

1. INTRODUCTION

1.1 General Background

Nepal, a small mountainous country is remarkable for its great beauty and visual variety. The Himalayan kingdom of Nepal is situated along the southern slope of Himalayas. Most part of the country is young and fragile mountain. It lies between the latitudes of 26^o 20' and 30^o28' N and between the longitudes of 80^o 15' E and 88^o10' E and covers the total area of 187141 km². The country is about 800 km long and 160 km wide. Large variations in altitude (60 m to 8,848 m) (Govil 2000). Within a small span of land area is the country's unique topography.

Although Nepal is small country it has been blessed with diverse biodiversity. The 1992 United Nations Earth Summit in Rio de Janeiro defined "biodiversity" as "the variability among living organisms from all sources, including, 'inter alia', terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems"(www.biodiv.org).

A total of 118 ecosystems, 75 vegetation (biodiv-nepal.gov.np) and 35 forest types have been identified (Sainton1972) in Nepal. Nepal supports globally known 186 mammals, 148 amphibians and reptiles, 847 birds, 185 fish, 641 butterfly, 144 spiders species etc. (BPP 1995).

The great biodiversity of Nepalese fauna is revealed by birds, for of the total species found throughout the entire area of south Asia, half are found along the foothill of Nepal (Shrestha 2000). Nepal is exceptionally rich and diverse in case of avifauna that's why on the basis of avian fauna; Nepal is described as paradise for ornithologist.

Bird Conservation Nepal (BCN) has published an official checklist of birds for Nepal with the total of 862 species (BCN 2006a). This is more than 8% of the total birds species found worldwide. Two species Greater fronted Goose *Aser aliform* and Red -breasted flycatcher *ficedula (Prave) prava* are the latest addition for this list (G.C. 2005 and Chaudhari *at el* 2006). This shows the number could rise in future. Among them around 611 species breed here in Nepal. About 62 species summer visitor or partial migrants and 150 species are winter migratory (Grimmett *et al.*2003). Spiny Babbler is the only endemic species recorded for Nepal.

This is the reflection of unique geographical position, altitudinal variation and climatic differences (Grimmeet *et al.*1991, BCN 2006a). Such a country of diverse contrasts shelters, as may be expected, a unique fauna, of which bird constitute the richest group both in number and variety of forms (Biswas 1960).

According to zoogeographical classification ~~by~~ (Udvardy 1975) Nepal lies at the junction of two big bio-geographic realms, Palaearctic to the north and Indo-Malayan or oriental region to the south. The boundary between two regions is the tree-line at about 3000m (Corbet and Hill 1992). Faunal elements above this altitude have Palearctic affinities (BPP 1995).

As we go from south to north of the country there is continuous increase in elevation, within the distance of 180 km from south to north there is found 60 m to 8848m altitude. Elevation is the main factor that defines the boundaries of the five physiographic zones (High Himalayas, High Mountains, Middle Mountains, Siwalik and Terai) of Nepal, that run as horizontal bands stretching from east to west across Nepal's 800-km length (Govil 2000).

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The climate is tropical in low land to arctic in high peak (Inskipp and Inskipp 1991). Climatologically Nepal is divided into summer and winter. Climate is dominated by the monsoon of south Asia. About 75% of rain falls in summer. The annual summer monsoon rain goes on decreasing as we go from east to west. The mean annual rainfall is maximum in the hilly region of the central part of the country and goes on decreasing both sides (North-South) but northern part receives more than southern. Thus amount of rainfall increases with altitude to maximum and then decreases again (Singha 1984 – 1985).

30 species are considered globally threatened (BLI 2001, 2003) and 133 species (15%) are identified as nationally threatened, furthermore 72 species are thought to be critically threatened or endangered (Baral & Inskipp 2004). 11 species are considered extinct (Inskipp & Inskipp 1991). 145 species are included in CITES. 15 species in appendix I, 103 species in appendix II and 27 in appendix III (UNEP-WCMC 2007). 58 species included in IUCN red data list (IUCN 2006)

Following 9 species are protected by National parks and Wild Life Conservation Act 1973, Government of Nepal. White Stork *Ciconia ciconia*, Black Stork *Ciconia nigra*, Himalayan Monal pheasant *Lophophanes impejanus*, Stry Partridge *Tragopan satrya*, Cheer pheasant *Catreus wallichii*, Bengal florican *Houbaropsis bengalensis*, Lesser Florican *Sypheotides indicia*, Sarus Crane *Grus antigone* and Great Hornbill *Uceros bicornis* (Baral & Inskipp 2004).

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

Avifaunal diversity decreases with increase in altitude (Inskipp1989, Inskipp and Inskipp 1991).The richest area for Nepalese birdlife lies in tropical low land below 300m where more than 500 species have been recorded in the sharp contrast, only about 80 species have been found above 4,270m in alpine zone (inskipp & inskipp 1991).

Kathmandu valley, lies in middle hill (1000- 3000m) and sub-tropical and lower temperate zone. Mixed forest like *Schima-Castanopsis*, *Alnus nepalensis*, and *rhododendron* forest are found surrounding hill of valley. Bagmati, Bishnumati, Manahara river and Taudaha lake are providing good habitat for both forest and wetland birds. One of the best places to observe Mahabharat bird life and changing vegetation pattern is on the southern rim of Kathmandu valley. The unique part of pahar zone supports 412 species of birds (Fleming *et al.* 1984).To date 423 species of birds have been recorded here in Kathmandu valley (Ghimire 2006).

Community Forestry (CF), as name implies has two major components: Forest resources and local communities. The process of establishment and maintenance of the relationships between these two elements could be called as community forestry. The concept of participation by local people in Nepal's forest management was officially initiated in the early 1950s, but it only gained momentum in the early 1970s due to a shift in development thinking and practice (Bartlett and Malla 1992). The forest act 1993 of Nepal decentralized forest management and many village community has now started to manage their own forest resources (Grimmett *et al.* .2000). Main strategy is the handling over of accessible and degraded forest area as community forest to the forest user group (FUG) for proper management and utilization of forest resources.

Community forestry in Nepal is often touted as a successful model for participatory, community-based forest management in developing countries (Timsina 2003) due to (I) legally recognized FUG with legal status, (II) responsibility bestowed up on the FUG for sustainable forest management and biodiversity conservation (III) Freedom to use forest products independently within the framework of constitution and forest operational plan and (IV) provision of the use of FUG fund for community forest development and rural development (DOF 2003/2004). Moreover, rural community forestry groups represent one of the most widespread and rapidly expanding attempts at participatory development (Agarwal 2001). These activities are finally providing bird's habitat in previously degraded area and stopped from degradation of good habitat

Up to Nov. 20 ,2006 total 1,21,19,111 hectere. Of community forest is handed over to 14,337 FUG all over the country. In Kathmandu district only 4,684 area is covered by community forest used by 148 FUG (DOF 2006).

Forests play a crucial role in rural livelihoods in Nepal. In Nepal, for example, agriculture and forestry are linked intimately (Bajracharya 1983, Thapa 1996) and a majority of the population are engaged in agriculture. In most areas of Nepal, agriculture depends on forests for both grazing and fodder collection; supporting livestock that provide manure used to fertilize fields and animal products to feed people. Over 80% of the country's energy is derived from fuel wood, used mostly at the household level (Sharma 1996).

1.2. Aims and Objectives

The main objective of the study was to access the status, seasonal diversity and community composition (habitat utilization) of birds in Satikhel and Dallu community forest of Seshanaraya VDC.

The specific objectives were;

1. To explore the seasonal diversity
2. To access community composition and distribution
3. To explore the habitat utilization of birds in the area.

1.3. Rationale

Although the documentation of bird diversity of Nepal has been carried out by many researchers, however, such study used to focused in protected area and endangered species but lacking in secondary habitat like fragmented community forests. Further detailed study on bird diversity, in this area has not been performed. Therefore, the present study was carried out to identify the seasonal diversity, community composition and habitat utilization birds in the area. The study provides information on effects of forest regeneration of the bird community in relation to habitat improvement. Bird diversity being the indicator of forest condition this study provides status of forest and predicts the presence of other higher mammals too.

2. STUDY AREA

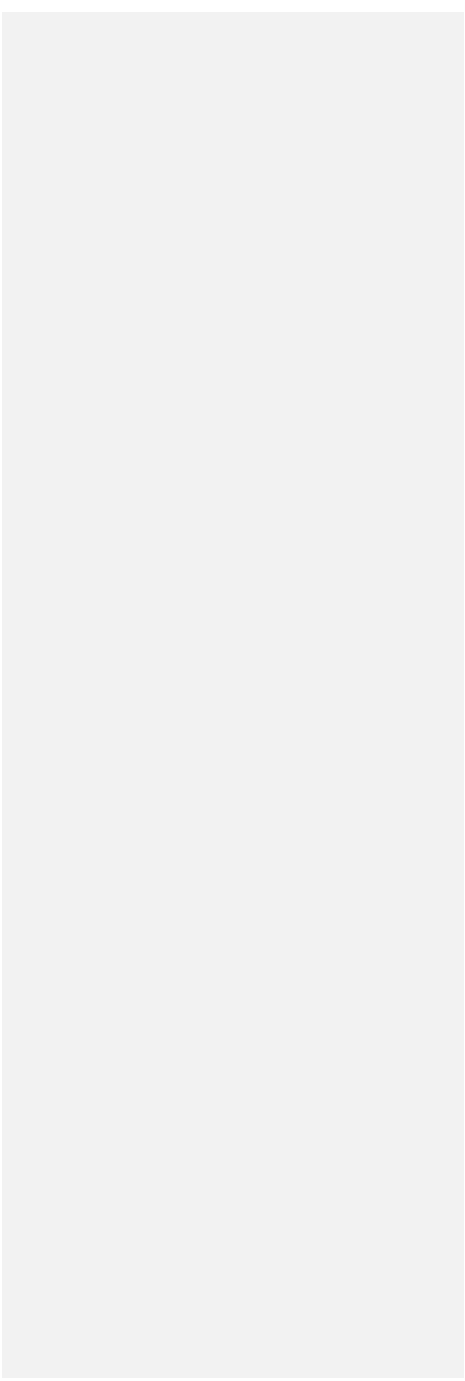
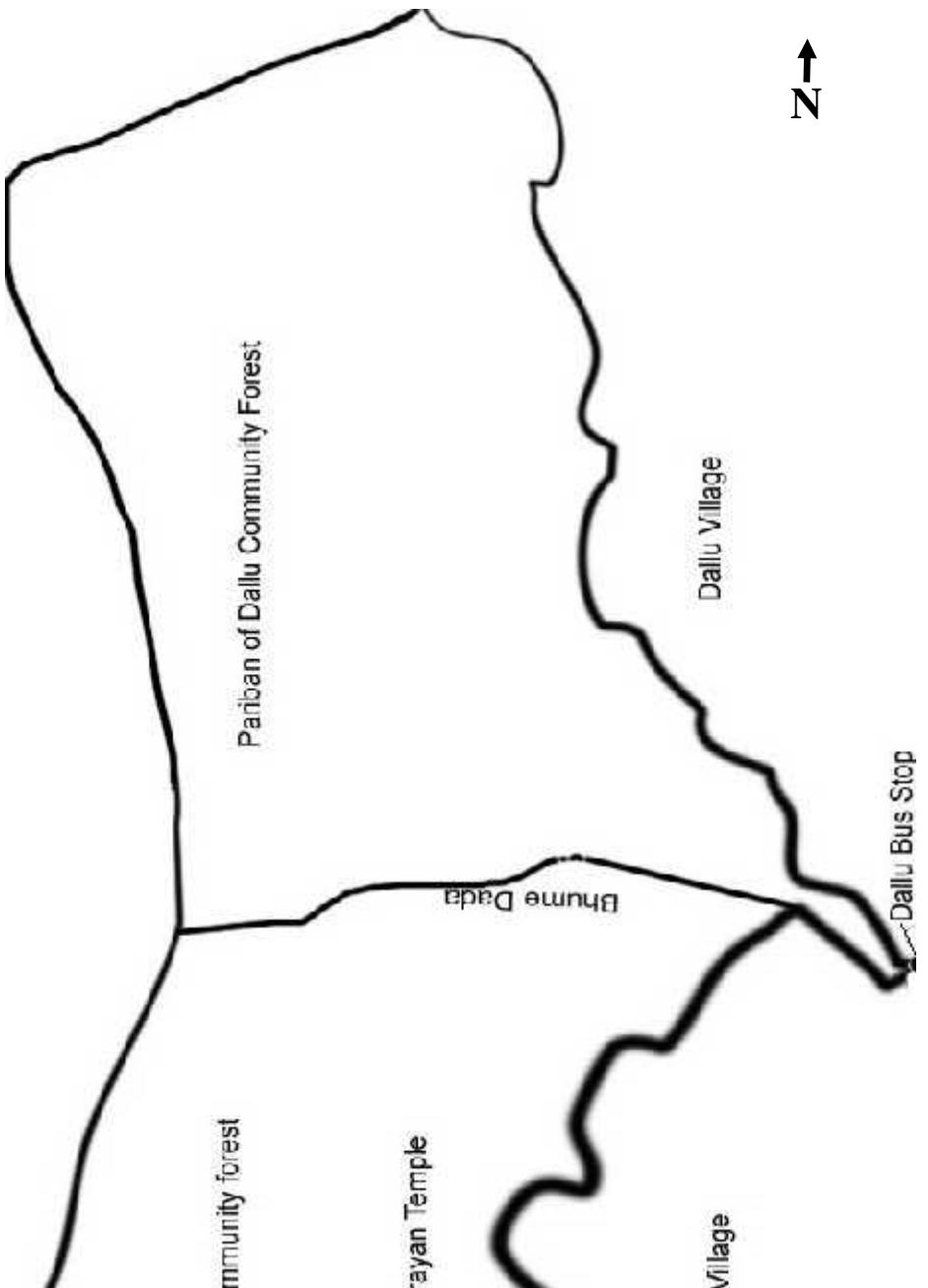
2.1. Location

The study was carried out in Satikhel women community forest and Dallu community forest of Sheshnarayan VDC. It lies at 27°37'22.68" N and 85°15'37.97", southern part of Kathmandu district. In northern part of Seshanarayan temple. Altitude is 5081- 5948 ft, 1693.68-1982.63m from sea level. 6.78km from Balkhu ring road. SCF in eastern part bordered by Satikhel village area, western part by Sanopokhari community forest-, southern part up to Seshanarayan temple and northern part is continuous with pariban area of Dallu community forest. It is divided into Muldol Pakha, Gauridol Pakha and Aaitabare Pakha by users. In eastern part of DCF lie Hattiban community forest, western part Udu Ban, and northern part Chalnakhel Ban and in southern part is Dallu Gaun and Satikhel community forest. Both CF covers 148.50 hec (48.50 and 100 hec). But my intensive study area covers only whole of SCF and Pariban area of DCF which covers 76.27818 hec. (762781.8 m².1499.473 rop.) and surrounding area of Pariban and SCF.

The SCF is registered to District forest office but the DCF is still utilized by forming local forest user group.

2.2. Geology and soil

Study area ~~is~~ is a mountainous terrain-. It is characterized by different types of rocks like limestone. Soil found in this area is Black Clay, Iron containing soil. The soil is light brown in color with poor water retention. Light blackish brown soil with less humus.



2.3. Climatic Condition

The study area is characterized by subtropical in climate dominated by monsoon. Climatological data available (1999 - 2005) were taken from the Khokana, the nearest station from the study area. Most of the rainfall occurs at the month of June and July, similarly January and February receives low amount of rainfall. Highest mean annual rainfall 274.8857mm was in 2003 and 559.8mm in July 1999. January and December are cold months. Temperature generally increases from April and decreases from October. Highest monthly mean temperature ranges from 17.8⁰c to 28⁰c similarly coldest temperature ranges from 1.27⁰c to 14.4⁰c. Mean monthly relative humidity (8.45am.) ranges from 80.8 in May to 95.486 in January.

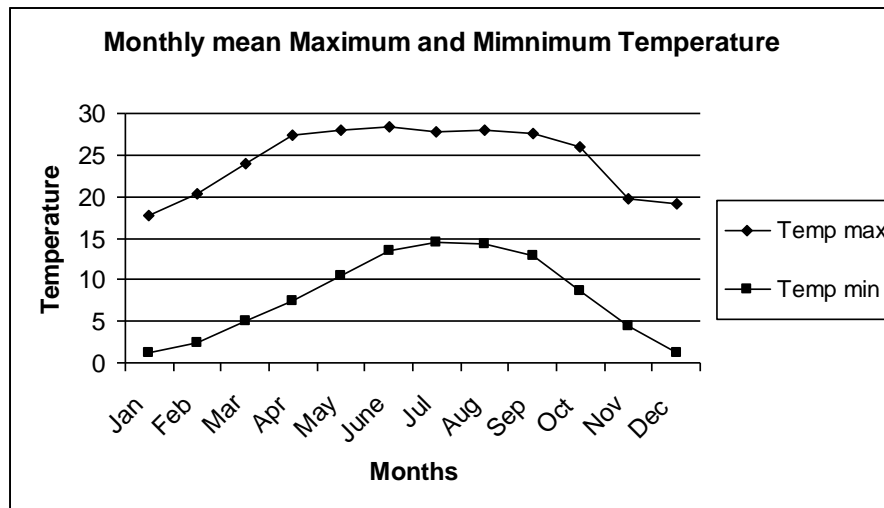
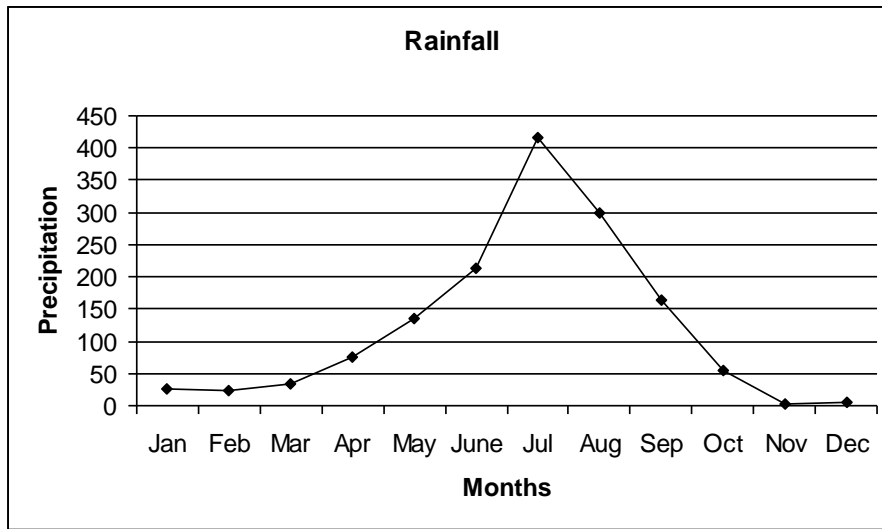


Figure 1: Average Monthly Mean of Maximum and Minimum Temperature at Khokana Station from 1999 to 2005



**Figure 2: Average Monthly Mean Rainfall at Khokana Station
From 1999 to 2005**

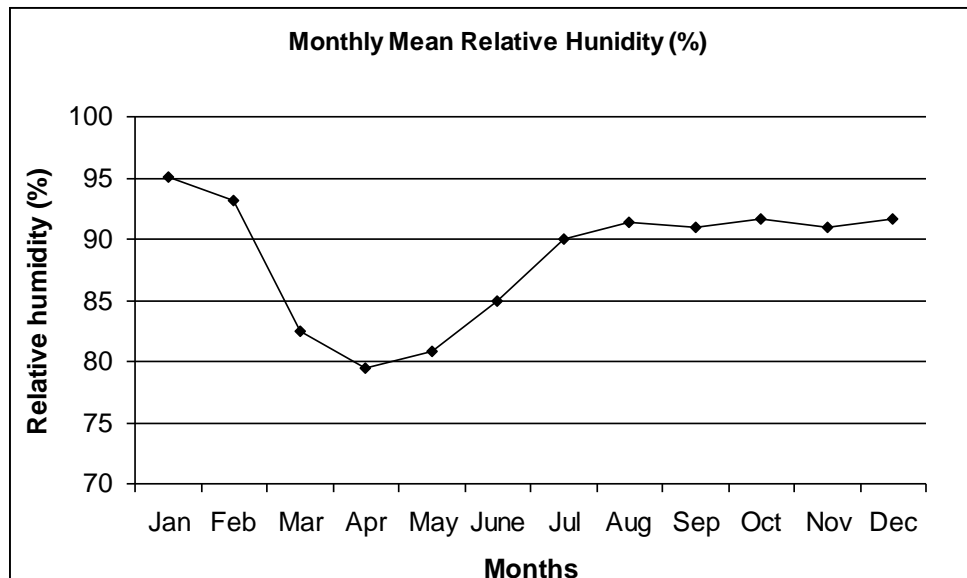


Figure 3: Average Monthly Mean Relative Humidity at Khokana Station from 1999 to 2005

2.4. Biological description

2.4.1. Floral Diversity

The principal vegetation of the study area comprises of typical sub-tropical type forest. Vegetation is dominated by *Schima-castanopsis* type forest. The forest consists of species such as *Schima wallichii* (Chilaune), *Castanopsis indica* (Masure katush) and *Castanopsis tribuloides* (Dhale Katush) on relatively humid areas while *Pinus roxburghii* (Ranisalla) and *Pinus wallichiana* (Gobresalla) forms forests in drier part. Other species of this area are *Myrsine semiserrata* (Setikath), *Myrsine yrsine capitellaata* (Kalikath), Kaphal (*Myrica esculenta*) and *Rhodendron arboreum* (Gurash):-

2.4.2. Faunal Diversity

Faunal inventory in the study area is still to be done. Although the forest is on growing stage, it being connected with other forest supports some mammals. Common mammalian species of study area includes Rhesus Monkey (*Macaca mulatta*), Purcupine (*Hystrix indica*), barking deer (*Muntiacus muntjack*), Jungle cat (*Civet*), Jackal (*Canis aureus*), Common leopard (*Panthera pardus*) and Flying Squirrel (*Petaurista sp.*).

2.4.3. Socio-economic Aspect

The Satikhel and Dallu community forest is used by the villagers of Seshanarayan VDC. Ward number 4, 5, 6, 7,8and 9. There are total 377 house holds. Total population is 1862, among them 1036 are male and 930 are

female. Residential people in these villages are Tamang, Brahman, Newar, Chhetri, Rai, and Lama. Agriculture, Animal husbandry and harvesting of forest product are the major economic activities of the area .livestock are the important component of agricultural system. Thus the forest products are used for various purposes like manure, fuel wood, fooder etc.

3. MATERIALS AND METHOD

3.1. Preliminary survey

Preliminary survey of the study area was done from March 5 to March 10/2006. During the survey, boundary, condition and situation of forest were identified with discussion with supervisor , bird experts from BCN, local people and members of community forest .Then the study area was surveyed by walking in different part of forest to identify characteristics of study area.

3.2. Materials

Birds were observed with the help of binocular (**OLYMPUS, 8-16x 40**). During observation name of birds, number, habitat and activity were noted. “Birds of Nepal” hand book (Grimmet *et al.* 2000, 2003) was used as field guide to identify observed birds. For record handycam (**DCR- DVD203 NTSC**) and photo shoot (**Nikon D50 with DG 300 mm lens**).Some familiar call giving birds like Indian Cuckoo, Asian ~~koel~~-Koel and ~~blue~~-Blue-throated Barbet were recorded by their call. And other unfamiliar calls were recorded and identified later on by the help of CD Rom by (Scott 1993) and bird specialist of BCN

3.2. Line transect sampling

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Line transects involve the observer continually walking and recording all contacts either side of the track walked. Four lines transect/ fixed walking routes were laid down to cover all habitat types and area of the study site as well. Due to steepness and denseness nature of the study open width line transect was chosen (Bibby *et al.* 1992 & Rodgers 1991).

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Each transect was visited 3 times every month during, early morning, the time of highest activity of birds. During bird census, birds were observed and counted either side of transects, walking slowly. Only the birds of in front and either side of observer were recorded- those behind were not. Where transect ended, birds beyond the end point were not counted. Distant birds only detectable with the help of binocular were not searched for. In each season, population of the observed birds was estimated by direct count counting (as Kopij 2002). The actual number of birds (population) were used was used for quantitative analysis.

- 1)i. Transect 1- along the Dallu River (length = 1000m.) This transect covered all parts of Pariban area of Dallu CF bordering with ~~Agricultural~~ agricultural fields with along Dallu river.
- 2)ii. Transect 2- along the eastern boundary of SCF (length = 550m). It covered agricultural land, human settlements and bushes ~~if within~~ the C.F.
- 3)iii. Transect 3- along the Aaitabare Pakha and part of ~~pariba~~ Pariban area of the C.F. (length = 400m.). It covered the bushes and pine forest.

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- iv. Transect 4 - It runs horizontally along the Muldol Pakha and ends up over the Seshanarayan Temple Length = (350m).

3.4 Data Analysis

3.4.1 Shannon's Index of Species diversity

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

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

or

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

3.4.2 Evenness index

$$e = \frac{\bar{H}}{\log S}$$

Where,

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

ni = importance value for each species is the number of individuals in each species; the abundance of each species.

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

N = total of importance value, total number of individuals observed.

e = evenness index.

$p_i = \frac{n_i}{N}$ = The relative abundance of each species, calculated as the proportion of individuals of a given species to the total number of individuals in the community.

3.4.3 Relative abundance

Species abundance is the number of individuals per species, and relative abundance refers to the evenness of distribution of individuals among species in a community. Two communities may be equally rich in species but differ in relative abundance.

Relative abundance or % of dominance = $\frac{ni}{N} \times 100$, (as Kopy 2002).

Species abundance is the number of individuals per species, and relative abundance refers to the evenness of distribution of individuals among species in a community.

3.4.4 Feeding guild analysis

Qualitative analysis was done for the feeding guild. (Ojha 2004), bird experts informations were used and google search was done.

3.5. Time schedule

Field Survey was carried out over a period of three seasons (Summer season-June, July and August, Autumn season-September, October and November, Spring Season- March, April and May). Which include five month form May 2006 to November 2006 as follow.

- 1) Spring season- May
- 2) Summer season- July and August
- 3) Autumn season- October and November

Finally a bird list was compiled by careful recording of all birds observed. The bird list followed the systematic order, common name and scientific names were taken from (Grimatte *et al.* 2000 and BCN 2006a).

4. RESULTS

4.1. Bird Diversity

~~I recorded One hundred and eighteen~~ ~~I recorded One hundred and eighteen~~ One hundred and eighteen ~~I recorded One hundred and eighteen~~ species of birds belonging to 10 ~~orders~~ ~~orders~~ and 29 ~~families~~ ~~families~~ during the study period were recorded. This is 28% (27.83019%) for the total list of Kathmandu and 14% (13.6891%) on the national scale. The Red-vented Bulbul *Pycnonotus cafer* has highest relative abundance (~~8.446582~~) followed by Grey-hooded Warbler *Seicercus xanthoschistos*, Grey Treepie *Dendrocitta formosae* and Black Bulbul *Hypsipetes leucocephalus*. Similarly Darjeeling Woodpecker *Dendrocopos darjellensis*, Bay Woodpecker *Blythipicus*

pyrrhotis, Common Snipe *Gallinago gallinago*, Large Cuckooshrike *Coracina macei*, Rufous-gorgeted Flycatcher *Ficedula strophciata*, Pale Blue Flycatcher *Cyornis unicolor*, Aberrant Bush Warbler *Cettia flavolivacea* have least relative abundance. ~~Only a single endemic bird to Nepal,~~ The Spiny Babbler *Turdoides nipalensis* was also recorded. (Annex I)

4.2. Seasonal Diversity of Birds

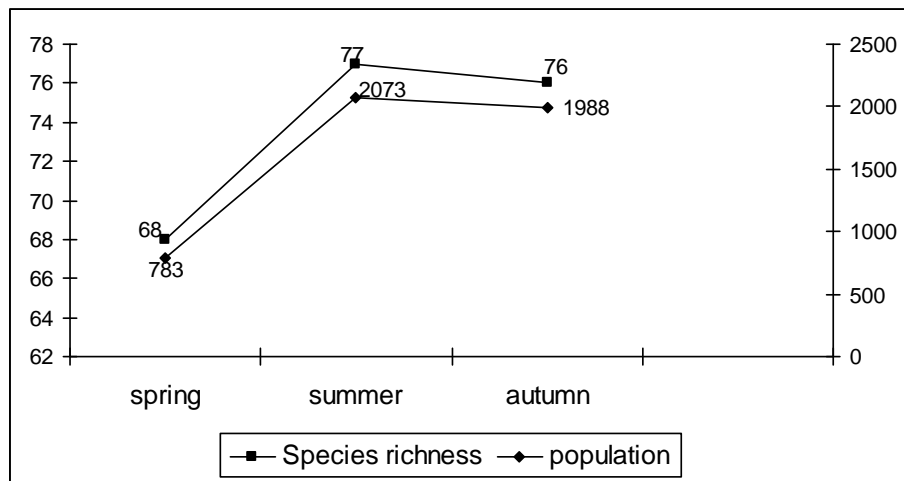


Figure 4 : Species Richness and Population of Birds.

4.2.1. Bird Diversity in Spring, Annex II

In spring season, the species richness, index of diversity and evenness were species richness $S = 68$, index of diversity $\bar{H} = 1.59533$ and evenness index $e = 0.870571$ respectively. The Population size of the bird in the area was 783. Among them dominant bird species was Red-vented Bulbul *Pycnonotus cafer* with highest relative abundance followed by Grey-hooded Warbler *Seicercus xanthoschistos*, Spotted Dove *Streptopelia chinensis*, Black Drongo *Dicrurus leucophaeus* and Black-throated Tit *Aegithalos concinnus*. Least relative abundance species were Darjeeling Woodpecker *Dendrocopos darjellensis*, Bay Woodpecker *Blythipicus pyrrhotis* and Paddy Field Pipit *Anthus rufulus*.

4.2.2 Bird diversity in Summer, Annex III

In summer season species richness $S = 77$, index of diversity $\bar{H} = 1.60408$, evenness index $e = 0.850298$ and total population was 2073. Among them dominant species with highest relative abundant was Grey-hooded warbler *Seicercus xanthoschistos*, followed by Red-vented Bulbul *Pycnonotus cafer*, Grey Treepie *Dendrocitta formosae*, and Rusty-cheeked scimitar Babbler *Pomatorhinus erythrogenys* and Black-chinned Babbler *Stachyris pyrrhops*. Similarly, Indian Cuckoo *Cuculus micropterus*, Grey Nightjar *Caprimulgus indicus*, Jungle Babbler *Turdoides striatus*, Orange-headed Thrush *Zoothera citrina* and White-rumped Munia *Lonchura striata* have least relative abundance.

4.2.3. Bird diversity in Autumn, Annex IV

In autumn season species richness $S = 76$, index of diversity $\bar{H} = 1.56484$, evenness index $e = 0.839812$ and population was 1988. Black Bulbul *Hypsipetes leucocephalus* has highest relative abundance followed by Red-vented Bulbul *Pycnonotus cafer*, Grey-hooded Warbler *Seicercus xanthoschistos*, Grey Treepie *Dendrocitta formosae* and Himalayan Bulbul *Pycnonotus leucogenys*. And Rufous-gorgeted Flycatcher *Ficedula strophciata*, Aberrant Bush warbler *Cettia flavolivacea*, Spiny Babbler *Turdoides nipalensis*, Blyths' Reed Warbler *Acrocephalus dumetorum* similarly Jungle Myna *Acridotheres fuscus*, Blue-fronted Redstart *Phoenicurus frontalis* and Hodgson's Redstart *Phoenicurus hodgsoni* have least relative abundance

Table 1 : Classification according to Order Family and number of birds

Order		Family	NBS
1	GALLIFORMES	1 Phasianidae	1
2	PICIFORMES	2 Picidae	4
		3 Magalaimidae	2
3	CORACIIFORMES	4 Dacelonidae	1
4	CUCULIFORMES	5 Cuculidae	5
5	PISTTACIFORMES	6 Psittacidae	1
6	APODIFORMES	7 Apodidae	1
7	STRIGIFORMES	8 Strigidae	1
		9 Caprimulgidae	1
8	COLUMBIFORMES	10 Columbidae	2
9	CICONIFORMES	11 Scolopacidae	1
		12 Accipitridae	5
		13 Falconnidae	2
		14 Ardeidae	2
10	PASSERIFORMES	15 Laniidae	2
		16 Corvidae	16
		17 Muscicapidae	21
		18 Sturnidae	3
		19 Sittidae	2

		20	Paridae	3
		21	Aegithalidae	1
		22	Hirudinidae	2
		23	Pycnontidae	4
		24	Cisticolidae	1
		25	Zosteropidae	1
		26	Sylviidae	18
		27	Nectariniidae	4
		28	Passiridae	9
		29	Fringillidae	2
10		29		118

NBS- Number of birds species

4.3. Distribution of birds in transect

The distribution of bird species in transects were not evenly distributed. Only 32 birds species were recorded from Transect 1. Similarly, 6 bird species from Transect 2, 5 from 3 and 2 from Transect 4 were observed. Remaining birds were found in the combination of transects. 11 species Birds were recorded from all transects in all seasons. They were Oriental Turtle Dove, Spotted Dove, Grey Treepie, Great Tit, Green Back Tit, Black-lored

tit , Himalayan Bulbul, Red-vented Bulbul, Rusty-checked Scimitar Babbler, Streak-breasted babbler, Black-chinned Babbler.

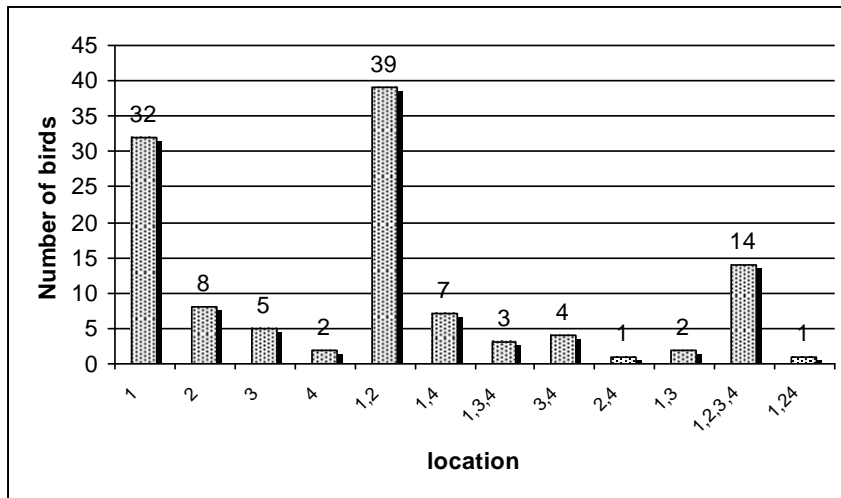
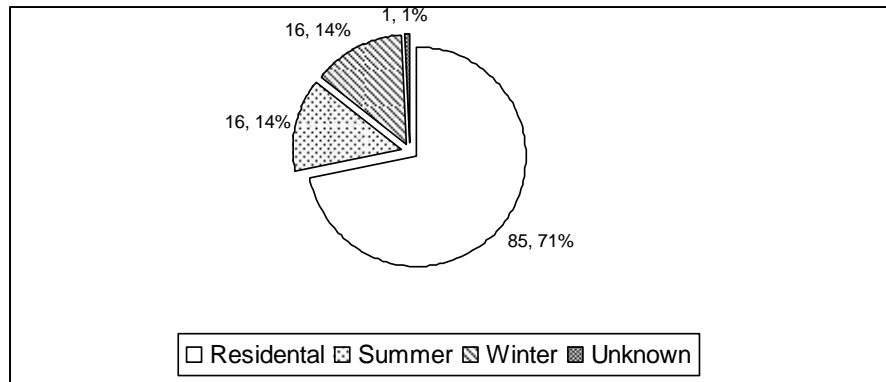


Figure 5 : Distribution of Birds in Different Transect (From Annex I)

4.4. Migratory Pattern

This study in spring, autumn and summer season. During the study period some of the winter migratory birds were observed in late autumn so they are classified as residential, summer and winter visitors. Similarly,

some of the birds were found to be use habitat in different altitude in different seasons. So, these species are categorized as the local migratory species.



**Figure 6 : Number of Birds Represented by Migratory Status
(From Annex I)**

4.5. Local Abundance Category

Abundance of the species was estimated from transect counts during observation. On the basis of population status, birds are further categorized in to very common, common, fairly common, uncommon and rare. Each category have different population and relative abundance category. (Annex I)

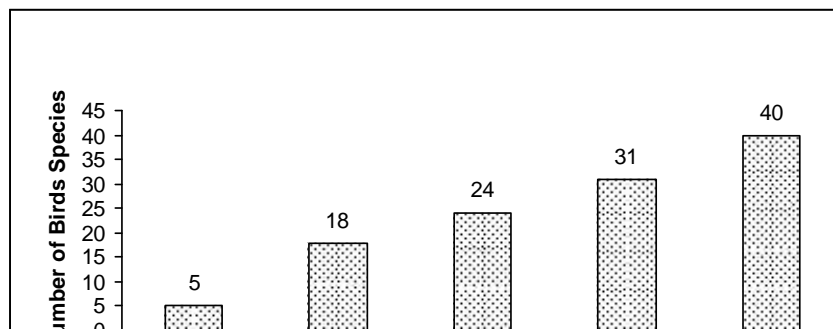


Figure 7 : Number of Birds Represented by their Relative Abundance (From Annex I and V)

4.6. Threatened Birds

A threatened species, Pale Blue Flycatcher *Cyornis unicolor* (VU) and following nine species are included in CITES Appendix were recorded. Among them eight species were in Appendix II and a single species was in Appendix III.

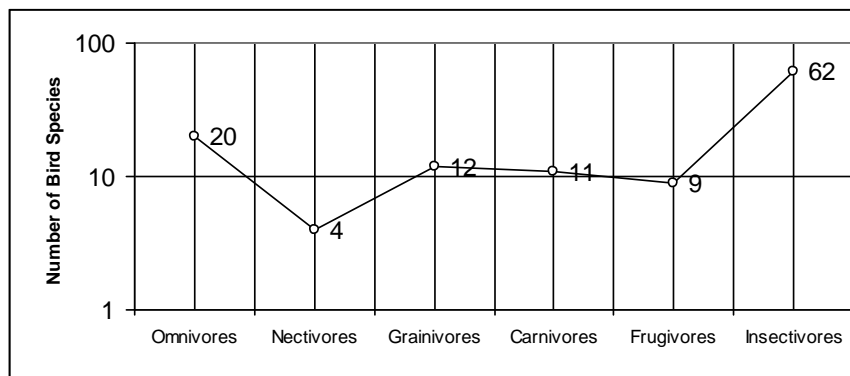
Table 2 : Birds Included in CITES List

S.N.	Names of Birds	Scientific Name	Appendix
1	Rose-ringed Parakeet	<i>Psittacula krameri</i>	III
2	Black Kite	<i>Mulvus migrans</i>	II
3	Himalayan Griffon	<i>Gyps himalayensis</i>	II
4	Besra	<i>Accipiter virgatus</i>	II

5	Common Buzzard	<i>Buteo buteo</i>	II
6	Steppe Eagle	<i>Aquila nipalensis</i>	II
7	Common Kestrel	<i>Falco tinnunculus</i>	II
8	Eurasian Hobby	<i>Falco subbuteo</i>	II
9	Cattle Egret	<i>Bubulcus ibis</i>	II

4.7. Feeding Gulid

Among the total 118 species, six feeding gulid category were recorded. Among them insectivores birds were highest in number and nectivores were least in number.



ing Gulid (From Annex I)

4.8. Habit utilization

- 1) **Forest:** Forest covers largest area which is the most important habitat in the area. The forest is mixed secondary and open canopy forest in some parts and closed undergrowth forest in other parts. Broad leaved forest is the most dominated forest which is associated with Pinus species. Many trees are on young stage however some of *Schima wallichii* are very old and scattered. In the lower part of Gauridol and Aaitabare Pakha only bush / secondary growth of ~~*Sschima-eastanopsis*~~ *Castanopsis* is found. Aaitabare Pakha is dominated dry pinus forest. *Myrsine forest* dominated in Muldol pakha most of the trees are growing as open canopy. Many parts are covered by dense bush which is not still shifted. Pariban Pakha dominated with *schima-castanopsis* forest, more wet forest than other area comparatively. A small trace of swampy habitat is also found at Aaitabare Pakha near water reservoir. 55 species of vegetation recorded is given in Annex VI. Scientific and family name was followed as (Shrestha 1998).
- 2) **Riverine habitat:** Dallu khola/river lies along the edge of pariban area this is small and perinial source of water .This is harvested for irrigation in agricultural lands in dallu village and for drinking purpose in pharping area .
- 3) **Agricultural land and human settlement:** Along the eastern side of Sathikhel community forest and nort-east of Pariban area there is human settlement and agricultural land. Satikhel is more associated with agricultural and human settlement in lower elevation then pariban area.

4.8.1. Habitat Association

Observed birds are further categorized in different group depending upon their major habitat utilizations pattern. Since a single species can found in many types of habitat so these habitat are selected in which it depend much. Birds associated with broad-leaved forest, coniferous forest, forest edge, Open forest, Bush, Secondary Growth, all are grouped in forest category.

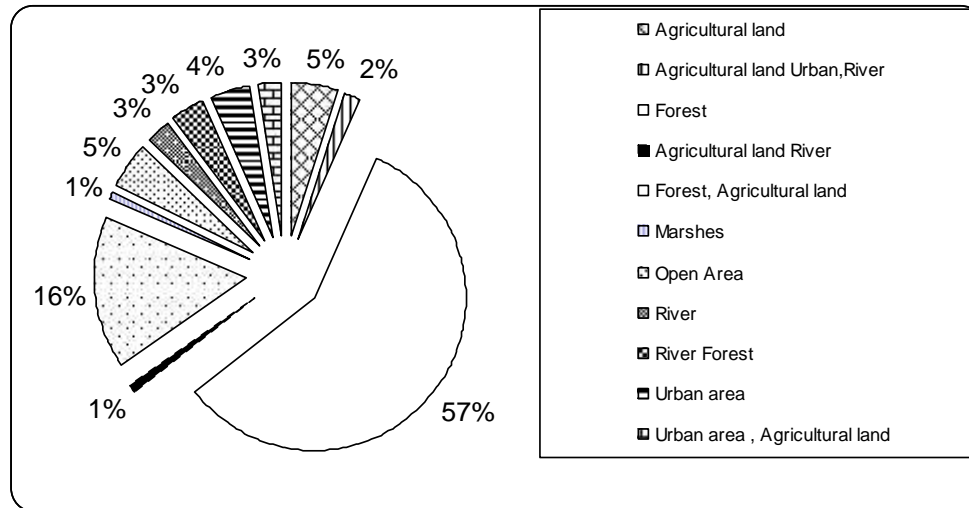


Figure 9: Number of Birds Associated with Different Habitat (Annex I)

4.9. Threats to birds

- Road- noise pollution- Vehicles that run on the Kathmandu-Dakshinkali road was the cause of noise pollution in that area. Especially near the Seshanarayan Temple less number of birds were recorded than expected.
- Traditional collection of forest product; Logging- During summer season shifting of pine branch and cutting of big pine trees was noticed which is the breeding season of birds.
- Water harvesting – The water of Dallu river was harvested for drinking and irrigation in fields as a result very low amount of water remains in the river channel.
- Cattle grazing – Illegal cattle grazing practice was found at the ridge of forest from non members of community forest. There are two ponds at the ridge where, buffalos, oxen and cows are brought there.
- Human activities- Inside the forest bottles of water, covers of biscuits, noodles and other plastics were found that indicates there is a human activity in large scale. Further there were many flags of Buddhist in forests.

- Accidental forest fire- In Muldol Pakha near the agriculture land there was found a patch of forest bush caught by fire. However nobody said how the forest was caught by fire that may be accidental fire from the agriculture land.
- Illegal hunting and poaching- Although these forest are better protected by FUGS, some villagers were found accepted, there is still poaching of game bird like Kalij pheasant.

5. DISCUSSION ~~This research has been carried out with the prime objective of determining seasonal diversity of birds, status habitat utilization and distribution of them in different area on the basis of habitat utilization for the partial fulfillment of my MSC Degree as a thesis work.—~~

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Community forests were the previously degraded forest but due to proper conservation birds are finding suitable habitats. Result of this work shows these forest patches now form an important part of the remaining wildlife habitats. This work has been carried out with the prime objective of determining seasonal diversity of birds, status habitat utilization and distribution of them in different area on the basis of habitat utilization for the partial fulfillment of my MSC degree as a thesis work

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In this study area 118 of birds during my three season period, five months intensive field visit. This is 28% (27.83019%) for the total list of Kathmandu and 14% (13.6891%) in national scale. If this result is compared in case of area and status of forest this number is surprisingly high. Bird Conservation Nepal has recorded 54 species during its one day bird watching programme (BCN 2005a). Although my result follow the same trend some species didn't recorded they recorded in this list. Similarly (Basnet *et al.* 2005) have recorded 110 bird species from Raja Rani Community forest, Morang. (Ojha 2004) has recorded 85 species from Setidedevi community forest, Bhaktapur. (BCN 2005b) has recorded 48 species from Thankot-Matatirtha area on its one day bird watching trip. Such variation may be due to different study area, condition of habitat, time and duration of intensive field visit.

Such high species richness was the result of combination of many habitats in this area. It assumes that structurally complex habitats may provide more niches and diverse ways of exploiting the environmental resources and thus increase species diversity (Bazzaz, 1975). Generally, habitats with a complex architecture support more species than habitats with a simple architecture because they provide more resources and/or opportunities for microhabitat segregation (Vickery *et al.* 2001). The 'habitat heterogeneity hypothesis' is one of the cornerstones of ecology (MacArthur & Wilson, 1967 in Tews *et al.* 2004).

Although the species diversity is high only one nationally threatened, Pale Blue Flycatcher, *Cyornis unicolor* and nine species belonging to cites category were recorded .Generally many of the threatened forest bird require dense or moist condition, a well developed understory and epiphytic growth (Baral and Inskipp 2004). Epiphytes

contribute to ecosystem processes such as nutrient cycling because they gain access to nutrient sources originating outside the ecosystem and transfer them to other members of the forest, thus functioning as a "keystone" resource (Nalini 1994). And many nationally threatened birds are low land (75- 1000), (Baral and Inskipp 2004)

Species richness in summer was highest i.e. 77 followed by autumn 76 and spring 69. This variation is due to climatic and biotic factors which used to vary in different seasons. The amount of energy available in a system (often measured as primary productivity) is thought to be one of the major determinants of species diversity, especially species richness (Bailey *et al.* 2004). Many residential and migratory birds were found associated with bush and secondary growth in my study which shows the growing stage of forest.

85 species were residential, 16 summer visitors and 16 winter visitors. Migratory pattern- of Dusky Thrush (*Turdus nurmani*) according to (Grimmett *et al.* 2000, 2003, Inskipp and Inskipp 1985 and Shrestha 2001) this species is a winter visitor. But it breeds here, observed in summer season 2 adults with 2 chicks. Although my study was not carried out during winter winter visitors were recorded in late autumn season. This may be due to availability of water resources, which is an important factor for winter visitor birds (Rafe *et al.* 1985). Some of the birds were found to use habitats in different altitudes in different seasons. So, these species are categorized as local migratory species. Many of Nepal's resident species are seasonal altitudinal migrants. The level to which they descend in winter depends on weather conditions (Inskipp and Inskipp 1991).

Forest is the most important habitat in this area about 68 species (57%) birds use this habitat in my result. Bird species richness has long been linked to habitat characteristics, in particular structural complexity. (MacArthur and MacArthur 1961) has proposed general rule for high bird diversity as follow (I) The amount of vegetation, measured in area of leaves per unit volume of space, which lie in three horizontal layer corresponding to herbs shrubs and trees over 25' tall trees. (II) The three layers have equal amount of foliage. (III) Bushy field and other early stage of forest. Thus more species may co-occur per unit area, leading to a positive correlation between bird diversity and structural diversity (MacNelly *et al.* 2001). Variety of elements contribute to habitat structure including vertical and horizontal zonation and patchiness of the vegetation (Willson 1974), structural elements of vegetation, such as the distribution and size of trees (MacNelly 1990), and provision of resources. Ground cover and litter are also key components structural diversity. Both area and habitat diversity influence species richness. The number of species is better correlated with a measure of habitat diversity than with area, but these two factors are themselves strongly correlated (Rafe *et al.* 1985)

Dominant forest of sub-tropical forest is *schima-castanopsis* and coniferous species. Between them *Schima-Castanopsis* forest is rich in bird diversity (Grimmet *et al* 2000, 2001 and inskipp1989). In my result also 22 bird species were broadleaved forest and coniferous forest associated only 3 species. Habitat availability for cavity-nesting birds will tend to be greatest in older broad-leaved forests, but coniferous plantations rarely reach a stage where decay or damage provide suitable nest holes(O'Halloran *et al.* 2002). Another factor for the low bird

diversity in coniferous forest is due to predation effect. A low level of illumination, such as that found in very dense areas dominated by coniferous trees, has a negative effect on foraging efficiency (Kacelnik 1979). The overall use of bird feeders was greater in more illuminated areas dominated by deciduous trees, and smaller in dark locations with high pine densities. More illuminated forest patches have better visibility, which may enhance detection of predators, increasing the likelihood of an effective escape (Kaby and Lind 2003). A low level of illumination, such as that found in very dense areas dominated by coniferous trees, has a negative effect on foraging efficiency (Kacelnik 1979)). Thus, birds avoid foraging under low light conditions when risk of predation is high (Krams 2000). Thus higher number of broadleaved trees present also has higher number of breeding bird species. No significant relationship between number of coniferous species and the number of bird species (O'Halloran 2002). But some species found breed in pine trees like Eurasian Hobby and Blue-capped Rock Thrush (Grimmet *et al.*200). Both bird species richness and density are minimal in coniferous forests characterized by high tree density, low canopy, and few species of trees. These patterns are not discernible by the classic bird species diversity/foilage height diversity method proposed by (Mac Arthur and Mac Arthur 1961)

Species richness in Transect I compared to III and IV due to structural complexity as (MacArthur and MacArthur 1961) and another factor was availability of water resource, (Dallu khola is perennial source of water present there). It has been suggested that riparian zones, when compared with upslope areas, are characterized by: (I) denser, more diverse, more productive vegetation; (ii) distinctive and diverse vertebrate assemblages especially

bird diversity (iii) greater invertebrate productivity (Hewitt 1990, Gregory *et al.* 1991 and Doyle 1990) and rivers, with their associated vegetation, are crucial sources of food and refuge for birds (Carothers *et al.* 1974). Similarly, Silva (1996) found that the importance of the river decreases with increasing distance from the source area because low species richness was found in other transects.

House crow (*Corvus splendens*) a very familiar bird to every Nepalese people was uncommon here (population 18, relative abundance 0.376333). This species presents great ecological flexibility, as well as an obligate association with human presence, to the extent that no populations are known to live independently of man. The house crows are known to be excellent invaders, reaching pest status in most of their introduced range. Breeding in a temperate climatic region, is key indication the potentially broad tolerances of this species, at least with human subsidy (Ryall 2002). Invaded areas are mainly urban or semi urban, where house crows benefit from improper human food and refuse handling: commercial areas, public housing areas and urban parks are associated with higher abundance (Lim *et al.* 2003). House crows spread to adjacent areas for nesting and roosting, often forage in farmland near forests, and can reduce populations of resident bird species markedly (Ryall 1992). House crow populations also have the potential to affect human health, serving as reservoirs of human diarrheal diseases (al-Sallami 1991).

Some forest edge species associated with other habitat recorded in this area are: White-throated kingfisher(AG,R,FE), Fulvous-breasted woodpecker(FE,OF), Small Niltava (BU,R,FE), Black-lored Tit (OF,FE),

Blyth's Reed warbler (AG,FE), Common Tailor Bird (FE,SG,G), Grey Bushchat (SG,FE), Blyth's Leaf Warbler (FE,BU).(Bender *et al.*1998 in Imbeau *et al.* 2003) categorised individual species' responses according to three possible types of habitat use within patches: 1) edge species, which are associated primarily with the perimeter of a habitat patch and not the core; 2) interior species, which are associated with the centre of patch sand 3) interior-edge generalist species, which utilize both edge and interior habitats. In such a framework, edge species are believed to be associated to the greater vegetative complexity usually found at forest boundaries or to require the simultaneous availability of more than one type of habitat (Matlack and Litvaitis 199). Based on these results, I agree with and (Hunter 1990 in Imbeau *et al.* 2003) that “real edge species” are probably quite rare.

The kalij Pheasant (*Lophura leucomelanos*), a popular game bird of Nepal (Chhetri 2002), found widely in dense broadleaf forest of middle hills was uncommon here , but the population must be high because of their forage time and my field visiting used to differ. The species mainly prefers closed forest of *Schima walichii* with high understory. They may also occur in low understory terraced field and open forest (Gautam and Baral 2002).

Species richness decrease from natural forest and young secondary forest to agroforestry systems and annual cultures. Species composition gradually changed as the habitat changed from natural to secondary forest, agroforestry systems, and annual cultures (Matthias et al. 2004). I found same result in figure 8. We can see that bird diversity is decreased form forest to agricultural land and human settlement. In Nepal only 76 species (16%)

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of all the forest birds which have adapted to breed in habitats heavily modified or created by man. Once they believed to breed in forest (Inskipp 1989).

Agricultural bird species those representing one of the following groups: (i) true field species, that both breed and feed on fields; (ii) edge species, mainly breeding and feeding on bushy verges; (iii) forest species, breeding in forest woodlots but feeding on fields; and (iv) farmyard species, nesting in farmyards around fields but feeding on fields (Tiainen & Pakkala 2001). Breeding densities of several agricultural bird species has been positively correlated with the proportion of pasture, and the amount of shrubs and trees in a pasture has been found to affect the abundance of farmland birds in Sweden (Part & Soderstrom 1999). In an agricultural environment, as in my study area and result the presence of both woodland and wetland is important for increasing the number of both breeding and wintering species (Rafe *et al.* 1985). The factors affecting diversity in agroforests may involve reduced tree height, canopy foliage volume, vertical diversity of the vegetation structure, floristic richness, and associated variety of food resources (Thiollay 1995).

Towards the human settlement adjacent to natural areas in simplified habitats and a community of birds with fewer species dominated by abundant non-native species to forest were abundant like; House Crow and sparrow.

Vegetation is invariably altered with urbanization. Suburban areas rarely include the full complement of vertical strata found in natural forests (Beissinger and Osborne 1982), and native plant species are often removed

or replaced by exotic ornamentals this is the reason for low species richness of birds in urban area. the number of species declines with increasing urbanization and that the remaining group of species is/was dominated by highly abundant species (Emlen 1974), like red vented Bulbul, Black Drongo, House Crow, Two species of Sparrow, Indian Macpie Robin and Common Myna etc. Birds may respond directly to local characteristics of the vegetation within urban habitats, but may also respond to broader landscape features including the proximity of large forested areas so that forest species were recorded in urban area during may study.

Near the Seshanarayan Temple abundance of birds was very low. There were found only familiar call giving birds like Red-vented Bulbul, black bulbul, Eurasian cokoo although this area contain the habitat structure suitable for birds diversity as stated by many author above. This may be due to noise pollution produced vehicles, there used to be echo. (Frank 2003) has found that bird diversity and community structure is affected by noise pollution. Behavioural research shows that birds may adopt new mode of vocal behaviour as response to increased noise: (Bregen and Abs 1997) found that Great Tit (*Parus major*) in area with considerable traffic noise starts singing earliar in the morning than elsewhere.

Black Drongo (*Dicrurus macrocerus*) residential bird of Nepal, common was observed in spring and summer but not a single species was recorded from autumn season. Migration of this birds in Nepal is not done. But work on in Thailand (Robert et. al 2004) has counted 11,290 migration Black Drongos in between 27 September primarily between 07h45 and 17h45.

Although many common birds recorded are resistant to human disturbance and able to adapt in degraded forest but some species like pied Thrush (*Zoothera wardii*) and Dusky thrush (*Turdus naumanni*) were recorded. According to (Grant and Stuart 2004) species successfully use secondary habitat might be species of lesser concern for immediate conservation action some species seem ecologically plastic and often appear in highly modified habitat i.e. .degraded forest and secondary forest they might have been able to survive in drier forest.

Steppe Eagle (*Aquila nipalensis*) residential and breeding birds throughout the Punjab side and lowland area of Baluchistan (T. J. Roberts 1991) is winter visitor, passage migrant to Nepal (–Grimmet *et al.* 2000). The migration of Steppe Eagles along the Himalayas was first referred to (Donald 1923). (Fleming 1983) estimated that possibly 45,000 eagles migrating west through Nepal and (de Roder 1989) 10,000-20,000 Steppe Eagles pass through Nepal each autumn. 10, 000 individuals migrant somewhere west to India, according to him c. 50- 100 % of Steep Eagles migrating through Nepal. But about 40% fewer individuals were recorded during spring than autumn due to winter mortality (Besten 2004).

Avian usage of dead wood mainly involves ‘snags’ (standing dead trees or tall remnants), rather than ‘logs’ (fallen trees), in the North American terminology. Dead trees, or old, partly decayed trees, provide structural complexity, particularly by providing nest cavities for birds like tits, and Nuthaches. Most cavities thus become available through fungal and insect damage. Fungal damage to living trees can also provide cavities. That snag or

dead limbs less than 10 cm in diameter tend to be of little or no use as nest-sites for cavity-nesting birds. Old forests typically have large amounts of dead (J. O'Halloran 2002).

Indicator species are expected to indicate the status of the environment or to serve as proxies for a larger number of species (Furness & Greenwood 1993) Woodpecker species (family Picidae) are attractive candidates for indicators of forest biodiversity in Europe (Scherzinger 1998). Most woodpeckers are dependent on trees for nesting sites, and many of them forage on trees and dead wood found only in forested landscapes. We analyzed the usefulness of woodpecker species in indicating the diversity of other forest birds at the landscape scale (Mikusinski Grzegorz *et al.* 2001). Their results suggest the usefulness of woodpeckers as a broad indicator system for assessing forest biodiversity. Although such type of study is not carried out in Asia. In my result only three species of Picidae – Speckled Piculet (*Picumnus innominatus*), Fulvous-breasted woodpecker (*Dendrocopos macei*) Darjeeling Woodpecker (*Dendrocopos darjellensis*) Bay Woodpecker (*Blythipicus pyrrhotis*) were recorded. This may be due to scarcity of such trees in large number.

The bird community was dominated by the very common species in population, they have high relative abundance, but the number of bird species was high in rare and uncommon species, which have low relative abundance. This is the typical characteristics of community especially birds (Dr. Baral H.S. orally).

Feeding guild comprises insectivores, granivores, omnivores, carnivores, nectarivores and frugivores. Among them highest numbers of species were recorded from insectivores i.e. 62 species. Species of smaller body size, granivores, insectivores and those that use both the interior and exterior parts of the gallery forest advanced noticeably further along the river than larger species, carnivores, nectarivores or frugivores, and those that frequent only a part of the forest (Manuel 2005). The species most affected by the degradation forests are large frugivores and large insectivores of the canopy and low understory. (Cueto & de Casenave 2000) detected foraging guild-specific variation in whether structure or floristic were more important; the insectivore guild responded primarily to structural differences, whereas the frugivore-insectivore responded more to differences in floristic composition. The number of birds species in guild associated (canopy insectivores, frugivores and bark feeders) like Mountain bulbul, Large Cuckoo-shrike, Grey-treepie, White-crested Laughingthrush, Red-billed Blue ~~magpie~~ Magpie and Yellow-billed Blue ~~magpie~~ Magpie were correlated with forest development and woody plant succession variables like; tree density and woody plant species richness. Species with other guild (understory insectivores) like Black-chinned Babbler, Streak-breasted Scimitar Babbler and Rusty-cheeked Scimitar Babbler appeared to be dominant during early and mid succession (Raman *et al.* 1998). Species thriving in agroforests are small frugivores, foliage insectivores, and nectarivores (Thiollay 1995).

6. CONCLUSION AND RECOMMENDATION

The present study has been carried out to explore the seasonal bird diversity, community composition and distribution and habitat utilization of birds in the SCF and DCF, Seshanarayan VDC.

Altogether 118 species belonging to 10 order and 29 families. Of them 85 species were residential, 16 species summer migratory, 16 species winter migratory and one was of unknown status. Highest species richness was in summer season followed by autumn and spring. Similarly Shannon's index of diversity was highest in summer followed by spring and autumn. Population in summer season was 2073 followed by 1988 in autumn and 783 in spring season. This results shows indicate that summer season is best for avifaunal diversity or this good breeding habitat for birds. Although my study was not carried out in winter season 16 species winter migratory species were recorded by this result I must say this area is good place for wintering birds as well.

The habitats found in the study area, were; forest, riparian, agricultural land, Marshes, Urban and human settlement. Bird diversity is significantly differing among the different habitat types. Majority of the birds were found associated with forest and remaining birds were found in combination of more than one specific habitat.

In case of distribution transect 1 of pariban area was found to be richest. The dissimilarity in distribution of birds in different area and rich in diversity as whole suggest that birds diversity depends op on the hetrogenity of habitat found in area, as well as heterogenity in forest structure.

Six feeding gulids were found ie insectivores, carnivores, frugivores, nectivores grainivores andomnivores. Among them 62 species were belonging to insectivores depending up on the forest. 20 specie belonging to omnivores suggest the proximity of forest to the agricultural and human settlement.

Although there are some threats to bird diversity in this area, the forest is well protected by FUG that's why the Satikhel community forest is ranked in "A" category by district forest office and by the structure and condition of forest as well as rich bird diversity the Dallu community forest is also well protected.

I have some recommendation / suggestion for the betterment of bird species.

- To register the Dallu Community forest in district forest office and hand over legally.
- Should be held the public awareness programme concerning the bird biodiversity in that area.
- Avoid the religious flags of Buddhist in and around the forest.
- Discourage the illegal cattle grazing.
- Be conscious during firing in agricultural land near the forest.
- Long term monitoring of bird diversity should be done in these community forest as well as along this belt.

- Forest resource should be collected in winter season only.
- Retain ponds or marshy areas.
- Plant a proportion of broadleaved species that are appropriate to the site. If possible, maintain a broad range of age-classes.
- Change the economic conservation view to biodiversity conservation of forest.
- Not clear the bushes until the forest grows fully.

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Annex I
Checklist of Birds recorded in the study area from May 2006 to November 2006 (spring to autumn season)

S.N.	Common Name	Seasons	Location	Habitat	Migration	Popl ⁿ	Feeding guild	R. Abundance
1	Kalij Pheasant	SP,SU	1,2	F,UG	R	8	O	0.167259
2	Speckled Piculet	SU,AU	1,2	BU,SG	R	16	I	0.334518
3	Fulvous-breasted woodpeaker	SP	1	FE,OF	R	4	O	0.08363
4	Darjeeling Woodpeaker	SP	1	BF, CF	R	1	O	0.020907
5	Bay Woodpeaker	SP	1	BF,SG	R	1	O	0.020907
6	Great Barbet	SP,SU,AU	1,2	F	R	39	F	0.815388
7	Blue-thorated Barbet	SP,SU,AU	1,2	OF	R	50	F	1.045369
8	White-thorated Kingfisher	SP,SU	1	AG,R,FE	R	28	C	0.585407
9	Indian Cukoo	SP,SU	1,2	F	S	5	I	0.104537
10	Eurasian Cukoo	SP,SU	1,2	F	S	22	I	0.459962
11	Plaintive Cukoo	SP,SU	1,2	F	S	2	I	0.041815
12	Asian Koel	SP,SU,AU	1,2	AG,G	R	19	F	0.39724
13	Green-billed Malkoha	SU	1,2	F	R	7	I	0.146352
14	Rose-ringed Parakit	SP	2	F,AG	R	9	G	0.188166
15	House Swift	SP	2	U	R	12	I	0.250889
16	Spotted Owlet	SP,SU	1,2	U,AG	R	6	C	0.125444
17	Grey Nightjar	SP	4	F	LM/S	4	I	0.08363
18	Oriental Turtle Dove	SP, SU, AU	1,2,3,4	U,AG,OF	R	67	G	1.400794
19	Spotted Dove	SP,SU,AU	1,2,3,4	AG,OF	R	115	G	2.404349
20	Common Snipe	SP	1	M	W/PM	1	I	0.020907

21	Black Kite	SP,SU,AU	2	U,OA	R	13	C	0.271796
22	Himalayan Griffon	AU	1	OA	R	6	C	0.125444
23	Besra	SP	2	BF,OA	S	2	C	0.041815
24	Common Buzzard	AU	2	OC,A	W/PM	11	C	0.229981
25	Steppe Eagle	AU	1	A,R	W/PM	8	C	0.167259
26	Common Kestrel	AU	12	OA	W/PM	12	C	0.250889
27	Eurasian Hobby	SP,SU,AU	3	CF,OA	R	22	C	0.459962
28	Cattle Egret	SU,AU	1,2	R	R	83	C	1.735313
29	Indian Pond Herone	SU,AU	1,2	R	R	19	C	0.39724
30	Long-tailed Shrike	SP,SU,AU	1,4	AG,	R	26	I	0.543592
31	Grey-backed Shrike	AU	1,2	AG,SG	W/LM	10	I	0.209074
32	Yellow-billed Blue Magpie	SP	3	BF,CF	R	5	F	0.104537
33	Red-billed Blue Magpie	SP	1,2	BF	R	58	F	1.212628
34	Common Green Magpie	SU	1	BF,AG	R	5	F	0.104537
35	Rufous Treepie	SP	3	F,SG	R	4	F	0.08363
36	Grey Treepie	SP,SU,AU	1,2,3,4	BF,SG	R	247	F	5.164123
37	House Crow	SP,SU,AU	2	AG,U	R	18	O	0.376333
38	Laege-billed Crow	SP,SU,AU	1,3,4	F,AG	R	21	O	0.439055
39	Eurasian Golden Oriole	SP,SU	1,2	AG,F	S	18	I	0.376333
40	Large Cuckooshrike	SU	2	BF	R	1	F	0.020907
41	Black-winged Cuckooshrike	SP,SU	1,2	BF	R	20	I	0.418148
42	Long-tailed Minivet	SU,AU	1,2,3,4	F,SG	R	57	I	1.191721
43	Scarlet Minivet	SP,SU,AU	1,3	U,AG	R	31	I	0.648129

44	White-thorated Fantail	SU,AU	1,4	BF,SG	R	60		1.254443
45	Black Drongo	SP,SU	1,2	U,AG	R	90		1.881664
46	Ashy Drongo	SP,SU	1,3,4	F	LM/S	49		1.024462
47	Asian Paradise-flycatcher	SU	1	OF,G	S	2		0.041815
48	Blue-capped Rock Thrush	SP,SU	3,4	F	S	10		0.209074
49	Blue Rock Thrush	AU	2	U	W	3		0.062722
50	Blue Whistling Thrush	SP,SU,AU	1,2	F,R	R	70		1.463517
51	Pied Thrush	SU	1	BF,SG	S	14		0.292703
52	Orange-headed Thrush	SP,SU	1,2	F	S/PM	3		0.062722
53	Dusky Thrush	SU	1	F,AG	U	4		0.08363
54	Rufous-gorgeted flycatcher	AU	1	BF,CF	LM/W	1		0.020907
55	Verditer Flycatcher	SP,SU	1,2,4	OF	PM/S	25		0.522685
56	Small Niltava	AU	1	BU,R,FE	PM/W	12		0.250889
57	Rufous-bellied Niltava	AU	1,2	SG	PM/W	9		0.188166
58	Pale Blue Flycatcher	SU	1	OF	R	1		0.020907
59	Blue-thorated Flycatcher ^{**}	SU	1	OF	PM/S	4		0.08363
60	Grey-headed Canary Flycatcher	SU,AU	1,2	F	PM/	52		1.087184
61	Oriental Magpie Robin	SP,SU,AU	1,2	U,AG	R	87		1.818942
62	Hodgsons Redstart	AU	1	OF,AG	W	2		0.041815
63	Blue-fronted redstart	AU	1	BU,OF	LM/W	2		0.041815
64	White-tailed Robin	AU	1	R,F	R	2		0.041815
65	Spotted Forktail	AP,SU,AU	1	R	R	21		0.439055
66	Common Stonechat	AU	1,2	AG,B	W	7		0.146352

67	Pied Bushchat	AU	1	AG,B	R	11	I	0.229981
68	Grey Bushchat	SU,AU	3,4	SG,FE	R	88	I	1.839849
69	Chestnut-tailed sarling	SP	2	OF	R	8	O	0.167259
70	Common Myna	SP,SU,AU	1,2	U,AG	R	15	O	0.313611
71	Jungle Myna	SP,SU,AU	1,2	AG,U	R	24	O	0.501777
72	Chestnut-bellied Nutach	SP,SU	1,2	BF	R	11	O	0.229981
73	White-tailed Nutach	SP,SU	1,2	BF	R	9	O	0.188166
74	Great Tit	SP,SU,AU	1,2,3,4	OF	R	130	I	2.717959
75	Green-backed Tit	SP,SU,AU	1,2,3,4	F	R	79	I	1.651683
76	Black-lored Tit	SP,SU,AU	1,2,3,4	OF,FE	R	67	I	1.400794
77	Black-thorated Tit	SP,SU,AU	2,1	F,SG	R	99	I	2.069831
78	Barn Swallow	SPSU	1,2	AG,U,R	R/S	12	I	0.250889
79	Red-rumped Swallow	SPSU	1,2	AG	LM	7	I	0.146352
80	Himalayan Bulbul	SP,SU,AU	1,2,3,4	SG	R	175	O	3.658792
81	Red-vented Bulbul	SP,SU,AU	1,2,3,4	F,SG,U	R	404	O	8.446582
82	Mountain Bulbul	SU,AU	1	F,SG	R	17	I	0.355425
83	Black Bulbul	AU	1,2	F	R	245	O	5.122308
84	Striated Prinia	SU,AU	3,4	SC	R	25	O	0.522685
85	Oriental White-eye	SP,SU,AU	1,2,3,4	BF	R	139	I	2.906126
86	Blyths' Reed Warbler	AU	1	AG,FE	W	2	I	0.041815
87	Common Tailorbird	SP,SU,AU	1,2	FE,SG,G	R	112	O	2.341627
88	Aberrant Bush Warbler	AU	1	FE,BU	LM/W	1	I	0.020907
89	Common Chiffchaff	AU	1	F,B,SG	W	13	O	0.271796

90	Hume's Warbler	AU	14	F,SG	W	20	I	0.418148
91	Western Crown Warbler	AU	14	B,SG	PM	5	I	0.104537
92	Blyth's Leaf Warbler	AU	1	FE,BU	R	9	I	0.188166
93	Grey-hooded Warbler	AP,SU,AU	1,2,3,4	B,SG	S	450	O	9.408321
94	White-throated Laughingthrush	SU	1	BF,SG	R	16	I	0.334518
95	White-crested Laughingthrush	AP,SU,AU	1	BF	R	22	I	0.459962
96	Rufous-chinned Laughingthrush	AU	1,4	FUG	R	18	I	0.376333
97	Scaly Laughingthrush	SP,SU	3,4	UG	R	11	I	0.229981
98	Rusty-cheeked Scimitar Babbler	SP,SU,AU	1,2,3,4	UG	R	202	I	4.223291
99	Streak-breasted Scimitar Babbler	SP,SU,AU	1,2,3,4	UG	R	58	I	1.212628
100	Black-chinned Babbler	SP,SU,AU	1,2,3,4	UG,SG	R	132	I	2.759774
101	Spiny Babbler*	SU,AU	3	SC	R	6	I	0.125444
102	Jungle Babbler	SU	3	SC	R	1	O	0.020907
103	Nepal Fulvetta	SP,SU,AU	1,4	UG	R	119	I	2.487978
104	Fire-breasted Flowerpecker	SU,AU	1,3	F,SG	R	41	N	0.857203
105	Green-tailed Sunbird	AU	4	BF,SG	R	4	N	0.08363
106	Crimson Sunbird	SP,SU,AU	1,2	BF,GA	R	16	N	0.334518
107	Fire-tailed Sunbird	SP	1	F	R	4	N	0.08363
108	House Sparrow	SP,SU,AU	1,2	U,AG	R	90	G	1.881664
109	Eurasian Tree Sparrow	SP,SU,AU	1,2	U,AG	R	115	G	2.404349
110	Grey Wagtail	AU	1	R	W	8	I	0.167259
111	Paddyfield Pipit	SP	1	AG	R	1	G	0.020907
112	Olive-backed Pipit	AU	1,2	OF	R	26	G	0.543592

113	Rosy Pipit	AU	1,2	AG	R	9	G	0.188166
114	Baya Weaver	SU	1	AG	R	11	I	0.229981
115	White-rumped Munia	SU	1	SC	R	2	G	0.041815
116	Scaly-breasted Munia	SP,SU,AU	1	OF,BU	R	37	G	0.773573
117	Yellow-breasted Greenfinch	SP,AU	2,4	OF,AG	R	10	G	0.209074
118	Common Rosefinch	AU	1,3	AG,BU	R/W	4	G	0.000836

SN	Category	Population	R. abundance/ % Dominance
1	Very common	>200	>4.223291
2	Common	50-200	1.045369 - 2.404349
3	Fairly common	20-49	0.418148 - 1.024462
4	Uncommon	6-19	0.125444- 0.39724
5	Rare	1-5	0.020907-0.104537

Seasons

SP- Spring Season, SU- Summer Season, AU – Autumn Season

Location

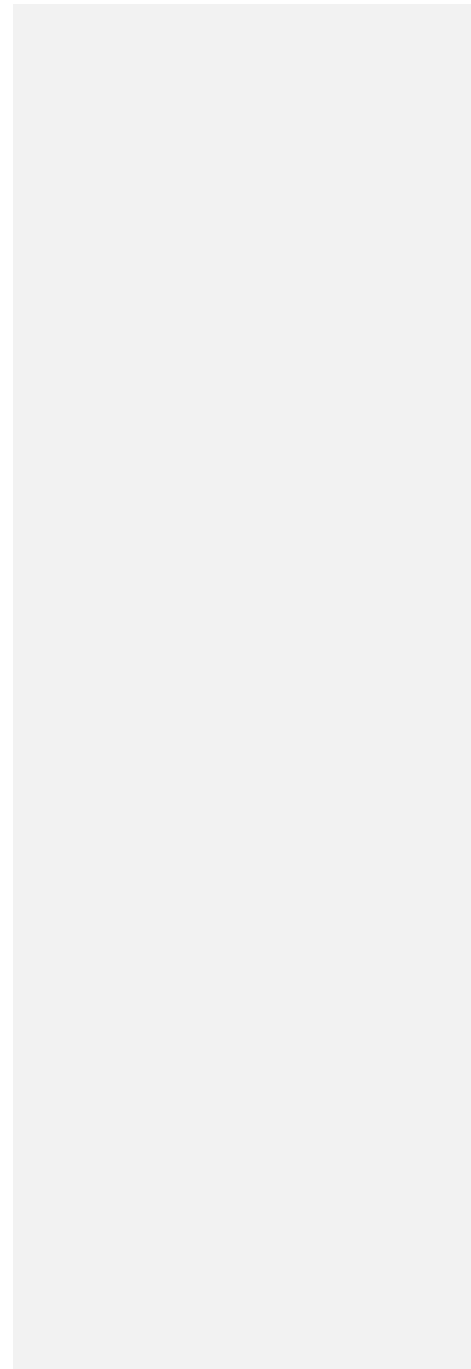
(1)Transect 1, (2) Transect 2, (3) Transect 3, (4) Transect 4

Habitat

F – Forest (both broad leaved and coniferous), BU – Bush, SG- Secondary growth, FE- Forest edge, OF – Open forest, BF= Broad-leaved forest, CF- Coniferous forest, UG- Under growth, SC – Scrub, AG – Agricultural land, U- Urban/ Human settlement, R –Riparian/Wetland, M- Marshes, OA- Open Area

Feeding Guild

O = Omiviores, N = Nectivores, G = Grainivores, C = Carnivores, F = Frugivores, I = Insectivores



Annex II
Checklist of bird Birds recorded during spring season

SN	Common Name	Total	$\frac{ni}{N}$	$\log \frac{ni}{N}$	$\frac{ni}{N} \log \frac{ni}{N}$	$\frac{ni}{N} \times 100$
1	Kalij Phesant	2	0.002554	-2.59273	-0.00662	0.255428
2	Fulvous-breasted woodpeaker	4	0.005109	-2.2917	-0.01171	0.510856
3	Darjeeling woodpeaker	1	0.001277	-2.89376	-0.0037	0.127714
4	Bay Woodpeaker	1	0.001277	-2.89376	-0.0037	0.127714
5	Great Barbet	3	0.003831	-2.41664	-0.00926	0.383142
6	Blue-thorated Barbet	13	0.016603	-1.77982	-0.02955	1.660281
7	White-thorated Kingfisher	12	0.015326	-1.81458	-0.02781	1.532567
8	Indian Cukoo	4	0.005109	-2.2917	-0.01171	0.510856
9	Plaintive cokoo	2	0.002554	-2.59273	-0.00662	0.255428
10	Eurasian Cukoo	10	0.012771	-1.89376	-0.02419	1.277139
11	Asian Koel	10	0.012771	-1.89376	-0.02419	1.277139
12	Rose-ringed Parakit	9	0.011494	-1.93952	-0.02229	1.149425
13	House Swift	6	0.007663	-2.11561	-0.01621	0.766284
14	Spotted Owlet	6	0.007663	-2.11561	-0.01621	0.766284
15	Oriental Turtle Dove	5	0.006386	-2.19479	-0.01402	0.63857
16	Spotted Dove	48	0.061303	-1.21252	-0.07433	6.130268
17	Common Snipe	1	0.001277	-2.89376	-0.0037	0.127714
18	Black Kite	5	0.006386	-2.19479	-0.01402	0.63857
19	Besra	2	0.002554	-2.59273	-0.00662	0.255428
21	Eurasian Hobby	6	0.007663	-2.11561	-0.01621	0.766284
22	Long-tailed Shrike	3	0.003831	-2.41664	-0.00926	0.383142
23	Yellow-billed Blue Magpie	5	0.006386	-2.19479	-0.01402	0.63857
24	Red-billed Bleu Magpie	8	0.010217	-1.99067	-0.02034	1.021711
25	Rufous Treepie	4	0.005109	-2.2917	-0.01171	0.510856
26	Grey Treepie	19	0.024266	-1.61501	-0.03919	2.426564
27	House Crow	5	0.006386	-2.19479	-0.01402	0.63857
28	Large-billed crow	8	0.010217	-1.99067	-0.02034	1.021711
29	Eurasian Golden Oriole	12	0.015326	-1.81458	-0.02781	1.532567
30	Black-winged cuckooshrike	3	0.003831	-2.41664	-0.00926	0.383142
31	Scarlet Minivet	6	0.007663	-2.11561	-0.01621	0.766284
32	Black Drongo	31	0.039591	-1.4024	-0.05552	3.959132
33	Ashy Drongo	21	0.02682	-1.57154	-0.04215	2.681992
34	Blue-capped rock thrush	5	0.006386	-2.19479	-0.01402	0.63857
35	Blue Whistling Thrush	13	0.016603	-1.77982	-0.02955	1.660281
36	Orange-headed	2	0.002554	-2.59273	-0.00662	0.255428

	Thrush					
37	Verditer Flycatcher	15	0.019157	-1.71767	-0.03291	1.915709
38	Oriental Magpie Robin	23	0.029374	-1.53203	-0.045	2.93742
39	Spotted Forktail	3	0.003831	-2.41664	-0.00926	0.383142
41	Chestnut-tailed Starling	8	0.010217	-1.99067	-0.02034	1.021711
42	Common Myna	5	0.006386	-2.19479	-0.01402	0.63857
43	Jungle Myna	11	0.014049	-1.85237	-0.02602	1.404853
44	Chestnut-bellied Nuthach	6	0.007663	-2.11561	-0.01621	0.766284
45	White-tailed Nuthach	2	0.002554	-2.59273	-0.00662	0.255428
46	Great Tit	23	0.029374	-1.53203	-0.045	2.93742
47	Green-Backed Tit	22	0.028097	-1.55134	-0.04359	2.809706
48	Black-lored Tit	2	0.002554	-2.59273	-0.00662	0.255428
49	Black-thorated Tit	29	0.037037	-1.43136	-0.05301	3.703704
50	Barn swallo	7	0.00894	-2.04866	-0.01832	0.893997
51	Red-rumped Swallo	3	0.003831	-2.41664	-0.00926	0.383142
52	Himalayan Bulbul	37	0.047254	-1.32556	-0.06264	4.725415
53	Red-vented Bulbul	85	0.108557	-0.96434	-0.10469	10.85568
54	Oriental White-eye	16	0.020434	-1.68964	-0.03453	2.043423
55	Common Tailorbird	17	0.021711	-1.66331	-0.03611	2.171137
56	Grey-hooded Warbler	69	0.088123	-1.05491	-0.09296	8.812261
57	White-crested Laughingthrush	2	0.002554	-2.59273	-0.00662	0.255428
58	Scaly laughingthrush	8	0.010217	-1.99067	-0.02034	1.021711
59	Rusty-cheeked Scimitar Babbler	22	0.028097	-1.55134	-0.04359	2.809706
60	Streak-breasted Scimitar Babbler	5	0.006386	-2.19479	-0.01402	0.63857
61	Black-chinned Babbler	6	0.007663	-2.11561	-0.01621	0.766284
62	Nepal Fulvetta	13	0.016603	-1.77982	-0.02955	1.660281
63	Crimson Sunbird	4	0.005109	-2.2917	-0.01171	0.510856
64	Fire-tailed Sunbird	4	0.005109	-2.2917	-0.01171	0.510856
65	House Sparrow	14	0.01788	-1.74763	-0.03125	1.787995
66	Eurasian Tree Sparrow	22	0.028097	-1.55134	-0.04359	2.809706
67	Paddy Field Pipit	1	0.001277	-2.89376	-0.0037	0.127714
68	Scaly-breasted Munia	2	0.002554	-2.59273	-0.00662	0.255428
69	Yellow-breasted greenfinch	2	0.002554	-2.59273	-0.00662	0.255428
		783			-1.59533	

Shannon's index of diversity

$$\bar{H} = - \sum \left(\frac{n_i}{N} \right) \log \left(\frac{n_i}{N} \right)$$

$$\bar{H} = 1.59533$$

Evenness index

$$e = \frac{\bar{H}}{\log S} = \frac{1.59533}{\log 68} = \frac{1.59533}{1.832509} = 0.870571$$

Annex III
Checklist of Birds recorded during summer season

SN	Common Name	Popl ^a	$\left(\frac{ni}{N}\right)$	$\log\left(\frac{ni}{N}\right)$	$\left(\frac{ni}{N}\right) \log\left(\frac{ni}{N}\right)$	$\frac{ni}{N} \times 100$
1	Kalij Pheasant	6	0.002894356	-2.53844805	-0.00735	0.289436
2	Speckled Piculet	8	0.003859141	-2.41350932	-0.00931	0.385914
3	Great Barbet	18	0.008683068	-2.0613268	-0.0179	0.868307
4	Blue-thorated Barbet	32	0.015436565	-1.81144932	-0.02796	1.543657
5	White-thorated Kingfisher	16	0.007718283	-2.11247932	-0.0163	0.771828
6	Indian Cuckoo	1	0.000482393	-3.3165993	-0.0016	0.048239
7	Eurasian Cuckoo	12	0.005788712	-2.23741806	-0.01295	0.578871
8	Asian Koel	8	0.003859141	-2.41350932	-0.00931	0.385914
9	Green-billed malkoha	7	0.003376749	-2.47150126	-0.00835	0.337675
10	House Swift	6	0.002894356	-2.53844805	-0.00735	0.289436
11	Grey Nightjar	4	0.001929571	-2.71453931	-0.00524	0.192957
12	Oriental Turtle Dove	37	0.017848529	-1.74839758	-0.03121	1.784853
13	Spotted Dove	82	0.039556199	-1.40278545	-0.05549	3.95562
14	Black Kite	3	0.001447178	-2.83947805	-0.00411	0.144718
15	Eurasian Hobby	11	0.005306319	-2.27520662	-0.01207	0.530632
16	Cattle Egret	4	0.001929571	-2.71453931	-0.00524	0.192957
17	Indian Pond Herone	7	0.003376749	-2.47150126	-0.00835	0.337675
18	Long-tailed Shrike	3	0.001447178	-2.83947805	-0.00411	0.144718
19	Red-billed Bleu Magpie	15	0.00723589	-2.14050804	-0.01549	0.723589
20	Common Green magpie	5	0.002411963	-2.6176293	-0.00631	0.241196
21	Grey Treepie	119	0.057404727	-1.24105234	-0.07124	5.740473
22	House Crow	8	0.003859141	-2.41350932	-0.00931	0.385914
23	Large-billed crow	7	0.003376749	-2.47150126	-0.00835	0.337675
24	Eurasian Golden Oriole	6	0.002894356	-2.53844805	-0.00735	0.289436
25	Large Cukooshrike	1	0.000482393	-3.3165993	-0.0016	0.048239
26	Black winged Cukooshrike	17	0.008200675	-2.08615038	-0.01711	0.820068
27	Long-tailed Minivet	28	0.013506995	-1.86944127	-0.02525	1.350699

28	Scarlet Minivet	4	0.001929571	-2.71453931	-0.00524	0.192957
29	White-thorated Fantail	47	0.022672455	-1.64450144	-0.03728	2.267246
30	Black Drongo	59	0.028461167	-1.54574729	-0.04399	2.846117
31	Ashy Drongo	28	0.013506995	-1.86944127	-0.02525	1.350699
32	Asian Paradise-flycatcher	2	0.000964785	-3.01556931	-0.00291	0.096479
33	Blue-capped Rock Thrush	5	0.002411963	-2.6176293	-0.00631	0.241196
34	Blue Whistling Thrush	38	0.018330921	-1.73681571	-0.03184	1.833092
35	Orange-headed Thrush	1	0.000482393	-3.3165993	-0.0016	0.048239
36	Dusky Thrush	4	0.001929571	-2.71453931	-0.00524	0.192957
37	Pied Thrush	14	0.006753497	-2.17047127	-0.01466	0.67535
38	Pale-blue Flycatcher	3	0.001447178	-2.83947805	-0.00411	0.144718
39	Blue Thorated flycatcher	4	0.001929571	-2.71453931	-0.00524	0.192957
40	Grey Headed Canary flycatcher	22	0.010612639	-1.97417662	-0.02095	1.061264
41	Verditer Flycatcher	18	0.008683068	-2.0613268	-0.0179	0.868307
42	Oriental Magpie Robin	32	0.015436565	-1.81144932	-0.02796	1.543657
43	Spotted Forktail	9	0.004341534	-2.36235679	-0.01026	0.434153
44	Grey Bushchat	75	0.03617945	-1.44153804	-0.05215	3.617945
45	Common Myna	5	0.002411963	-2.6176293	-0.00631	0.241196
46	Jungle Myna	11	0.005306319	-2.27520662	-0.01207	0.530632
47	Chestnut-bellied Nuthach	5	0.002411963	-2.6176293	-0.00631	0.241196
48	White-tailed Nuthach	7	0.003376749	-2.47150126	-0.00835	0.337675
49	Great Tit	64	0.030873131	-1.51041933	-0.04663	3.087313
50	Green-Backed Tit	39	0.018813314	-1.7255347	-0.03246	1.881331
51	Black-lored Tit	25	0.012059817	-1.91865929	-0.02314	1.205982
52	Black-thorated Tit	35	0.016883743	-1.77253126	-0.02993	1.688374
53	Barn swallo	5	0.002411963	-2.6176293	-0.00631	0.241196
54	Red-rumped Swallo	4	0.001929571	-2.71453931	-0.00524	0.192957
55	Himalayan Bulbul	63	0.030390738	-1.51725875	-0.04611	3.039074
56	Red-vented Bulbul	130	0.062711047	-1.20265595	-0.07542	6.271105
57	Mountain Bulbul	6	0.002894356	-2.53844805	-0.00735	0.289436
58	Striated Prinia	25	0.012059817	-1.91865929	-0.02314	1.205982
59	Oriental White-eye	68	0.032802701	-1.48409039	-0.04868	3.28027
60	Common Tailorbird	49	0.023637241	-1.62640322	-0.03844	2.363724
61	Grey-hooded Warbler	236	0.11384467	-0.9436873	-0.10743	11.38447
62	White-thorated Laughingthrush	16	0.007718283	-2.11247932	-0.0163	0.771828

63	White-crested Laughingthrush	12	0.005788712	-2.23741806	-0.01295	0.578871
64	Scaly laughingthrush	3	0.001447178	-2.83947805	-0.00411	0.144718
65	Rusty-cheeked Scimitar Babbler	113	0.054510371	-1.26352086	-0.06887	5.451037
66	Streak-breasted Scimitar Babbler	42	0.020260492	-1.69335001	-0.03431	2.026049
67	Black-chinned Babbler	74	0.035697057	-1.44736758	-0.05167	3.569706
68	Spiny Babbler	4	0.001929571	-2.71453931	-0.00524	0.192957
69	Jungle Babbler	1	0.000482393	-3.3165993	-0.0016	0.048239
70	Nepal Fulvetta	38	0.018330921	-1.73681571	-0.03184	1.833092
71	Fire-breasted Flowerpeaker	33	0.015918958	-1.79808536	-0.02862	1.591896
72	Crimson Sunbird	6	0.002894356	-2.53844805	-0.00735	0.289436
73	House Sparrow	48	0.023154848	-1.63535806	-0.03787	2.315485
74	Eurasian Tree Sparrow	53	0.025566811	-1.59232343	-0.04071	2.556681
75	Baya Weaver	11	0.005306319	-2.27520662	-0.01207	0.530632
76	White-rumped Munia	2	0.000964785	-3.01556931	-0.00291	0.096479
77	Scaly-breasted Munia	4	0.001929571	-2.71453931	-0.00524	0.192957
		2073			-1.60408	100

Calculation,

For Summer season, shannon's index of diversity

$$\begin{aligned} \bar{H} &= - \sum \left(\frac{n_i}{N} \right) \log \left(\frac{n_i}{N} \right) \\ &= - (-1.60408) \\ &= 1.60408 \end{aligned}$$

Evenness index

$$e = \frac{\bar{H}}{\log S} = 0.850298$$

Annex IV
Checklist for Oct and Nov during autumn season

SN	Common Name	Total	$\frac{n_i}{N}$	$\log \frac{n_i}{N}$	$\frac{n_i}{N} \log \frac{n_i}{N}$	$\frac{n_i}{N} \times 100$
1	Speckled Piculet	8	0.0040262	-2.39511	-0.00964311	0.402617
2	Great Barbet	18	0.0090589	-2.04293	-0.01850662	0.905888
3	Blue-thorated Barbet	5	0.0025164	-2.59923	-0.00654058	0.251636
5	Oriental Turtle Dove	17	0.0085556	-2.06775	-0.01769086	0.855561
6	Spotted Dove	25	0.0125818	-1.90026	-0.02390863	1.258178
7	Black Kite	5	0.0025164	-2.59923	-0.00654058	0.251636
8	Himalayan Griffon	6	0.0030196	-2.52005	-0.0076096	0.301963
9	Common Buzzard	11	0.005536	-2.25681	-0.01249364	0.553598
10	Steppe Eagle	7	0.0035229	-2.4531	-0.00864202	0.35229
11	Common Kestral	2	0.0010065	-2.99717	-0.00301678	0.100654
12	Eurasian Hobby	3	0.0015098	-2.82108	-0.0042593	0.150981
13	Cattle Egret	79	0.0397584	-1.40057	-0.05568449	3.975843
14	Indian Pond Herone	12	0.0060393	-2.21902	-0.01340121	0.603926
15	Long-tailed Shrike	20	0.0100654	-1.99717	-0.02010234	1.006543
16	Grey Back Shrike	10	0.0050327	-2.2982	-0.01156617	0.503271
17	Red-billed Bleue Magpie	35	0.0176145	-1.75413	-0.03089811	1.761449
18	Grey Treepie	109	0.0548566	-1.26077	-0.06916159	5.485657
19	House Crow	5	0.0025164	-2.59923	-0.00654058	0.251636
20	Large-billed crow	6	0.0030196	-2.52005	-0.0076096	0.301963
21	Long-tailed Minivet	23	0.0115752	-1.93647	-0.0224151	1.157524
22	Scarlet Minivet	27	0.0135883	-1.86683	-0.02536715	1.358832
23	Blue Rockthrush	3	0.0015098	-2.82108	-0.0042593	0.150981
24	White-thorated fantail	13	0.0065425	-2.18425	-0.01429054	0.654253
25	Blue Whistling Thrush	19	0.0095622	-2.01944	-0.01931024	0.956215
26	Rufous-gorgeted flycatcher	1	0.0005033	-3.2982	-0.00165989	0.050327
27	Verditer Flycatcher	7	0.0035229	-2.4531	-0.00864202	0.35229
28	Grey Headed Canary flycatcher	30	0.0150981	-1.82108	-0.02749487	1.509814
29	Small Niltava	12	0.0060393	-2.21902	-0.01340121	0.603926
30	Rofous-billed Niltava	9	0.0045294	-2.34396	-0.01061681	0.452944

31	Oriental Magpie Robin	32	0.0161047	-1.79305	-0.02887646	1.610468
32	Hodgson's Redstart	2	0.0010065	-2.99717	-0.00301678	0.100654
33	Blue-fronted redstart	2	0.0010065	-2.99717	-0.00301678	0.100654
34	White -tailed Robin	2	0.0010065	-2.99717	-0.00301678	0.100654
35	Spotted Forktail	9	0.0045294	-2.34396	-0.01061681	0.452944
36	Common Stonechat	7	0.0035229	-2.4531	-0.00864202	0.35229
37	Pied Bushchat	11	0.005536	-2.25681	-0.01249364	0.553598
38	Grey Bushchat	13	0.0065425	-2.18425	-0.01429054	0.654253
39	Common Myna	5	0.0025164	-2.59923	-0.00654058	0.251636
40	Jungle Myna	2	0.0010065	-2.99717	-0.00301678	0.100654
41	Great Tit	43	0.0216407	-1.66473	-0.03602585	2.164066
42	Green-Backed Tit	18	0.0090589	-2.04293	-0.01850662	0.905888
43	Black-lored Tit	40	0.0201309	-1.69614	-0.0341447	2.013085
44	Black-thorated Tit	35	0.0176145	-1.75413	-0.03089811	1.761449
45	Himalayan Bulbul	75	0.0377453	-1.42314	-0.05371678	3.774534
46	Red-vented Bulbul	189	0.0951183	-1.02174	-0.09718577	9.511827
47	Mountain Bulbul	11	0.005536	-2.25681	-0.01249364	0.553598
48	Black Bulbul	245	0.1233015	-0.90903	-0.11208495	12.33015
49	Oriental White-eye	55	0.0276799	-1.55784	-0.04312075	2.767992
50	Common Tailorbird	56	0.0281832	-1.55001	-0.04368422	2.818319
51	Aberrant Bush warbler	1	0.0005033	-3.2982	-0.00165989	0.050327
52	Blyths' Reed Warbler	2	0.0010065	-2.99717	-0.00301678	0.100654
53	Common Chiffhaf	13	0.0065425	-2.18425	-0.01429054	0.654253
54	Humes Warbler	20	0.0100654	-1.99717	-0.02010234	1.006543
55	Blyth's Leaf Warbler	9	0.0045294	-2.34396	-0.01061681	0.452944
56	Western Crown Warbler	5	0.0025164	-2.59923	-0.00654058	0.251636
57	Common Chiffhaf	15	0.0075491	-2.12211	-0.01601993	0.754907
58	Grey-hooded Warbler	145	0.0729743	-1.13683	-0.0829594	7.297433
59	White-crested Laughingthrush	8	0.0040262	-2.39511	-0.00964311	0.402617
60	Rufous-chinned Laughingthrush	18	0.0090589	-2.04293	-0.01850662	0.905888
61	Rusty-cheeked Scimitar Babbler	67	0.0337192	-1.47212	-0.04963877	3.371917
62	Streak-breasted Scimitar Babbler	11	0.005536	-2.25681	-0.01249364	0.553598
63	Black-chinned Babbler	52	0.0261701	-1.58219	-0.0414062	2.617011

64	Spiny Babbler	2	0.0010065	-2.99717	-0.00301678	0.100654
65	Nepal Fulvetta	68	0.0342224	-1.46569	-0.05015946	3.422245
66	Fire-breasted Flowerpeaker	8	0.0040262	-2.39511	-0.00964311	0.402617
67	Green-tailed Sunbird	4	0.0020131	-2.69614	-0.00542755	0.201309
68	Crimson Sunbird	6	0.0030196	-2.52005	-0.0076096	0.301963
69	House Sparrow	28	0.0140916	-1.85104	-0.0260841	1.40916
70	Eurasian Tree Sparrow	40	0.0201309	-1.69614	-0.0341447	2.013085
71	Grey Wagtail	8	0.0040262	-2.39511	-0.00964311	0.402617
72	Olive-backed Pipit	26	0.0130851	-1.88322	-0.02464209	1.308505
73	Rosy Pipit	9	0.0045294	-2.34396	-0.01061681	0.452944
74	Scaly-breasted Munia	31	0.0156014	-1.80684	-0.02818919	1.560141
75	Yello Breasted green finch	8	0.0040262	-2.39511	-0.00964311	0.402617
76	Common Rosefinch	4	0.0020131	-2.69614	-0.00542755	0.201309
		1988				100

Shannon's index of diversity

$$\bar{H} = -\sum \left(\frac{n_i}{N} \right) \log \left(\frac{n_i}{N} \right)$$

$$\bar{H} = 1.56484$$

Evenness index

$$e = \frac{\bar{H}}{\log S} = \frac{1.56484}{\log 73} = 0.839812$$

Annex V
Birds recorded in the study area with common name, scientific name, order and family

S.N.	Common Name	Scientific Name	Abundance
	GALLIFORMES		
	Phasianidae		
1	Kalij Pheasant	<i>Lophura leucomelanos</i>	UC
	PICIFORMES		
	Picidae		
2	Speckled Piculet	<i>Picumnus innominatus</i>	UC
3	Fulvous-breasted woodpecker	<i>Dendrocopos macei</i>	R
4	Darjeeling Woodpecker	<i>Dendrocopos darjellensis</i>	R
5	Bay Woodpecker	<i>Blythipicus pyrrhotis</i>	R
	Magalaimidae		
6	Great Barbet	<i>Magalaima virens</i>	FC
7	Blue-thorated Barbet	<i>Magalaima Franklinii</i>	C
	CORACIIFORMES		
	Dacelonidae		
8	White-thorated Kingfisher	<i>Halcyon smyrnensis</i>	FC
	Cuculiformes		
	Cuculidae		
9	Indian Cukoo	<i>Cuculus micropterus</i>	R
10	Eurasian Cukoo	<i>Cuculus canorus</i>	FC
11	Plaintive Cukoo	<i>Cacomantis merulinus</i>	R
12	Asian Koel	<i>Eudynamys scolopacea</i>	UC
13	Green-billed Malkoha	<i>Phaenicophaeus tristis</i>	UC
	PSITTACIFORMES		
	Psittacidae		
14	Rose-ringed Parakit	<i>Pittacula roseata</i>	UC
	APODIFORMES		
	Apodidae		
15	House Swift	<i>Apus affinis</i>	UC
	STRIGIFORMES		
	Strigidae		
16	Spotted Owlet	<i>Anthene brama</i>	UC
	Caprimulgidae		
17	Grey Nightjar		R

	COLUMBIFORMES		
	Columbidae		
18	Oriental Turtle Dove	<i>Streptopelia orientalis</i>	C
19	Spotted Dove	<i>Streptopelia chinensis</i>	C
	CICONIIFORMES		
	Scopacidae		
20	Common Snipe	<i>Gallinago gallinago</i>	R
	Accipitridae		
21	Black Kite	<i>Milvus migrans</i>	UC
22	Himalayan Griffon	<i>Gyps himalayensis</i>	UC
23	Besra	<i>Accipiter vigatus</i>	R
24	Common Buzzard	<i>Buteobuteo</i>	UC
25	Steppe Eagle	<i>Aquila niplensis</i>	UC
	Falconidae		
26	Common Kestrel	<i>Falco numani</i>	UC
27	Eurasian Hobby	<i>Falco subbuteo</i>	FC
	Ardeidae		
28	Cattle Egret	<i>Bubalcus ibis</i>	C
29	Indian Pond Herone	<i>Ardeola grayii</i>	UC
	PASSERIFORMES		
	Laniidae		
30	Long-tailed Shrike	<i>Lanius schach</i>	FC
31	Grey-backed Shrike	<i>Lanius tephronotus</i>	UC
	Corvidae		
32	Yellow-billed Blue Magpie	<i>Urocissa flavirostris</i>	R
33	Red-billed Blue Magpie	<i>Urocissa erythrorhyncha</i>	C
34	Common Green Magpie	<i>Cissa chinensis</i>	R
35	Rufous Treepie	<i>Dendrocitta vagabunda</i>	R
36	Grey Treepie	<i>Dendrocitta formosae</i>	VC
37	House Crow	<i>Corvus splendens</i>	UC
38	Laage-billed Crow	<i>Corvus macrorhynchos</i>	FC
39	Eurasian Golden Oriole	<i>Oriolus oriolus</i>	UC
40	Large Cuckooshrike	<i>Coracina macei</i>	R
41	Black-winged Cuckooshrike	<i>Coracina melaschistos</i>	FC
42	Long-tailed Minivet	<i>Pericrocotus ethologus</i>	C
43	Scarlet Minivet	<i>Pericrocotus flammeus</i>	FC

44	White-thorated Fantail	<i>Rhipidura albicollis</i>	C
45	Black Drongo	<i>Dicrurus macrocercus</i>	C
46	Ashy Drongo	<i>Dicrurus leucophaeus</i>	FC
47	Asian Paradise-flycatcher	<i>Terpsiphone paradise</i>	R
Muscicapidae			
48	Blue-capped Rock Thrush	<i>Mantidula cinclorhynchus</i>	UC
49	Blue Rock Thrush	<i>Mantidula solitarius</i>	R
50	Blue Whistling Thrush	<i>Myophonus caeruleus</i>	C
51	Pied Thrush	<i>Zoothera wardii</i>	UC
52	Orange-headed Thrush	<i>Zoothera citria</i>	R
53	Dusky Thrush	<i>Turdus naumanni</i>	R
54	Rufous-gorgeted flycatcher	<i>Ficedula strophliata</i>	R
55	Verditer Flycatcher	<i>Eumyias thalassina</i>	FC
56	Small Niltava	<i>Niltava macgrigoriae</i>	UC
57	Rufous-bellied Niltava	<i>Niltava sundara</i>	UC
58	Pale Blue Flycatcher	<i>Cyornis unicolor</i>	R
59	Blue-thorated Flycatcher	<i>Cyornis rubeculoides</i>	R
60	Grey-headed Canary Flycatcher	<i>Culicicapa ceylonensis</i>	C
61	Oriental Magpie Robin	<i>Copsychus saularis</i>	C
62	Blue-fronted redstart	<i>Phoenicurus frontalis</i>	R
63	Hodgsons Redstart	<i>Phoenicurus hodgsoni</i>	R
64	White-tailed Robin	<i>Myiomela leucura</i>	R
65	Spotted forktail	<i>Enicurus maculatus</i>	FC
66	Common Stonechat	<i>Saxicola torquata</i>	UC
67	Pied bushchat	<i>Saxicola caprata</i>	UC
68	Grey Bushchat	<i>Saxicola ferrea</i>	C
Sturnidae			
69	Chestnut-tailed sarling	<i>Sturnus malabaricus</i>	UC
70	Common Myna	<i>Acridotheres tristis</i>	UC
71	Jungle Myna	<i>Acridotheres fuscus</i>	FC
Sitidae			
72	Chestnut-bellied Nutach	<i>Sitta castanea</i>	UC
73	White-tailed Nutach	<i>Sitta himalayensis</i>	UC
Paridae			
74	Great Tit	<i>Parus major</i>	C
75	Green-backed Tit	<i>Parus monticolus</i>	C

76	Black-lored Tit	<i>Parus xanthogenys</i>	C
	Aegithalidae		
77	Black-thorated Tit	<i>Aegithalos concinnus</i>	C
	Hirundinidae		
78	Barn Swallow	<i>Hirundo rustica</i>	UC
79	Red-rumped Swallow	<i>Hirundo daurica</i>	UC
	Pyconotidae		
80	Himalayan Bulbul	<i>Pyconotus leucogenys</i>	C
81	Red-vented Bulbul	<i>Pyconotus cafer</i>	VC
82	Mountain Bulbul	<i>Hypsipetes mccllellandii</i>	UC
83	Black Bulbul	<i>Hypsipetes leucocephalus</i>	VC
	Cisticolidae		
84	Striated Prinia	<i>Prinia criniger</i>	FC
	Zosteropidae		
85	Oriental White-eye	<i>Zosterops palpirosus</i>	C
	Sylviidae		
86	Aberrant Bush Warbler	<i>Cettia flavolivacea</i>	R
87	Blyths' Reed Warbler	<i>Acrocephalus dumetorum</i>	R
88	Common Tailorbird	<i>Orthotomus satorius</i>	C
89	Common Chiffchaff	<i>Phylloscopus collybita</i>	UC
90	Hume's Warbler	<i>Phylloscopus humai</i>	FC
91	Western Crown Warbler	<i>Phylloscopus occipitalis</i>	R
92	Blyth's Leaf Warbler	<i>Phylloscopus reguloides</i>	UC
93	Grey-hooded Warbler	<i>Seicercus xanthoschistos</i>	VC
94	White-thorated Laughingthrush	<i>Garrulax albogularis</i>	UC
95	White-crested Laughingthrush	<i>Garrulax leucolophus</i>	FC
96	Rufous-chinned Laughingthrush	<i>Garrulax rufogularis</i>	UC
97	Scaly Laughingthrush	<i>Garrulax subnicolor</i>	UC
98	Rusty-cheeked Scimitar Babbler	<i>Pomatorhinus erythrogenys</i>	VC
99	Streak-breasted Scimitar Babbler	<i>Pomatorhinus ruficollis</i>	C
100	Black-chinned Babbler	<i>Stachyris pyrrhops</i>	C
101	Spiny Babler	<i>Turdoides nipalensis</i>	UC
102	Jungle Babbler	<i>Turdoides striatus</i>	R
103	Nepal Fulvetta	<i>Alcippe nipalensis</i>	C

	Nectariniidae		
104	Fire-breasted Flowerpeaker	<i>Dicaeum ignipectus</i>	FC
105	Green-tailed Sunbird	<i>Aethopyga nipalensis</i>	R
106	Crimson Sunbird	<i>Aethopyga siparaja</i>	UC
107	Fire-tailed Sunbird	<i>Aethopyga ignicauda</i>	R
	Passiridae		
108	House Sparrow	<i>Passer domesticus</i>	C
109	Eurasian Tree Sparrow	<i>Passer montanus</i>	C
110	Grey Wagtail	<i>Motacilla cinerea</i>	UC
111	Paddyfield Pipit	<i>Anthus rufulus</i>	R
112	Olive-backed Pipit	<i>Anthus Hodgsoni</i>	FC
113	Rosy Pipit	<i>Anthus roseatus</i>	UC
114	Baya Weaver	<i>Ploceus philippinus</i>	UC
115	White-rumped Munia	<i>Lonchura striata</i>	R
116	Scaly-breasted Munia	<i>Lonchura punctulata</i>	FC
	Fringillidae		
117	Yellow-breasted Greenfinch	<i>Carduelis sipnoides</i>	FC
118	Common Rosefinch	<i>Carpodacus erythrinus</i>	R

Birds they not recorded during my observation period

1	Eurasian Sparrowhawk	<i>Accipiter nisus</i>	
2	Peregrine Falcon	<i>Falco peregrinus</i>	
3	Bronzed Drongo	<i>Dicrurus aeneus</i>	
4	Lemon-rumped Warbler	<i>Phylloscopus chloronotus</i>	

Abundance: VC- very common, C- common, FC- fairly common, UC- uncommon, R- rare.

Annex VI
Woody and shrubberies vegetation recorded from SCF and DCF

SN	Common name	Scientific Name	Family
1.	Kali Kath	<i>Myrsine semiserrata</i>	Myrsinaceae
2.	Seti Kath	<i>Myrsine capitellaata</i>	Myrsinaceae
3.	Kaphal	<i>Myrica esculenta</i>	Myricaceae
4.	Dhale Katush	<i>Castanopsis indica</i>	Fagaceae
5.	Musure katush	<i>Castanopsis tribuloides</i>	Fagaceae
6.	Laknure	<i>Fraxinus floribunda</i>	Oleaceae
7.	Chilauni	<i>Schima wallichii</i>	Theaceae
8.	Jamun	<i>Syzygium cumini</i>	Myrtaceae
9.	Gobresalla	<i>Pinus wallichiana</i>	Pinaceae
10.	Bhalayo	<i>Rhus succedaenea</i>	Anacardiaceae
11.	Kholesalla	<i>Pinus ruxberghii</i>	Pinaceae
12.	Phalat	<i>Quercuss glauca</i>	Fagaecae
13.	Nim	<i>Azadirachta indica</i>	Meliaceae
14.	Phirphire	<i>Acer oblungum</i>	Aceraceae
15.	Ban Timur	<i>Zanthoxylum oxyphyllum</i>	Rutaceae
16.	Jamane Mandhro	<i>Mahoonia nipaulensis</i>	Berberidaceae
17.	Khari	<i>Celtis australis</i>	Ulmaceae
18.	Pafele	<i>Corydalis chaerophylla</i>	Piperaseae
19.	Mauva	<i>Engelhardia spicata</i>	Junglandaceae
20.	Sindhure	<i>Bixa orelana</i>	Boxaceae
21.	Kaphal	<i>Myrica esculenta</i>	Rosaceae
22.	Jure Kaphal	<i>Eriobotrya dubia</i>	Myricaceae
23.	Dhasingare	<i>Gaultheria fragrantissima</i>	Ericaceae
24.	Lali Gurash	<i>Rhodendron arboreum</i>	Ericaceae
25.	Ainselu-rato	<i>Rubus rosifolius</i>	Rosaceae
26.	Khari	<i>Celtis australis</i>	Ulmaceae
27.	Amriso	<i>Thysanolaena maxima</i>	Santalaceae
28.	Angeri	<i>Melastoma melabathricum</i>	Melastomaceae
29.	Asuro	<i>Justicia adhatoda</i>	Acanthaceae
30.	Cutro	<i>Berberis aristata</i>	Berberidaceae
31.	Dabdabe	<i>Garnga pinnats Roxb</i>	Borseraceac
32.	Dhaiyro	<i>Woodfordia fruticosa</i>	Lythraceae

33.	Dudhhilo	<i>Ficus neriifolia</i>	Moraceae
34.	Khirro	<i>Sapium insigene</i>	Euphorbiaceae
35.	Lapsi	<i>Choerospondias axillaries</i>	Anacardiaceae
36.	Lalupate	<i>Euphorbia pulcherrima</i>	Euphorbiaceae
37.	Narket	<i>Phragmites karka</i>	Gramineae
38.	Nigalo	<i>Drepanostachyum intermedium</i>	Gramineae
39.	Painyu	<i>Prunus cerasoides</i>	Rosaceae
40.	Pipal	<i>Ficus religiosa</i>	Moraceae
41.	Rudhilo	<i>Nyctanthes</i>	Oleaceae
42.	Sindure	<i>Bixa orellana</i>	Bixaceae
43.	Tanki	<i>Bauhinia purpurea</i>	Leguminosae
44.	Titepati	<i>Artemisia indica</i>	Compositae
45.	Unyu	<i>Dryopteris spss</i>	Aspidiaceae
46.	Uttis	<i>Alnus nepalensis</i>	Betulaceae
47.	Vanmara	<i>Eupatorium adenophorum</i>	Compositae
48.	Khasru	<i>Quercus semecarpifolia</i>	Fagaceae
49.	Mayal	<i>Pyrus pashia</i>	Rosaceae
50.	Bakkino	<i>Metea azedarach</i>	Maliaceae
51.	Jure Kaphal	<i>Eriobotrya dubia</i>	Rosaceae
52.	kahulo	<i>Terminalia arjuna</i>	Combretaceae
53.	Saur	<i>Betula alnoides</i>	Betulaceae
54.	Coya bans	<i>Dendrocalamus hamiltonii</i>	Gramineae
55.	Dursul	<i>Solanum jasminoides</i>	Solanaceae