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. Pages 29-32.

Sharma, H.K. 2004. Diversity of threatered birds and their coservation threats in Barandabhar corridor forest, Chitwan. M.Sc Thesis. Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Shrestha, T.K. 2004. Birds of Nepal. Vol I and II. B. Shrestha Publication, Kathmandu, Nepal.

Subba, B.R. and Chhetri, D.C. 2005. Study of fauna of Betana village development committee, Morang, Nepal. A report submitted to APEC, Biratnagar.

Sutherland, W.J. 1996. Ecological sensus technique, a hand book. Cambridge university Press, Cambridge, New York.

Terborgh, J. 1989. Where Have All the Birds Gone? Princeton University Press, Princeton, New Jersey.

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. Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Thapa, B. 2015. Diversity and Habitat Association of Avifauna in Someshwor Range of Madi, Chitwan, Nepal. M.Sc. Thesis. Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Turner, I.M. 1997. Species loss in fragments of tropical rain forest: a review of the evidence. Journal of Applied Ecology **33**: 200-209.

Waltert, M., Mardiastuti, A. and Muhlenberg, M. 2004. Effects of Land Use on Bird Species Richness in Sulawesi, Conservation Biology Indonesia **18**: 1339-1346.

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

Wiens, J.A and Rotenberry, J.T. 1981. Habitat association and community structure of birds in shrubsteppe environment, Ecol. Monogrophy **51**: 21-41.

Wiens, J.A. 1989. Spatial scale and temporal variation in studies of shrub-steppe birds, : 154-172. In: Community Ecology (J. Diamond and T. J. Case, eds.), Harper and Row, New York.

# Photo Plates

Jungle Babbler

Indian Cuckoo

Spotted Dove

Indian Pond Heron

Crested Serpent Eagle

Dollar Bird

Indian Cuckoo

Asian Barred Owlet

Intermediate Egret

Little Cormorant

Brown Hawk Owl

**Asian** Open-bill

Black Ibis

Chestnut-headed Bee eater

Researcher observing birds

Researcher taking interview with local people