1. INTRODUCTION

1.1. General Background

Distribution of Birds' population mainly relates to abundant forage, water, escape cover and disturbances. Bird population are highly sensitive to change and monitoring birds can give important early warning signs of future environmental crisis (Bird Life International 2000). Birds have been considered good predictors of habitat quality, as they relate to changes in their associated habitats in numerous ways (Shankar Raman *et al.* 1998) because they respond to habitat structure (MacArthur and MacArthur 1961) and represent several trophic groups or guilds (Steele *et al.* 1984). Nepal's birdlife is one of the richest in world considering the small size of the country. Nepal holds 864 birds' species (BCN 2009 and Giri and Choudhary 2009). The latest bird new to Nepal is Daurian's Redstart *Phoenicurus auroreus*. This figure is more than eight percent of the total birds species found worldwide, with account of about 611 breeding species, 62 summer visitor or partial migrants species and 150 species are winter migratory (Grimmett *et al*. 2003). This is the reflection of unique geographical position, altitudinal variation and climatic differences. Similarly, Nepal lies at the junction of two big bio-geographic realms, Palaeartic to the north and Indo-Malayan or oriental region to the south. The boundary between two regions is the tree-line at about 3000m (Corbett and Hill 1992). Faunal elements above this altitude have Palearctic affinities (Biodiversity Profile Project 1995). Elevation is the main factor that defines the boundaries of the five physiographic zones (High Himalayas, High Mountains, Middle Mountains, Siwalik and Tarai) of Nepal, that run as horizontal bands stretching from east to west across Nepal's 800-km length (Forest Department 2000). The climate is tropical in low land to arctic in high peak (Inskipp and Inskipp 1991).

The observed species diversity is an indication of not only the amount of rainfall the area receives annually but also the degree of topographical and habitat variation within the study area (Makuloluwa *et al*. 1997). Nepal's species richness can be attributed to the factor like –the dramatic changes in altitude within the short span of area, Nepal's geographic position, a region of overlap between palaeartic realm and oriental realm and Nepal's varied climate in the country (Inskipp and Insipp 1991).

Wetlands are important conservation site due to their rich biodiversity, they are among the most productive ecosystem in the world, and they harbor many globally threatened species (Green 1996, Petrie 1998 and Getzner 2002). Diverse wetland complexes are of greatest value in providing habitat for wetland bird species. Over ninety percent of Earth's wetland has been lost during the past fifty years (Kempka *et al.* 1991), along with increased habitat fragmentation within those that remain. Wetlands provide homes for a huge diversity of wildlife: birds, mammals, frogs, insects and plants (Buckton 2007).

The Barandabhar Corridor Forest is an extremely important forest corridor, providing a migration route for the passage of birds and other wildlife (Dahal 2002). Bees Hazari Tal is also an important wetland for birds and other wildlife lies within the forest corridor. It is also included in Ramsar site. It is important for the globally threatenedLesser Adjutant *Leptoptilos javanicus* and near-threatened Great Hornbill *Buceros bicornis*, Grey-headed Fish Eagle *Ichthyophaga ichthyaetus* and Darter *Anhinga melanogaster* (Baral 1996, Dahal 2002).

A total of 33 species recorded in Nepal was recently identified as globally threatened by Birdlife International (Birdlife International 2001, 2004, 2009a and 2009b). Similarly, 133 bird species are considered as nationally threatened (Baral and Inskipp 2004). Habitat loss is the major threat to 86% of birds. In all 88 species (68% of the total threatened) depend on forests, wetlands (30 species), grasslands (14 species), scrub (2 species), open country (1 species) and stony ground (1 species) (Baral and Inskipp 2004). Total of 29 endangered species of wetland birds are at risk due to various anthropogenic pressures in Nepal (Baral and Inskipp 2004). Wetland birds are especially at risk from hunting and trapping. Bird hunting, netting and egg collecting have been identified as serious threats in Chitwan's rivers (Roberts *et al*. 2002 and Tyabji 2002). Wetlands like Beesh Hajari Lake is facing problem due to over fishing, use of poisons and explosives for fishing and introduction of exotic plant species like Water hyacinth, siltation and over enrichment (Dahal 1999, Subedi 2001 and Roberts *et al.* 2002).

Forests cover almost 37% of Nepal's land area and form an important part of the country's economy and repository of biodiversity (Asian Development Bank 2006). More than 250 threatened birds in Asian are forest dependent and other categories

such as grassland, savanna, shrub-land, wetland, coastline and sea all have less than 100 each (Birdlife International 2006). Almost half of the 33 globally threatened species of Nepal are directly and indirectly dependent on forests and trees at sometime in their life cycled. Only around 22% of Nepal's land area remains closed canopy forest, whilst 10% the land is shrub vegetation (Forest Resource Information System Project 1999). Forests covered 73.3% of the total area of the Tarai (the subtropical lowlands) between central and western Nepal during the 1950s (Joshi 2002). Due to the importance of these forests for both commercial and subsistence purposes (Webb and Sah 2003), in the past few decades, heavy human pressures have reduced the forested area resulting in degradation and fragmentation of historically contiguous landscapes and posing threats to biodiversity conservation and local livelihoods. Forests and scrubland hold the high proportion of 77% of the country's breeding birds (Baral and Inskipp 2004). These habitats are especially important for Nepal's restricted-range species. Similarly, the grasslands are also a major habitat type hold important breeding populations of the globally threatened Swamp Francolin *Francolinus gularis*, Bengal Florican *Houbaropsis bengalensis*, Slender-billed Babbler *Turdoides longirostris* and Bristled Grassbird *Chaetornis striatus*, and wintering Hodgson's Bushchat *Saxicola insignis*.

Nepal's major bird habitat consists of forest, wetland and grassland. Forest and bushes hold 77% of Nepal's breeding birds (Grimmett *et al.* 2000). Among them 78 species (59%) of total threatened species depends upon forest (Baral and Inskipp 2004).

Forests and shrubs cover is declining and only 29% of the country possesses the forest cover (Burlakoti and Karmacharya 2004). This is certainly going to put pressure on the survival of birds, since many of the birds, inhabiting Nepal depends on forest, 77% of Nepal's breeding birds and 93% of those for which the country may hold significant world population utilize forest or shrubs (Inskipp 1989). In the lowlands, wildlife habitat is interspersed in a mosaic of settlement and intensive cultivation. Grasslands are deteriorating due to overgrazing, haphazard burning, conversion into agricultural land and other management practices, which are not environmentally friendly.

1.2. Objectives and Hypothesis

The main objective of my research is to assess the sea seasonal diversity and habitat utilizations of birds in the BCF. My research hypotheses were guided by following objectives.

1. To explore the current species composition extant birds
2. To investigate diversity pattern of birds
3. To examine the pattern of habitats utilize by birds

In order to answer my objective, I set two hypotheses:

i. Diversity of birds is affected by seasonal variations
ii. Type of habitat and the pattern of habitat utilization determine diversity of birds

1.3. Importance of study

Despite having a rich diversity of avifauna and being one of the Important Bird Areas (IBAs) of Nepal, proper investigation and research work on birds are still lacking in the Barandabhar Corridor forest. In Nepal most of the studies on birds have been conducted only in protected areas and focusing only on threatened bird species. Only the few organization like Bird conservation Nepal, Bird education Society and National Trust For Nature Conservation have conducted research works in the BCF. The current information on status, diversity of birds with respect to season and habitat types is inadequate. This study was conducted to fill this gap in some extent.

2. LITERATURE REVIEW

The quality of habitat and disturbance are major factors to determine the diversity of bird species. It is important to analyze the habitat type and abundance of bird species with respect to seasons to prioritize for the conservation avian fauna. Moreover, food-supply can affect the bird diversity, abundance density, breeding ecology, body condition, ranging behavior and/or flocking behavior (Sodhi 2000).

Birds are good indicators and useful models for studying a variety of environmental problems (Urfi *et al.* 2005) because they potentially detect aspects of wetland landscape conditions that are not detected by other groups commonly used as indicators. Many previous studies have looked on wetland biodiversity (BPP 1995, Bhandari 1998 and Sah 1997) but a few studies investigated particularly on wetlands birds (Inskipp and Inskipp 1991, Baral 1998, Gyawali 2003, Hungden and Clarkson 2003) in Nepal. Theses research studies were largely focused on species specific and baseline approaches and did not take into account the effect of the invasive alien plant species on the community structure of wetland birds since the concern in invasion of wetlands was very recent for Nepal. Although some short-term observations have been made for the qualitative description of the impact on biodiversity (Baral 2002, Baral and Inskipp 2004), these do not provide adequate information because the study was mainly focused on the state of birds of Nepal rather than effects of invasive alien plant species on wetland.

Koshi Tappu Wildlife Reserve holds the largest population of Swamp Francolin (Baral 1998, Dahal 2000) in Nepal. Baral (2000) estimated over 100 Swamp Francolin in Suklaphanta which is rather larger but still lower than Koshi's population.

In upper mustang 21 bird species are recorded (Chettri 2007). Counts of Selender billed Vulture and White Rumped Vulture *Gyps bengalensis* at different localities in Bardia National Park in total vulture species are 28 (20 WRV and 8 SBV) (Giri 2007). Eight species of vulture have been recorded from Nepal (Grimmett *et al.* 2000), of them Himalayan Griffon and Lammergeier breed at higher elevation (Gautam *et al.* 2003*).* Himalayan Griffon inhabitant in the Himalayan of Pakistan, Nepal, India and Bhutan. Habitat lies mostly in between 1500 -4000 meter above the sea level

(Thiollay 1994). Annapurna area is probably the best known stronghold for the Himalayan Griffon with high density (Baral *et al*. 2002). Distribution of Himalayan Griffon found to be distributed within all area of Annapurna region however their breeding status confirmed in Manang and Mustang district (Tucker 2005, Suwal 2003, Saha 2001, Acharya 2003, 2004, Baral *et al.* 2002).

Bardia National park is also one of the IBAs of Nepal .A total of 426 species of birds has been recorded in this National Park including 11 globally threatened species. The park holds the remarkable population of Bengal Florican (Baral and Inskipp 2005).A recent bird survey in the Mai-Valley carried out by BCN as a part of CEPF project has recorded 252 species (Baral *et al.*2008).

Lambert and Collar (2002) studied the impact of logging and fragmentation on the avifauna of forested sites. He recorded a total of 274 resident forest bird species confined to the lowlands of the Sundaic region (excluding Palawan), 83 (30% of the avifauna) are adversely affected by fragmentation and 26 (9.5%) negatively affected by logging, with forest-interior sallying insectivores, terrestrial insectivores and woodpeckers being particularly susceptible to both threats.

Kumar *et al*. (2008) reported that water bird community of Nal Lake Bird Sanctuary (NLBS), Gujarat was varied among the seasons. He recorded total of 109 water bird species belonging to 64 genera and 18 families were documented, including 42 year-round residents and 67 seasonally present or migratory species. Among these, eight species were considered to be abundant, 51 common and 50 rare.

Giri (2008) concluded that water birds in the Phewalake, Pokhara varied according to seasons. He recorded 31 bird species in winter and 17 species of bird each in summer and spring.

A total of 543 number of bird species has been recorded in Chitwan (Baral and Upadhyay 2006). Species status given here is taken from Baral and Upadhyay (1998). As many as two-thirds of Nepal's globally threatened bird species have been recorded in Chitwan. The site is especially important for several grassland species, including Bengal Florican *Houbaropsis bengalensis*, Grey-crowned Prinia *Prinia cinereocapilla* and Slender-billed Babbler *Turdoides longirostris*, and also for Lesser Adjutant

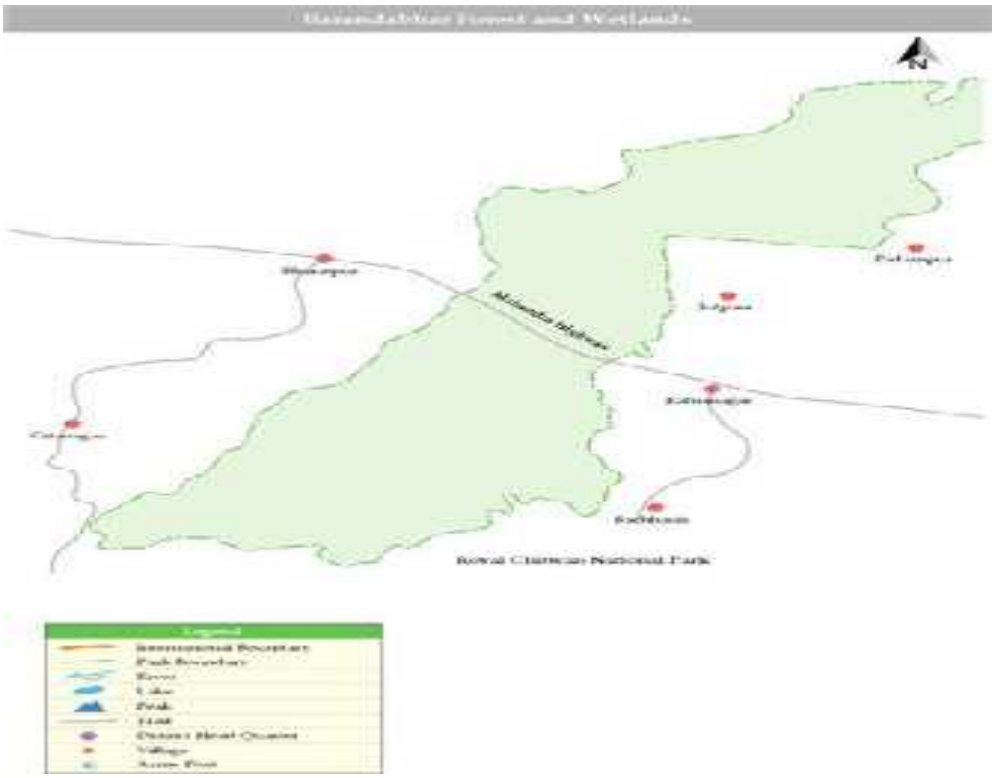
Leptoptilos javanicus. It is the only Nepalese locality where the Slender-billed Babbler *Turdoides longirostris* has been recorded and it may support a larger population than any other area in the Indian subcontinent. Chitwan is the only Nepal site where Grey-crowned Prinia *Prinia cinereocapilla* is common and it may also hold the largest population in the species' range (Inskipp and Inskipp 1991 and Baral 2002).

Chitwan's number of bird species form 61.5% of the total recorded in all of Nepal. In Chitwan the extensive Sal forest (70% of the park), grasslands (20%) and wetlands support 19 of Nepal's globally threatened bird species, two-thirds of the total recorded in all of Nepal (Bird Life International 2001). Bird Education Society (1999) recorded 269 bird species in the Barandabhar Corridor forest. Similarly, (Dahal 2002) has recorded 228 birds species from the same area.

3. STUDY AREA

3.1. Location and site description

The Barandabhar Corridor Forest is located between 84º22′30″and 84º33′0″ East Longitude and 27º34′7″and 27º43′30″North latitude in the tarai region in Chitwan district of Narayani Zone (Map 1). It covers an area of 12300ha with an altitude range of 150-400m asl. The Barandabhar forest ranges from 1.8-7 km in width and stretches from Chitwan national park in the south to Mahabharat Range in the north. The forest south of the Mahendra Highway lies in buffer zone. It is one of the partially protected areas, identified as one of the Nepal's important bird areas and includes Ramsar site, the Beesh Hazari Lake (Baral and Inskipp 2005).



The forest is regarded as the only remaining wildlife corridor that links the lowland to mid-hill ecosystems in the central region of the country (Basnet *et al.* 2000). The Mahendra Highway drives the Barandabhar Corridor Forest into two executive

jurisdictions. The buffer zone forest south of the Mahendra highway is managed under the auspices of the Chitwan National Park, while the district forest office manages the forest north of the highway.

3.2. Climate

The climate of the study area is subtropical, mainly dominated by the southeast monsoon. Three seasons are distinct, a dry hot pre-monsoon from the late February to May (average monthly rainfall 83 mm, average temperature 24º), a humid and hot monsoon season from June to September (average monthly temperature 30º and monthly average rainfall 473mm) and cool and dry post-monsoon season from October to January (Thapa 2003).

Conditions are subtropical with a summer monsoon from mid-June to late-September, and a relatively dry winter. Mean annual rainfall is 2400 mm with about 90% falling in the monsoon from June to September. Monsoon rains cause dramatic floods and changes in the character and courses of rivers. Temperature is highest (maximum 38^{o}C). During these season and drop to a minimum of 6^{o}C in the post-monsoon period (October to January), when dry northerly winds from the Himalaya and Tibetan plateau are prevalent (Bolton 1975 and Laurie 1978).

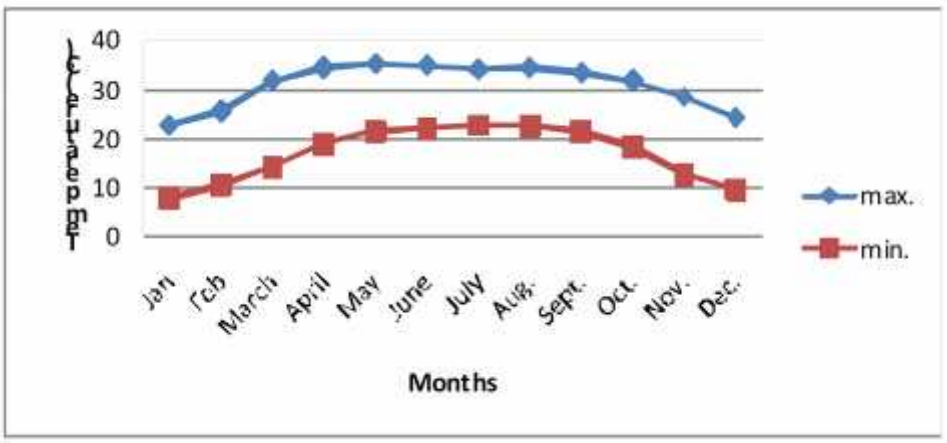


Figure 3.2. Mean temperature (in degree Celsius) record from 2001 to 2007

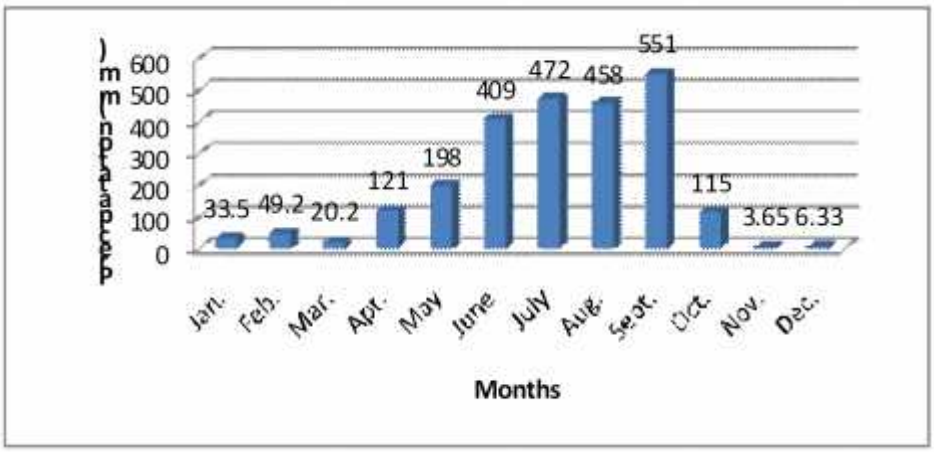


Figure 3.3. Mean rainfall (in mm) record from 2004 to 2007

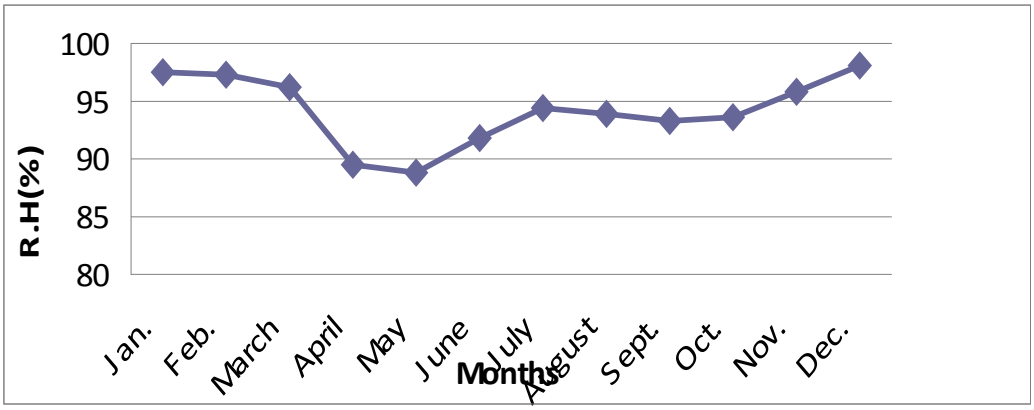


Figure 3.4. Mean Relative Humidity (RH) record from 2001 to 2007

3.3. Fauna

Barandabhar corridor forest is an important corridor and provides way for the movement of large mammals from CNP between the Churia hills and Mahabharat range. A total of 273 bird species representing 61 families have been recorded from Beeshajari Tal (Baral1996). Nepal conservation research and training center (NCRTC) monitoring team had recorded 17 species of mammals such as Indian Rhinoceros *Rhinoceros unicornis*, Asian Elephant *Elephas maximus*, Chital *Axis axis*,Tiger *Panthera tigris* etc and 10 species of reptiles in the Bagmara community forest. The large numbers of 218 bird species are recorded from Bagmara community

forest including two globally threatened and 11 nationally threatened species (Dhakal 2002).

3.4. Vegetation

The vegetation in the BCF is dominated by almost monotypic stands of Sal *Shorea robusta*, patches of riverine forests are found along the reported, of which 32 are trees, 64 are shrubs and herbs and 35 are aquatic species (Bhandari *et al*.1998). The riverine forest of the Barandabhar Forest occupies a very small area and is located mostly in the northern belt as well as along the Khageri stream as its eastern boundary. The flora of the riverine forest includes Vellor *Trewia nudiflora*, Simal *Bombax ceiba*, Sindure *Mallotus philippensis*, Kutmero *Listsea monopelata, Sapium insignene* and others.

Large tracts of the Barandabhar Corridor Forest comprise Sal forest, which extend up to the foothills of the Mahabharat range. Disturbed Sal *Shorea robusta* forest occupies almost the entire length of the edge on northern section of Barandabhar Forest (Bhojad). Sal *Shorea robusta* is the dominant species and other major species are Sisso *Dalbergia sisoo* and Kyamuna *Cleistocalyx operculatus* etc.

4. MATERIALS AND METHODS

4.1. Preliminary survey

I carried out preliminary survey in the Barandabhar Corridor Forest from September 5 to 15, 2007. During the survey, boundary, condition and situation of forest were identified with discussion with supervisor, bird experts from National Trust for Nature Conservation (NTNC), local people and members of community forest. Then the study area was surveyed by walking in different part of forest to identify characteristics of the study area.

4.2. Line transects sampling

I conducted bird survey at BCF during the months of October, 2007 and May 2008 covering two different seasons. Line transects sampling method was used to evaluate the bird diversity and their habitat association. In which the observer continually walks and records all observed birds on either side of the track walked. A total of six lines transect/ fixed walking routes (Picture 1) were laid down to cover major habitat types and area of the study site as well. The Birding routes covers different habitats i.e. wetland, forest, grassland, edge of the forest and residential area. The six transects were divided according to the permanent transect which included: 1) Tikauli gate to Bhozad along the Khageri river 2) Bhozad to Devnagar Range post 3) Devnagar Range Post to Ghatghain 4) Ghatghain to Khorsor (Elephant center) 5) Khorsor to Tikauli (Millijully CF gate) 6) Tikauli Gate to Devnagar Range Post along with Bishhazari Tal. Birds Songs of Nepal- CD ROM (Scott 1993) was used for the identification of heard bird. Finally a bird list was compiled by careful recording of all birds observed. The bird list followed the systematic order (BCN 2009). Birds were observed with the help of binoculars (**OLYMPUS, 8-16× 40**) and **15-45X spotting scope**. During observation I noted name of birds, their numbers, location, habitat type and activities. “Birds of Nepal” hand book (Grimmett *et al.* 2000, 2003) was used as reference book for the identification of observed birds. Cannon 400 D SLR Camera with VR 500 mm lens was used for bird photography.

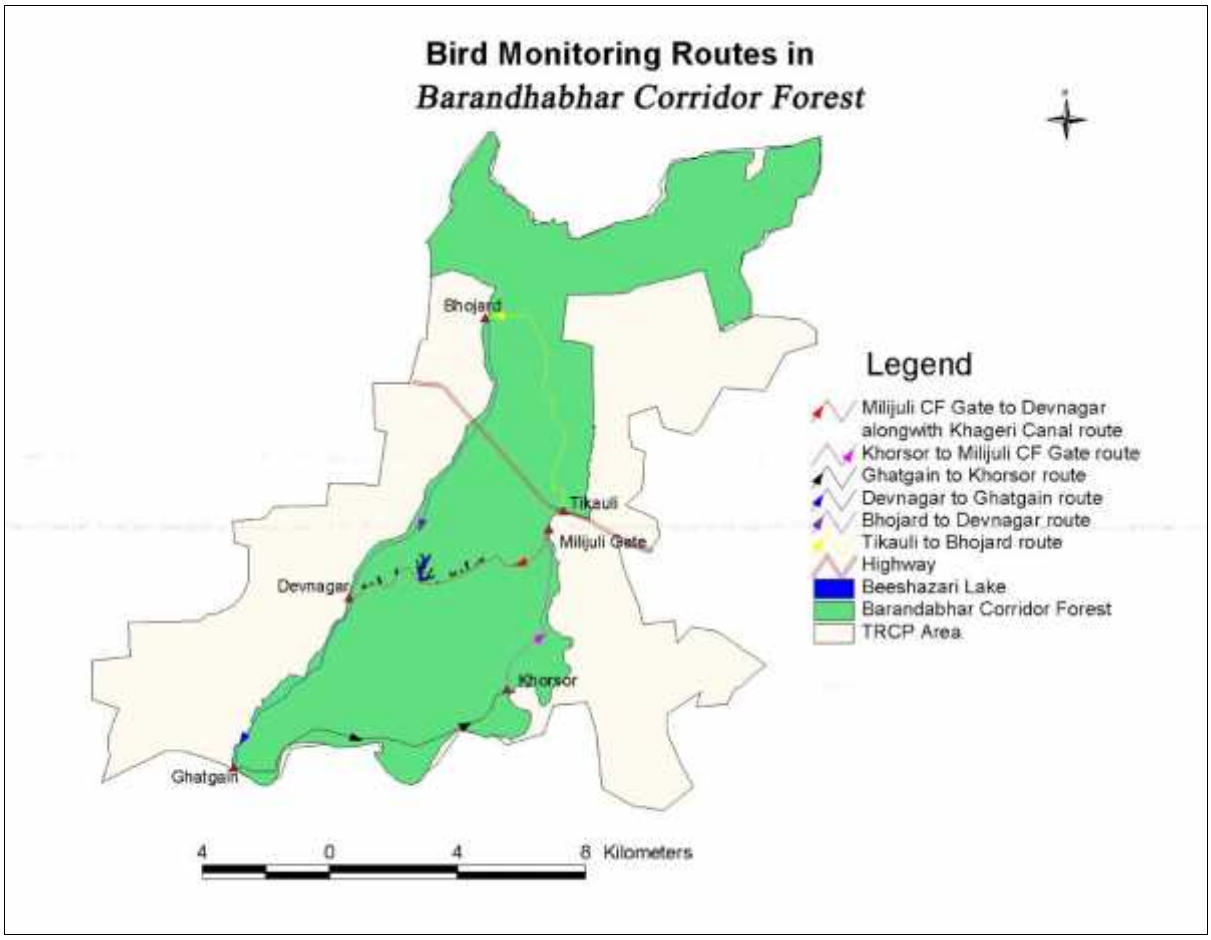


Figure 4.1. Study area showing Distribution of Transects in BCF

Table 4.1 Transect routes their habitat types

Transect no	Line Transect	Habitat types
1	Khorsor to Tikauli (Millijully CF gate)	Mix Riverine forest, Open grassland, Sal forest
2	Tikauli gate to Bhozad along the Khageri river	Open grassland, Mix Riverine, Sal/grassland
3	Ghatghain to Khorsor (Elephant center)	Sal forest, Sal/grassland, Sal mix forest
4	Devnagar Range Post to Ghatghain	Mix forest, Sal forest, Sal mix forest
5	Bhozad to Devnagar Range post	Sal forest and Sal/grassland,Grassland associated with few sal trees

6	Tikauli Gate to Devnagar Range Post along with Bishhazari Tal.	Wetlands, Sal forest, Sal mix forest

4.3. Data Analysis

4.3.1. Shannon's Index of Species diversity

Species diversity of birds was calculated by using Shannon index of general diversity (Shannon and Weaver 1963).

$$\overline{H} = -\sum\left(\frac{ni}{N}\right)\log\left(\frac{ni}{N}\right)$$

Or

$$\overline{H} = -\sum pi \log pi$$

Where

$\overline{H}$ = *index of diversity*

$pi = propotion\ of\ individual = \frac{ni}{N}$

$ni = importance\ value\ for\ each\ species\ (Number\ of\ individual)$

$N = Total\ importance\ value\ (Total\ number\ of\ individual)$

4.3.2. Evenness index

I also used Jacob's coefficient to calculate the relative diversity of species

Jacob's coefficient $J = \frac{\overline{H}}{H\max}$

Where,

$\overline{H}$ = index of diversity. It combines both evenness and richness in a single measure

H_{max} = logK= proportion of maximum possible diversity

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

4.3.3. Statistical Tools

I used a χ^2 test to analyze the habitat utilization by birds in different seasons. Two ways - ANNOVA test was used to examine the effect of seasons and habitats on the population of birds. I used Statistical Package for the Social Sciences (SPSS) 13.0 for the statistical analyses.

5. RESULTS

5.1. Species composition

I recorded a total of 123 bird species belonging to 15 Order and 43 Families from two different birding seasons (Annex I). The highest numbers of bird species i.e. 52 were represented by order Passeriformes along with 14 families. Other major order were Ciconiformes (10 families and 25 species), Coraciformes (5 families and 8 species), Piciformes (2 families and 11 species), Cuculiformes (2 families and 8 species), Columbiformes (1 family and 5 species), Psittacaformes (1 family and 4 species), Stringiformes (1 family and 2 species), Galliformes (1 family and 2 species), and next other orders representing 1 family and 1 species were Turniciformes, Bucerotiformes, Upupiformes, Apodiformes, Gruiformes and Anseriformes.

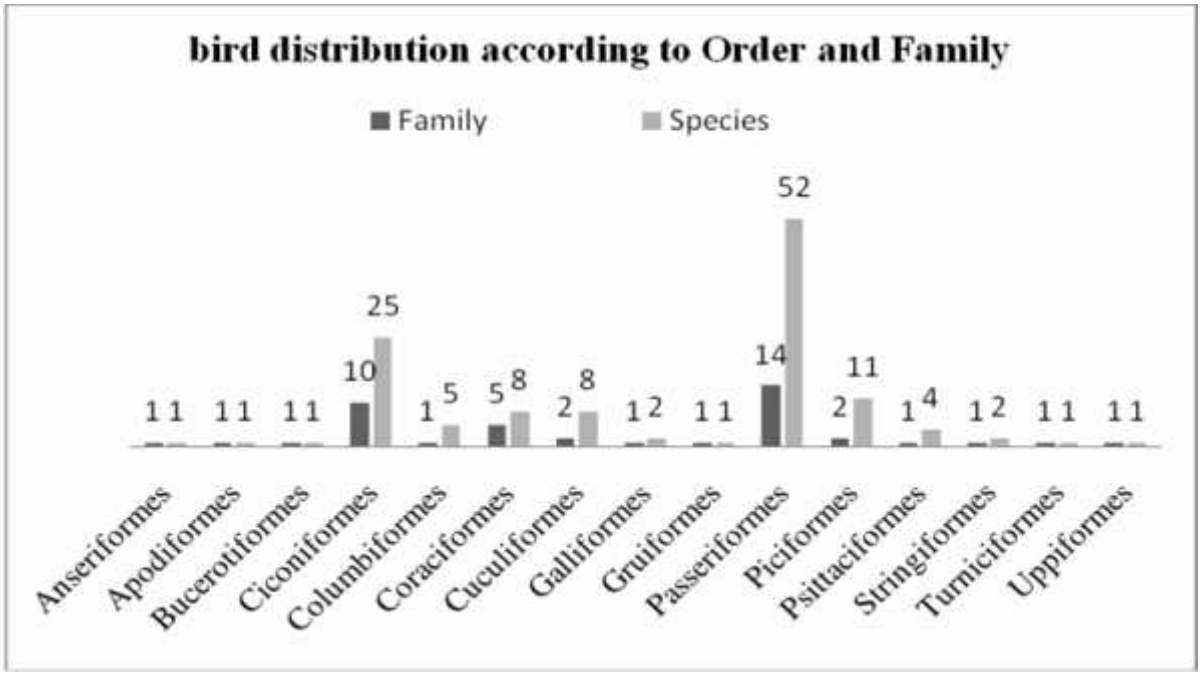


Figure 5.1. Number of bird species represented by Order and Family

Out of 123 recorded during study period 94 species were resident, 12 species were winter visitor, 16 were summer visitors and 1 species was local migrant.

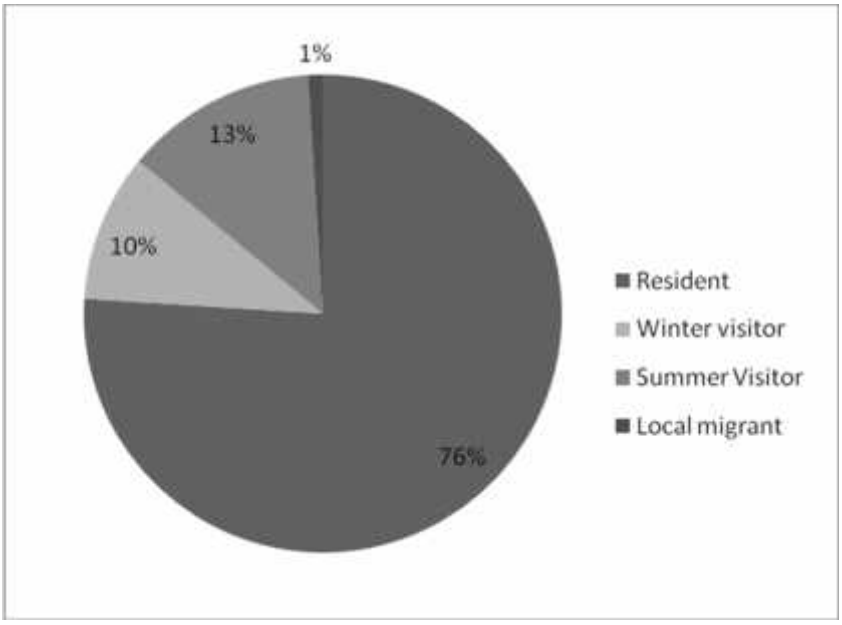


Figure 5.2. Status of Bird at BCF

5.2. Seasonal diversity

It was noticed that there was significant difference in bird diversity between seasons (mean 99.5 ± SD 17.5). In spring, Shannons-Wiener Diversity Index ($\overline{H}$) was 1.70 in spring and 1.54 in autumn. The relative diversity of species of autumn and spring season was 0.806 and 0.825 respectively.

Table 5.2. Bird diversity in the study area

Seasons	Number of species	Shannon-Wiener Index ($\overline{H}$)	Jacob's coefficient(J)
Autumn	82	1.54	0.806
Spring	117	1.7	0.825

5.3. Habitat association

The survey result showed that habitat association of birds with the habitats in the BCF varied significantly (χ^2 = 143.52, P < 0.05 at df =7). Similarly the species diversity of birds was significantly different among the seasons (F= 5.59 P=0.05 df =7) and as well as in habitat type (F= 3.97 P=0.05 df =7). Most of the species (46.48%) were recorded from Sal forest followed by open grass land (22.81%), Salforest/grassland

forest (13.21%), Sal Mixed forest (8.70%),Wetland (2.88%), Mixed Riverine forest (2.47%), Grassland associated with few sal trees (2.02%) and Mixed forest (1.39%).

The two way – ANNOVA showed that there was significant relationship between seasons with the number of bird population (p = 0.05, degree of freedom 1 and 7). Similarly the habitat type and the number of bird population were also significantly related (p = 0.05, degree of freedom 7 and 7).

Table 5.3. Birds Number in different habitats and seasons

Source of variance	**Sums of square**	**df (degree of freedom)**	**Mean sums of square**	**Correction Factor (Cf)=grand total /total number**	**F-ratio**	**Critical value of F for different df at 0.05 level**
Between seasons	25280.75	2-1=1	25280.75	307470.25	9.82	For 1 and 7 df is 5.59
Between habitats	418630.75	8-1=7	59804.39		23.25	For 7 and 7 df is 3.97
Within samples	18004.25	7	2572.03			
Total sums of square	461915.75					

5.4. Activities of Birds at two different seasons

During the study period, I recorded different activities of birds in the area. The activities of the birds noticed were resting, calling, eating, flying, preening, feeding and nesting (figure 3 and 4). The activities of birds were highly correlated between seasons (t= 0.290, P=0.05, df=4) with excluding the nesting and feeding activities. The nesting and feeding activities were only recorded during spring season.

Table 5.4. Different activities of birds in autumn and Spring Season

Activities of Birds	**Autumn Season**		**Springs Season**	
	Number of individuals	**Percentage**	**Number of Individuals**	**Percentage**
Resting	388	48.74	216	15.14
Calling	205	25.75	409	28.66
Eating	104	13.07	367	25.72

Flying	94	11.81	278	19.48
Preening	5	0.63	11	0.77
Feeding			38	2.66
Nesting			108	7.37

Table 5.5. Association of birds with habitats and seasons

Habitat types	Biological character	Major birds association	Season(Autumn and Spring)
1.Sal forest	Sal is dominant .The trees grow upto 15m.The common tree associates are *Terminalia bellirica, Syzygium cumini ,Bombax ceiba, Dalbergia sissoo etc.* Major faunal species *Rhinocerus unicornis,Panthera tigris* are found here	Jungle Babbler, Red throated Flycather, Black hooded Oriole, Crested serpent eagle, Ashy Drongo	Both seasons
2.Open grassland	Alluvial flood plains which support luxuriant growth of grasses, Elephant grass reaches about twenty feet, *Imperata cylindrica Saccharum, pharamites, arundo, Themeda, Narenga* etc. Support higher ungulates biomass density than Sal forest	Ashy wood Swallow,Barn Swallow,House Crow,White bellied Drongo,Spotted Dove.	Barn swallow was only in Autumn
3.Salforest and grassland	This type of habitat includes both Sal forest and Grassland in an equal ratio	Fulvous breasted Woodpecker, Great Tit, Alexandrine Parakeet, Rufous Treepie, Eurasian Collard Dove	Autumn and Spring
4.Grassland associated with few sal trees	Consists of high proportion of grassland with sparse sal trees. Good habitat of *Rhinocerous Unicornis*	Redvented Bulbul, Black Drongo, Black Bulbul, Grey-headed Canary Flycather	Grey-headed Canary Flycather in Autumn
5.Sal mix forest	Sal in association with *Terminalia alata, Adina cordifolia, Terminalia belerica, Terminalia chebula, Holrrhena antidysenterica, Schleichera trijuga* etc. Many shrubs, creeper ferns, grasses grow and under the Sal forest	Black rumped Flamback, Jungle Babbler, Grey Breasted Prinia, Long tailed Shrike	Autumn and Spring
6.Mix forest	Includes trees, shrub, climbers, herbs, grasses etc . Good habitat for herbivorous animals, such as barking deer	Oriental Magpie Robin,Asian Pied Starling	Both seasons.
7.Mix riverine forest	Occupies a small area mostly in the northern belt and the Khageri stream. Characteristic species include *Trewia nudiflora, Bombax ceiba, Mallotus philippensis, Listsea monopelata, Sapium insignene* and others	Grey Caped Pigmy Woodpecker,Crested Serpent Eagle,Spotted Dove, White Brown Wagtail	Common Iora was only found in spring season
8.Wetland	Characterized by the presence of water, unique soils and vegetation adapted to wet condition with *Hydrilla verticillata,Eichhornia crassipes,Trapa quadrispinosa.*	Lesser Adjutant, Little Cormorant, Darter, Strokbilled Kingfisher, Black Ibis, Wolley Necked Stroke	Darter and Cormorant were only observed in Spring

	Major habitat for migratory birds. Beeshazari Tal harbors wetland dependent faunal species such as *Varanus Flavescens,Python Molurus,Crocodylus palustris*		

a.Oriental Magpie Robin *Copsychus saularis*

b.White Throated Kingfisher *Halcyon smymensis*

c. Darter *Anhinga*

d.Asian Openbill *Anastomus oscitans*

e.Indian Peafowl *Pavo cristatus*

f.Lesser Adjutant *Leptoptilus javanicus*

Plate 1. Some important birds found in the Barandabhar Corridor Forest

a. Sal and Grassland Forest

b. Grassland

c .Sal forest near wetlands

d .Wetland (Beesh Hazari Tal)

e. Habitat disturbances by picnickers

f. Forest cover by mycenae

Plate 2. Habitat Types and Threats

a. Black Kite *Milvus migrans*

b. Shikra *Accipiter badius*

c. Spotted Owlet *Athene brama*

d. Alexendrine Parakete *Psittacula eupatria*

e. Zitting Citicola *Cistocola juncidis*

f. Black Baza *Aviceda leuphotes*

Plate 3. Some important birds found in the Barandabhar Corridor Forest

6. DISCUSSION

6.1. Seasonal diversity

The total number of the bird species recorded in the Barandabhar Corridor Forest during the study period was 123. The bird species was found higher in spring season than in autumn season. 117 bird species were recorded in spring and 82 bird species in the autumn. KMTNC (2005) recorded 303 bird species in the BCF, which belonged to 15 orders and 54 families. The number of bird species in my study seems low when compared to the record of 303 found there by KMTNC. This discrepancy might be due to the timing of my study period that was carried out only in two season autumn and spring.

Several studies have shown similar results (Basnet 2006, Malla 2006 and Khanal 2008). In Godawari and its adjacent region Basnet (2006) recorded 161 bird species belonging to 11 order and 36 families. Among them 107 species of birds were recorded in spring and 100 species of birds were recorded in autumn. Malla (2006) recorded 117 bird species belonging to 12 orders and 37 families in the Nagarjun forest during the study period. Sixty five percent of the species was represented by order Passeriformes along with 22 families. Shannon weinner showed highest value in spring season followed by within autumn, and summer. Similar type of result was observed by Khanal in the Nawalparasi forest. Khanal (2008) recorded 121 bird species, which belonged to 14 order and 37 families. Highest numbers of species were represented by order Passeriformes. Seasonal variation of the bird was high - 102,88 and 64 species in Winter, Autumn and Summer respectively.The result of Khanal showed resemblance with my work as the species recorded were similar in different season. As the climate and vegetation of Chitwan and Nawalparasi are almost same, we got similar type of result.

Similar seasonal variation was also seen in Raja rani community forest, Morang (Basnet et al. 2005).There the bird species recorded in the Autumn and Spring were 63and 64 species respectively.

My study showed the maximum number of resident birds followed by winter visitor, summer visitor and local migrant. 94 species of birds were resident of which the major were Indian Peafowl *Pavo cristatus*, Lesser Adjutant *Leptoptilos javanicus*, Rose-ringed Parakeet *Psittacula krameri*, House Crow *Corvus splendens* Common Hoopoe *Upupa epops*, Spotted Dove *Streptopelia chinensis* etc. 12 winter visitors bird species were Great egret *Casmerodius albus*, Blyth's Reed Warbler *Acrocephalus dumetorum*, Common Chifchaf *Phylloscopus collybita*, Little cormorant *Phalacrocorax niger*, Osprey *Pandion haliaetus*, Olive-backed Pipit *Anthus hogsoni*, Greenish Warbler *Phylloscopus trochhiloides* , Grey Wagtail *Motacilla Cinera* , Red-throated Flycatcher *Ficedula parva*, Peregrine Falcon *Falco peregrines*, and Grey-headed Fisheagle *Ichthyophaga ichthyaetus*. About 149 bird species are winter migrants in Nepal (Inskipp and Inskipp 1991). Similarly, Summer visitors were represented by 16 species which were Chestnut-shouldered Petronia *Petronia xanthocollis*, Ashy Drongo *Dicrurus leucophaeu*, Asian Koel *Eudynamys scolopacea*, Black Bazaa *Aviceda leuphotes*, Chestnut-headed Beeeater *Merops leschenault*, Crow-billed Drongo *Dicrurus annectans*, Dollar Bird *Eurystomus orientalis*, Eurasian Cuckoo *Cuculus canorus*, Grey- billed Cuckoo *Cacomantis passerines*, Hooded Pitta, Indian Cuckoo *Cuculus micropters* Indian Pitta *Pitta sordida*, Asian Paradise Flycatcher *Terpsiphone paradisi*, Spangled Drongo *Dicrurus hottentorrus*, Eurasian Golden oriole *Oriolus oriolus* and Drongo Cuckoo *Surniculus lugubris*. Booted Eagle *Hieraaetus pennatus* was the only species that was found to be local migrant. Resident, wintering and summering birds are the main avifaunas in Beesh Hazari Lake. Of the total, as many as 149 species (55%) are resident birds, 24 additional species (9%) are summer migrant. Of these 35 species (13%) are known to breed here in spring and summer time. Waders, waterfowls and some passerines are the main winter visitors to the area. In winter the lake is home to hundreds of migrating and wintering waders and waterfowls. It is an important staging site for sma ll number of migrant, which pass through Chitwan.

A total of 84 species (30%) are known to come here in winter season of which most species are wetland dependent. I have also mentioned several studies on the status of birds in different area (Poudel 2005, Mall 2006, Basnet 2006, Subedi 2006, Thakuri 2 007). Poudel (2005) recorded 73 species of birds, among them,39 (54%) species were winter migrants and 9 (12%) species were summer migrants at Kirtipur municipality,

Kathmandu. Of the 117 species recorded 76 (64.95%) species were resident, 18 (15.38%) species were winter visitor, 19 (16.23%) species were summer visitors were recorded at Nagarjun forest Kathmandu (Malla 2006). Basnet (2006) recorded 161 species of which 109 were residents, 30 species were winter visitors, 19 species were summer visitors and 3 passage migrants at Godawari and its adjacent region. Subedi (2006) reported that out of 30 species of wetland birds at Rupa Lake, 16 species were residential, 12 species were winter migratory, summer migratory and vagrant each were represented by one species. Thakuri, (2007), out of 118 bird species 85 were residential, 16 species were summer migratory, 16 species were winter migratory were recorded at Satikhel Community Forest and Dallu community Forest in Seshanarayan VDC. Basnet, (2001) concluded that out of 114 species recorded 86 (75.5%) species were resident, 22(19.3%) species were winter visitors, only 3 species were summer visitors were recorded at Siwalik belt of Morang Nepal.

My study showed the highest diversity index in spring (H = 1.70) followed by autumn (H=1.54). Similarly relative diversity was highest in spring season (0.825) than in autumn season (0.806). This showed that spring season was most favorable for birds than autumn season. Similarly diversity index value of spring and autumn was 3.79 and 3.43 respectively of the birds surveyed in the Nagarjun Forest and relative diversity value of spring and autumn was 0.870 and 0.828 (Malla 2006). Diiversity 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 increase in the density and number of birds in December (Jayson and Mathew 2000b) in the silent valley Kerala.

I also recorded the activities of the birds such as eating, calling, resting, flying, preening, feeding, nesting. In autumn, most of the birds were recorded at resting (48.74%) followed by calling (25.75%), eating (13.07%), flying (11.81%) and preening (0.63%) but in spring season they were found calling (28.66%), eating (25.72%), flying (19.48%), resting (15.14%), nesting (7.37%), feeding (2.66%) and preening (0.77%). I observed nesting by large Cuckoo Shrike, Bayaweaver and Chestnut Tailed Starling and Asian Open bill *Anastomus oscitans*. Similarly, the bird species such as Great tit, Chestnut bellied nuthatch and Ashy wood swallow were seen feeding their young ones. Birds like Common Myaena *Acridotheres tristis*, Oriental Magpie Robin *Copsychus saularis*, Changeable Hawk Eagle *Spizaetus*

cirrhatus were preening in both seasons. I observed that birds were active during the morning and evening than during the noon. The activity and song output of the birds are greatest near dawn, low during the middle of the day, and increase again close to dusk (Robbins 1981, Lay 1938) and thereby giving the best result in the early morning compared to later (Grinnell and Storer 1924, Lay 1938)

6.2 Habitat utilization

The bird's population also showed a great fluctuation within the habitat type. Major eight habitat types were found on the line transect laid down in the BCF. Sal forest harbored maximum bird population (46.48%). The species diversity of birds was significantly different among the habitat types ($F= 3.97$, $P<0.05$ df $=7$). Birds utilized different habitat type. Even the wetland bird species were sharing habitat with other species. Lesser Adjutant *Leptoptilos javanicus* preferred marshy place of Open grassland. Oriental Darter *Anhinga melanogaster* was only seen on Beesh Hazari Tal resting on dead wooden log but forest birds, bush birds and grassland birds were abundant in all type of habitats. Bronze winged jacana was the permanent resident bird for Beesh Hazari Tal. Similarly Black Ibis *Pseudibus papillosa* was recorded only in the wetlands .

The population of spotted dove was remarkable in BCF and it was highly dominant in the Sal forest and Rhino Lake, newly built lake in the BCF was adorned with Black Ibis and Indian Pond Heron *Ardeola grayii*. Indian Peafowl *Pavo cristatus*, Jungle Babbler *Turdoides striates*, Black Drongo *Dicrurus macrocercus* was recorded in almost every habitat type. Booted Eagle *Hieraaetus pennatus* and Changeable Hawk Eagle *Spizaetus cirrhatus* were least recorded and they were found in Sal *Shorea robusta* and grassland habitat. In the *Shorea robusta* near Tikauli, 21 nest of Asian Open Bill were seen. That location was the new breeding site for the Asian Openbill *Anastomus oscitans*. The least number of bird's population (1.39%) were recorded on the mix forest. Similar results have been carried out by other studies (Gautam and Baral 2002, Chettri *et al*.2004, Sharma 2004, Mahato 2005 and Khanal 2008). Gautam and Baral (2002) reported that in the Kaski district, the maximum number of sightings of Nepal kaliz bird was in closed forest with high understorey (49.43%), followed by closed forest with low understory (27.58%), terraced field (12.64%) and open forest (10.64%).

The study carried out in the Sikkim Himalaya over two year period recorded 143 species of which 40%(57 species) were common under all habitat conditions (Chettri *et al.* 2005). Mahato (2005) recorded 12 species of Galliformes Order in the Piper and santel areas of Seti river valley. Seven species – Hill partridge *Arborophila torqueola* , Himalayan Monal *Lophophorus impejanus*, Satyr Tragopon *Tragopan satyra*, Koklass pheasant *Pucrasia macrolopha*, Kaliz Pheasant *Lophura leucomelanos* , Blood pheasant *Ithaginis cruentus* and Black francolin *Francolinus francolinus* have been found in both areas. However, another five species Chukar *Alectoris chukar*, Rufous-throated Partridge *Arborophila rufogularis*, Snow Patridge *Lerwa lerwa*, Tibetan Partridge *Perdix hodgsoniae* and Himalayan Snowcock *Tetraogallus himalayensis* have so far been recorded only in piper area. Sharma (2004) observed that Lesser Adjutant *Leptoptilos javanicus* and Grey-headed Fish Eagle *Ichthyophaga ichthyaetus* utilized maximum of five and four habitats respectively while the others utilized just one or two habitat Khanal (2008) concluded that; the number of bird species in the Nawalparasi forest were found highest in agricultural crop fields (75) followed by mix forest(51),wetlands (32), Salforest (29), wooded grass lands (20) and grassland (17).

The distribution of many bird communities is affected by habitat fragmentation or other habitat parameters and reflect inter-specific dynamics and population trends associated with the habitat (O'Connell *et al*. 2000). This sensitivity suggests that the bird communities have a high potential to act as a surrogate for their habitats at struct ural, regional, and landscape level management (Canterbury *et al.* 2000, Lindenmaver *et al*. 2000 and O'connell *et al*. 2000).Indicator species are expected to indicate the status of the environment or to serve as proxies for a larger number of species (Furness and Greenwood, 1993).Woodpecker species (family Picidae) are attractive candidates for indicators of forest diversity in Europe (Sherzinger 1998).Most Woodpecker are dependent on trees for nesting sites, and many of them forage on trees and dead wood found only in forested landscapes. Grzegorz *et al.* 2001 analyzed that the usefulness of woodpeckers' species in indicating the diversity of other forest birds at the landscape scale. Their results suggested the usefulness of Woodpecker as a broad indicator system for assessing forest biodiversity. The result of my study identified eight species of Woodpeckers occupying mostly Sal forest, Sal and grassland and Sal mix forest. They included Grey capped pygmy Woodpecker

Dendrocopos canicapillus, Fulvous breasted Woodpecker *Dendrocopos macei*, Lesser Yellownape *Picus chlorolophus,* Streak-throated Woodpecker *Picus xanthopygaeus,,* Grey-headed Woodpecker *Picus canus*, Himalayan Flameback *Dinppium Shorri,* Black rumped Flameback *Dinopium benghalense* and Greater flameback *Chrysocolaptes lucidus.* Similarly four species of Parakeet such as Alexandrine Parakeet *Psittacula eupatria*, Rose–ringed Parakeet *Psittacula krameri*, Plum-headed Parakeet *Psittacula cyanocephala* and Red-breasted Parakeet *Psittacula alexandri* were noticed utilizing mostly Salforest. Their population was remarkably high in spring.

6.3. Habitat disturbance and conservation threats

Disturbance to the bird's habitat was the major threat to the extant birds of BCF. Bishazari Taal was in a jeopardized condition due to fisherman, crocodile hunters, firewood collectors and edible vegetation collector eg nigro *Dryopteris specis*, koiralo *Bauhinia variegate* and kurilo (*Asparagus sp*). Noise pollution by vehicles inside BCF was another responsible factors for the disturbances of birds in the Beesh Hazari Taal. Free access to all types of vehicles was observed time during study period. Due to fishing, fish dependent birds such as Kingfisher species, Oriental Darter *Anhinga melanogaster* and Grey-headed Fish Eagle *Ichthyophaga ichthyaetus* were immensely affected. I recorded four Tortoise hunters during autumn season and if they fail to catch the target species, they will move to fishing practice and thus affecting fish dependent birds. Lesser Adjutant *Leptoptilos javanicus* was also killed by the local hunters for their flesh. Illegal hunting and trapping of birds is rampant in the area. As it a large bird heavily dependent on agriculture field, it is an easy target for many hunters and youngsters killing birds (Baral 2004). Although there were many aquatic floating and submerged plants, two species of main invasive alien plant species- Water hyacinth *Eichhornia crassipes* and American cutgrass *Leersia hexandra* were recorded from the Beesh Hazari Taal. Because of the over-growing of such alien plant species the water birds like Common coot was not recorded. Similarly, the Rhino Lake was also facing similar problem as it was used for frivolous purposes like boating and picnic. Some picnickers' were seen carrying catapult for hunting birds for pleasure.

Baral and Inskipp (2005) stated that wetlands face threats from drainage, diversion, abstraction, siltation, pollution from industrial and pesticide pollutions, over

enrichment from agriculture run-off ,poison used to kill fish, over -fishing, heavy grazing and grass cutting. Threats in all habitat types are hunting, invasive alien species, chemical poisoning, inappropriate tourist development and climatic change. Nepal's wetland Habitat loss and alterations face threat from drainage, diversion, abstraction, siltation, pollution and poisons used to kill fish (Grimmett *et al.* 2000).
The areas between Ghatghain to Khorsor were covered by alien invasive species like Banmara *Mycenae macrantha* affecting Sal *Shorea robusta* and underground vegetation and also bird feeding on canopy and ground levels. The grassland birds Lesser Councel *Centropus bengalensis,* Small Buttonquail *Turnix sylvatica* and Zitting Cisticola *Cisticola juncidis* were the most affected species. Most of the community forests near the village settlement were heavily exploited. Dachinkali community forest near Devnagar, Bandevi Community Forest near Gondranj, Rambel Community Forest near Naurange and Navagjagriti community forest near Bojhad were suffering from the heavy human encroachment and livestock pressure. They collected the firewood, fodders for animal and other resources such as sal leaves, beehive etc. Loss of the trees, which supports bird for nesting, is recognized as the major threat at Chitwan declining of Bombox Ceiba in Chitwan is a good example (Gyawali 2003).

Human cause nearly all of the many immediate threats that directly impact bird species and the sites and habitats in which they live. For example, some 95% of European Important Bird Areas (IBAs) are used for human activities, which often involve the entire, and over 40% are subject to one or more high –impact threats. Similarly over 90% of Globally Threatened Birds (GTBs) that are currently threatened by over-exploitation are also affected by the destruction of their habitats. (Bird life in Action)

7. CONCLUSION AND RECOMMENDATIONS

The present study explored birds diversity with reference to seasonal variation, habitat types and their activities .The BCF harbored more than 123 species of birds belonging to 15 orders and 43 families. Among them 94 species were residents, 16 species were summer visitors, 12 species were winter visitors and one was a local migrant. Shannons- Wiener Diversity Indices ($\overline{H}$) were 1.70 and 1.54 in spring and autumn respectively suggesting that the diversity was high in spring. The relative diversity of species was 0.806 in autumn and 0.825 in spring season, which indicated a seasonal variation in avifaunal diversity. Nesting was the main activities of many birds in spring including Large Cuckooshrike *Coracina macei*, Baya Weaver *Ploceus phillipinus*, Chestnut-tailed Starling *Sturnus malabaricus* and Asian Openbill *Anastomus oscitans*. Brooding parasitism of Asian Koel *Eudynamys scolopacea* was observed in Large-billed Crow *Corvus macrorhynchos* nest.

Birds were recorded from eight different Habitat type. The habitat types were Open grassland, Sal forest and Grassland, Sal forest, Grassland associated with few sal trees, Sal mix forest, Mix Riverine forest, Mix forest and Wetlands. The highest bird population (46.48%) was recorded from Sal forest and lowest bird population (1.39%) was recorded from Mix forest. Most of the birds utilized more than six habitat types. Some birds like Darter, Bronze winged Jacana and Black ibis were recorded only in the wetlands during spring an autumn.

Based on my study I have drawn some recommendation for the BCF.

- Discourage the illegal cattle grazing in and around the BCF
- Illegal fishing practices as well as tortoise hunting in the wetlands areas
- Collection, rearing, and hunting of young chicks and adult birds should be checked
- Cleaning of Beesh Hazari Tal should be done according to migratory pattern of birds.
- Hunting of bee hive in and around the BCF should be strictly prohibited as bee-eaters birds are dependent on it

- Diversity of the fruiting plants for example Simal (*Bmbox ceiba*), Jamuna, Bayer should be maintained in high level
- Invasive and alien species should be controlled
- Artificial fire incidences, mainly from the honey harvesters and smokers should be checked
- Puiblic and livestock pressure inside the community forest such as Panchakanya Community Forest, Bandevi Community Forest, Navajagriti Community Forest should be monitored
- Awareness programs about the conservation of birds should be done through bird watching program and by establishment of green clubs
- Use of pesticide should be reduced and alternative methods such as biological control should be employed

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Annexes

1. Date Sheet used During Field Survey

Data Sheet

Date: **Weather:**

Location: **Starting Time:**

Transect: **Ending Time:**

S.N.	Habitate Type	Common Name	No. of Individual	Activities	Status

2. Birds Check List

S.N.	Order, Family, common name and scientific name	Season	
		Autumn	Spring
	GALLIFORMES		
	Phasianidae		
1	Indian Peafowl *Pavo cristatus*	+	+
2	Black Francolin *Francolinus francolinus*		+
	ANSERIFORMES		
	Dendrocygnidae		
3	Lesser Whisting Duck *Dendrocygna javanica*		+
	TURNICIFORMES		
	Turnicidae		
4	Small Buttonquail *Turnix sylvatica*		+
	PICIFORMES		
	Picidae		
5	Grey-caped Pygmy Woodpecker *Dendrocopos canicapillus*	+	+
6	Fulvous-breasted Woodpecker *Dendrocopos macei*	+	+
7	Lesser Yellownape *Picus chlorolophus*		+
8	Greater Yellownape *Picus Flavinucha*		+
9	Streak-throated Woodpecker *Picus Xanthopygaes*	+	+
10	Himalayan Flameback *Dinopium shorii*	+	+
11	Black-rumped Flameback *Dinopium bengalense*	+	+
12	Greater Flameback *Chrysocolaptes lucidus*	+	+
13	Grey-headed Woodpecker *Picus canus*	+	+
	Megalaimidae		
14	Lineated Barbet *Megalaima lineated*	+	+
15	Coppersmith Barbet *Megalaima haemacephala*		+
	BUCEROTIFORMES		
	Bucerotidae		
16	Oriental Pied-Hornbill *Anthracoceros albirostris*		+
	UPUPIFORMES		
	Upupidae		
17	Common Hoopoe *Upupa epops*	+	+
	CORACIIFORMES		
	Coraciidae		
18	Indian Roller *Coracias benghalensis*	+	+
19	Dollarbird *Eurystomus orientalis*		+
	Alcedinidae		
20	Common Kingfisher *Alcedo attis*	+	

	Dacelonidae		
21	Stroke-billed Kingfisher *Pelargopsis capensis*		+
22	White-throated Kingfisher *Halcyon smymensis*	+	+
	Cerylidae		
23	Pied Kingfisher *Ceryle rudis*		+
	Meropidae		
24	Blue-beared Bee-eater *Nyctyornis athertoni*	+	+
25	Chestnut-headed Bee-eater *Merops leschenaulti*		+
	CUCULIFORMES		
	Cuculidae		
26	Common Hawk Cuckoo *Hierococcyx varius*	+	+
27	Indian Cuckoo *Cuculus micropterus*	+	+
28	Eurasian Cuckoo *Cuculus canorus*	+	+
29	Drongo Cuckoo *Surniculus lugubris*	+	+
30	Asian Koel *Eudynamys scolopacea*		+
31	Sirkeer Malkoha *Phoenicophaeus leschenaulti*		+
	Centropodidae		
32	Greater Coucal *Centropus sinensis*	+	+
33	Lesser Coucal *Centropus bengalensis*		+
	PSITTACIFORMES		
	Psittacidae		
34	Alexandrine Parakeet *Psittacula eupatria*	+	+
35	Rose-ringed Parakeet *Psittacula krameri*	+	+
36	Plum-headed Parakete *Psittacula cyanocephala*	+	+
37	Red-breasted Parakeet *Psittacula alexandri*	+	+
	APODIFORMES		
	Apodidae		
38	Silver-backed Needletail *Hirundapus cochinchinensis*		+
	STRINGIFORMES		
	Strigidae		
39	Asian Barred Owlet *Glaucidium cuculoides*		+
40	Jungle Owlet *Glaucidium radiata*		+
	COLUMBIFORMES		
	Columbidae		
41	Spotted Dove *Streptopelia chinensis*	+	+
42	Red Collared Dove *Streptopelia tranquebarica*	+	+
43	Eurasian Collared Dove *Streptopelia decaocto*	+	+
44	Emerald Dove *Chalcophaps indica*	+	+
45	Yellow-footed Green Pigeon *Treron phoenicoptera*		+
	GRUIFORMES		
	Rallidae		
46	White-breasted Waterhen *Amaurornis phoenicurus*		+
	CICONIFORMES		

	Jacanidae		
47	Bronze-winged Jacana *Metopidius indicus*	+	+
	Burhinidae		
48	Eurasian Thick-knee *Burhinus oedicnemus*		+
	Charadriidae		
49	Little Ringed Plover *Charadrius dubius*		+
50	Red-wattled Lapwing *Vanellus indicus*	+	+
	Accipitridae		
51	Osprey *Pandian haliatus*	+	
52	Black Baza *Aviceda Leuphotes*		+
53	Grey-headed Fish Eagle *Ichthyophaga ichthyaetus*		+
54	Crested Serpent Eagle *Spilornis cheela*	+	+
55	Shikra *Accipiter badius*	+	+
56	Booted Eagle *Hieraaetus pennatus*	+	
57	Changeable Hawk Eagle *Spizaetus cirrhatus*	+	
	Falconidae		
58	Collared Falconet *Microhierax caerulescens*	+	
59	Peregrine Falcon *Falco peregrinus*	+	
	Anhingidae		
60	Oriental Darter *Anhinga melanogaster*		+
	Phalacrocoracidae		
61	Great Cormorant *Phalacrocorax carbo*		+
	Ardeidae		
62	Little Egret *Egretta gazzeta*	+	+
63	Great Egret *Casmerodius albus*	+	+
64	Intermediate Egret *Mesophoyx intermedia*	+	
65	Cattle Egret *Bubulcus ibis*	+	+
66	Indian Pond Heron *Ardeola grayii*		
	Threskiornithidae		
67	Black Ibis *Pseudibus papillosa*	+	+
	Ciconiidae		
68	Painted Stroke *Mycteria leucocephala*		+
69	Asian Openbill *Anastomus oscitans*	+	+
70	Wolley-necked Stroke *Ciconia episcopus*		+
71	Lesser Adjutant *Leptoptilos javanicus*	+	+
	PASSERIFORMES		
	Pittidae		
72	Hooded Pitta *Pitta sordida*		+
73	Indian Pitta *Pitta brachyura*		+
	Irenidae		
74	Golden-fronted Leafbird *Chloropsis aurifrons*		+
	Laniidae		
75	Long-tailed Shrike *lanius schach*	+	+

	Corvidae		
76	Red-billed Blue Magpie *Urocissa erythrorhyncha*	+	+
77	Rufous Treepie *Dendrocitta vagabunda*	+	+
78	House Crow *Corvus splendens*	+	+
79	Large-billed Crow *Corvus macrorhynchos*	+	+
80	Ashy Woodswallow *Artamus fuscus*	+	+
81	Eurasian Golden oriole *Oriolus oriolus*	+	+
82	Black-hooded Oriole *Oriolus xanthornus*	+	
83	Large Cuckooshrike *Coracina macei*	+	+
84	Scarlet Minivet *Pericrocotus flammeus*	+	+
85	Black Drongo *Dicrurus macrocercus*	+	+
86	Ahy Drongo *Dicrurus leucophaeus*	+	+
87	White-bellied Drongo *Dicrurus coerulescens*	+	+
88	Crow-bellied Drongo *Dicrurus annectans*		+
89	Spangled Drongo *Dicrurus hottentottus*	+	+
90	Common Iora *Aegithina tiphia*		+
91	Common Woodshrike *Tephrodornis pondicerianus*	+	+
92	Asian Paradise Flycatcher *Terpsiphone paradisi*	+	+
	Muscicapidae		
93	Pale-chinned Flycatcher *Cyornis poliogenys*	+	+
94	Grey-headed Canary Flycatcher *Culicicapa ceylonensis*	+	
95	Oriental Magpie Robin *Copsychus saularis*	+	+
96	White-rumped Shama *Copsychus malabarious*		+
	Sturnidae		
97	Asian Pied Starling *Sturnus contra*	+	+
98	Common Myna *Acridotheres tristis*	+	+
99	Jungle Myna *Acridotheres fuscus*	+	+
100	Chestnut-tailed Starling S*turnus malabaricus*		+
	Sittidae		
101	Chestnut-bellied Nuthatch *Sitta castanea*	+	+
102	Velvet-fronted Nuthatch *Sitta frontalis*	+	+
	Pycnonotidae		
103	Red-ventedBulbul *Pycnonotus cafer*	+	+
104	Red-whiskered Bulbul *Pycnonotus jacosus*	+	+
105	Black Bulbul *Hypsipetes leucocephalus*	+	+
	Paridae		
106	Great Tit *Parus major*	+	+
	Hirundinidae		
107	Plain Martin *Riparia diluta*	+	+
108	Barn swallow *Hirundo rustica*	+	
109	Red-rumped Swallow *Hirundo daurica*	+	+
	Cisticolidae		
110	Zitting Cisticola *Cisticola juncidus*		+

	Sylviidae		
111	Blyth's Reed Warbler *Acrocephalus dumetorum*		+
112	Common Tailerbird *Orthotomus sutoris*	+	+
113	Common Chiffchaff *Phylloscopus collybita*		+
114	Greenish Warbler *Phylloscopus trochiloides*	+	
115	Puff-throated Babbler *Pellomeum ruficeps*	+	+
116	Stripped Tit Babbler *Macronous gularis*	+	+
117	Jungle Babbler *Turdoides striates*	+	+
	Nectariniidae		
118	Crimson Sunbird *Aethopyga siparaja*		+
	Passeridae		
119	House Sparrow *Passer domesticus*	+	+
120	Chestnut-shouldered Petronia *Petronica xanthocolis*	+	+
121	Grey Wagtail *Motacila cinera*	+	
122	Baya Weaver *Ploceus phillipinus*		+
123	Paddyfield Pipit *Anthus rufulus*		+

3. Total number of bird species in different habitat in two seasons

Habitat type	**Number of birds in Autumn season**	**Number of birds in Spring season**
Open grass land	166	304
Sal forest/grassland	8	37
Sal forest	484	547
Sal/grassland	62	231
Sal mixed forest	23	170
Mix riverine forest	11	44
Mix forest	11	20
Wetland	26	38