

Avian Diversity in Association with Vegetation Structure in Outer Foothills of Garhwal Himalayas, Uttarakhand

Mohan Kukreti

Department of Zoology, Government Degree College Satpuli, Pauri Garhwal, Uttarakhand 246172, India

Corresponding author's e-mail: mohankukreti@gmail.com

ABSTRACT

In the present study vegetation structure variables and its association with bird community structure were analyzed at different forest sites of the outer Himalayas foothills of Uttarakhand. Bird and vegetation sampling was carried out in 24 predefined transects of 1 Km in forest habitat during January 2015 to December 2016. A total of 201 bird species belonging to 60 families were recorded at different elevations in the forest. Findings of this study suggest that the mean value of bird species richness (BSR: 14.70) and diversity (BSD: 4.31) was high at lower elevation sites (300-600 m asl) in comparison to mid (600-900 m asl) and higher elevation (900-1200 m asl) forest site. Avian species richness and diversity were positively correlated with tree density (BSR versus TD: $r = 0.86$; BSD versus TD: $r = 0.92$), plant species diversity (BSR versus PSD: $r = 0.85$; BSD versus PSD: $r = 0.91$), foliage height diversity (BSR versus FHD: $r = 0.89$; BSD versus FHD: $r = 0.83$), canopy cover (BSR versus CC: $r = 0.76$; BSD versus CC: $r = 0.84$) and canopy height (BSR versus CH: $r = 0.85$; BSD versus CH: $r = 0.77$). This study suggested that vegetation structure was a principal component upon the spatial pattern of bird species richness at the local scale.

Key words: Avian diversity, bird vegetation association, bird species richness, Himalayas, Garhwal

INTRODUCTION

Spatial diversity patterns have important implications for the conservation of biodiversity and understanding these patterns contributes to our knowledge of community structure (Collinge, 2001). Variation in vegetation structure elements in particular canopy cover, height, foliage and tree density strongly influences the avian composition and diversity in forest ecosystems (Holmes, 2011; Beskardes, *et al.*, 2018; Hanle, 2020). Vegetation structure is determined by physiognomy and floristic composition (Rotenberry, 1985), and the vertical arrangement of foliage provide shelter and cover, which increase bird species richness (MacArthur and MacArthur, 1961). Also, it is an important factor for the presence and absence of birds (Slater, 1995; Whelan, 2001). Several studies have shown how dependent bird species are on vegetation

structure (Slater, 1995; Hino, 2000; Ruiz-jaen and Aide, 2005). Measures of vegetation structure provide information on habitat suitability, ecosystem's productivity, and help to predict successional pathways (Wang *et al.*, 2004).

There are few studies in India describing vegetation characteristics and its association with avian diversity and richness (Pramod *et al.*, 1997; Vijayan *et al.*, 1998; Raman *et al.*, 1998; Kunte *et al.*, 1999; Chettri *et al.*, 2001; Jayson and Mathew, 2003; Bhatt and Joshi, 2011; Naithani and Bhatt, 2012; Acharya and Vijayan, 2017). Moreover, the Himalayan vegetation structure profile and avian diversity for a wider range remain relatively least investigated (Chettri *et al.*, 2001; Laiolo, 2002; Price *et al.*, 2003; Sultana *et al.*, 2007; Acharya *et al.*, 2011).

In the present study, an attempt was made to correlate avian diversity with different vegetation

structure variables such as canopy cover, tree density, foliage height diversity and plant species diversity, to understand how these variables affect the diversity of birds in three different forest sites located in outer foothills of Lansdowne forest Division of Pauri Garhwal district of Uttarakhand, India.

MATERIAL AND METHODS

Study sites

This study was conducted at three forest sites of Kotdwar and Laldhang forest ranges in Lansdowne Forest division situated between 29° 37' to 30°2' North latitude and 78°19'13" to 78° 43'0" East longitudinally located in the south west portion of district Pauri Garhwal of Uttarakhand state. In the North eastern part Chir (*Pinus roxburghii*) and Banj (*Quercus leucotrichophora*) forests can be found. The remaining parts are occupied by Sal (*Shorea robusta*) and associated species. The altitude of forest division varies from 200 m to 2000 m (Lal, 2004).

The three study sites are: low elevation site A (Kanvasram; 200-600 m asl; 29°47'49.98"N-78° 27'39.09"E), mid-elevation site B (Nadikatal; 600-

900 m asl; 29°54'40.38" N-78°26'13.96" E) and high-elevation site C (Mungaon reserve forest; 900-1200 m asl; 29°54'25.43"N-78° 25'49.70" E) (Fig. 1).

The floral species identified at the three study sites were as: dominant tree species like *Mallotus philippensis*, *Dalbergia sissoo*, *Terminalia alata*, *Acacia catechu*, *Bombax ceiba*, *Ficus benghalensis*, *F. racemosa*, *Cassia fistula*, *Sapium insigne*, *Holoptelea integrifolia*, *Syzygium cumini*, *Aegle marmelos*, *Ziziphus mauritiana*, *Ougeinia oojeinensis*, *Albizia odoratissima*, *Anogeissus latifolia*, *Holorrhena pubescens*, *Adina cordifolia*, and *Semecarpus anacardium*. Major Shrubs of the site are *Murraya koenigii*, *Lantana camara*, *Parthenium hysterophorus*, *Clerodendron infortunatum*, *C. viscosum*, *Ardisia solanacea*, *Dendrocalamus strictus*, *Desmodium triflorum*, *Asparagus adscendens* and *Vitex negundo*. Major herbs of the area are *Argemone Mexicana*, *Cynodon dactylon*, *Commelinae benghalensis* and *Saccharum spontaneum*, *Adhatodo vasica*, *Cannabis sativa*, *Cassia tora*, *Oxalis corniculata*, *Cyperus niveus*, *Apluda mutica*, *Chrysopogen gryllus*, *Eragrostis atrovirens*, *E. tenella*, *Themeda villosa*, *Thysanolanca maxima*.



Fig. 1. Showing location of study sites in Lansdowne Forest Division (Pauri Garhwal), Uttarakhand.

Bird Sampling

The fixed-length line-transect surveys (Verner, 1985) were carried out at all 24 transects (8 transect per site) in the year 2015 and 2016, covering all seasons. All birds seen or heard within 50 m on each side of the transect line were recorded, birds identified by sound were only counted if estimated to be within 30 m. All transects within forest sites were of equal length (1 Km each), at least 5 minutes were spend at vantage points in the predefined transect, if necessary, during which all birds identified by sight or by call were recorded to minimize the number of birds missed. In summer bird counts were undertaken only between 5 am to 8 am in the morning and 4 pm to 6 pm in the evening, while in winters predefined transects were covered from 6:30 am to 9:30 am in the morning and 3 pm to 6 pm in the evening only on fine days i.e., birds were not surveyed in extreme weather condition such as heavy rain, wind, fog, etc. (Bibby *et al.*, 1992; 2000; Buckland *et al.*, 1993). Each transect was regularly visited during each month, and this survey protocol were followed in subsequent years. For identification, field guide by Grimmett *et al.* (2001) and Ali (2002) were used and nomenclature was based on Praveen *et al.*, (2016) and its subsequent updates (Praveen *et al.*, 2018; Praveen *et al.*, 2019; Praveen *et al.*, 2020). The bird's migratory status were categorized as; resident, summer migrant, winter migrant, and resident altitudinal migrant on the basis of presence or absence data (Thakur *et al.*, 2010) and available literature (Grimmett *et al.*, 2001; Ali, 2002). Also, the residential status were classified as per MacKinnon and Phillipps (1993), on the basis of relative abundance (based on sighting frequency) as: common, uncommon, fair and rare. Avian

species were also categorized according to threatened categories of International Union for the Conservation of Nature (IUCN, 2018).

Vegetation Sampling

To understand the avifaunal-vegetation association, sampling of the forest habitats was carried out on transects used for bird census. Fifteen quadrates each in forest sites were randomly placed to quantify composition and structure of vegetation. For sampling trees, quadrates of size 10 m × 10 m were laid down in each forest site along the transects used for avian survey. Each quadrate was subdivided into a 5 m × 5 m sample plot for recording shrubs and 1 m × 1 m for herbs (Misra, 1968). Plant species were identified with the help of relevant floras described in Kanjilal, 1928 and Gaur, 1999. For canopy cover estimation, a grid consisting of 100 squares was used into the eyepiece of an 8 × 10 prismatic binocular (Olympus 10 × 50 DPSI). By looking through the objective at canopy directly above the point chosen in the predefined transect, the cover in percentage was estimated by counting off the number of squares with foliage in it and 20 readings were taken (Singh, 2004; Bibby *et al.*, 1992; Bibby *et al.*, 2000). Forest canopies were classified as open when the 10% to 39% of the sky is obstructed by tree canopies, moderately closed (tree canopies obstruct the sky by 40% to 69%), and closed canopies, if the sky is obstructed 70% to 100% (FSI, 2015). Canopy height for small trees was measured directly, for taller trees height can be measured trigonometrically by measuring the angle to the treetop observed from a known distance from the tree (Waring and Schlesinger, 1985; Leverett and Bertolette, 2015). 20 readings were taken in each transect laid and the mean

was used for analysis. Foliage cover was estimated by assigning all vegetation under stratification layers as follows: over-story cover (Above 10 m), mid-story cover (2 m to 10 m), lower canopy (0.5 m to 2 m), and ground layer (0 m to 0.5 m) (Richards, 1952; Short, 1986; Hnatiuk *et al.*, 2009). Foliage cover was estimated by using an acetate grid consisting of 100 squares on the viewfinder of an SLR camera with a 250 mm zoom lens, by looking at the foliage directly above the point chosen (Singh, 2004). The cover in percentage was estimated by counting off the number of squares with foliage in it at different height intervals (MacArthur and MacArthur, 1961) and then using the Shannon diversity index (Magurran, 2004) to calculate foliage height diversity (FHD). 20 points were chosen in each transect and the mean was used for analysis. Shannon index is used to measure the plant species diversity (PSD) (Magurran, 2004).

Data analysis

BSD and BSR were measured using Shannon's index and Margalef's richness index respectively using PAST 3.21 statistical software (Hammer *et al.*, 2001). Beta diversity was calculated as β

$$\frac{S}{\alpha - 1}$$

where, s is the total number of species and α is the average number of species (Whittaker, 1972). Pearson's correlation coefficient (r) was used for the analysis of bird vegetation relationship.

RESULTS AND DISCUSSION

Composition of bird communities in forest habitats

Avifaunal species recorded was 201 belonging to

60 families. Family Muscicapidae was found to be dominant (26 species), whereas Accipitridae was second highest with 12 species and family Picidae was third in the ranking with 11 species (appendix 1). A detailed description of the bird community structure has been given in table 1. When bird communities were compared among study sites, relatively high beta diversity values (Table 2) were observed between site A and site C than between site A and site B or between site B and C. The low value of beta diversity indicates that most of the avian species were overlapped between sites, while the high value shows the species variation between sites. This study revealed that bird species richness (BSR) was considerably higher in low elevation forest sites as compared to mid and high elevation because of declining habitat heterogeneity along an elevational gradient (Rahbek and Graves, 2001).

Vegetation structure of forest habitats

The mean canopy height (CH) was found to be 11.83m, canopy cover (CC) was 71.8(%) indicating closed canopy, tree density (TD) 109/100 m², foliage height diversity (FHD) (using 20 points in predefined transect used for birds survey) was 2.16, indicating mid-story and the value of plant species diversity (PSD) recorded was 2.87. The correlation between avian richness and diversity parameters with vegetation structure revealed that BSR and BSD is positively correlated with canopy cover (CC), tree density (TD), plant species diversity (PSD) and foliage height diversity (FHD) (Table 3).

The most common approximation for species diversity is species richness (Magurran, 2004) also known as α and β diversity (for local and regional species richness, respectively; Whittaker

1972). By contrast, species spatial turnover, or β diversity (Whittaker, 1972) is often neglected (Koleff *et al.*, 2003). In the present study, high values of β diversity were found between high elevation site (C) and low elevation site (A) in the forest, suggesting the distinct species community at different elevations. The low values of beta diversity observed between mid (B) and low elevation (A) indicate that most of

the avian species overlapped between these elevations, while high value showed the species variation between habitats (Table 2). The high values of β -diversity may be a result of two contributing factors: the large proportion of unique species, and the distinct spatial structures of the landscapes (Koleff *et al.*, 2003; Lira-Noriega *et al.*, 2007; Ochoa-Ochoa *et al.*, 2014).

Table 1. Comparative parameters of bird's diversity indices and vegetation structure variables among forest sites.

Parameters	(Site A) 200-600 (m asl)	(Site B) 600-900 (m asl)	(Site C) 900-1200 (m asl)
Shannon Species Diversity (H')	4.31	4.17	3.84
Species Richness	14.70	12.67	9.75
Total Species Recorded	155	126	97
Canopy Cover (CC)	69.4	72.4	73.6
Tree Diversity (TD)	95	113	119
Foliage Height Diversity (FHD)	2.11	2.23	2.13
Plant Species Diversity (PSD)	2.29	3.22	1.13

Table 2. Beta diversity values between forest habitat sites.

	Site A (300-600 m asl)	Site B (601-900 m asl)	Site C (901-1200 m asl)
Forest Site			
A	0	0.103	0.230
B		0	0.130
C			0

Table 3. The Pearson coefficients of correlation between bird species diversity (BSD) and bird species richness (BSR) with vegetation structure variables of forest sites.

Variables versus BSD/BSR	Correlation values (r)	p-value	r ² (R-squared)
TD			
TD vs. BSD	0.92	0.3	0.84
TD vs. BSR	0.86	0.3	0.74
CH			
CH vs. BSD	0.77	0.4	0.59
CH vs. BSR	0.85	0.4	0.71
CC			
CC vs. BSD	0.84	0.4	0.70
CC vs. BSR	0.76	0.5	0.58

FHD			
FHD vs. BSD	0.83	0.4	0.68
FHD vs. BSR	0.89	0.3	0.79
PSD			
PSD vs. BSD	0.91	0.3	0.83
PSD vs. BSR	0.85	0.4	0.73

Vegetation structure in different bird habitats often affects the distribution, abundance, richness, and diversity of the bird communities (Block and Brennan, 1993; Augenfeld *et al.*, 2008). It is also reported that birds not only get influenced by the physiognomic structure and complexity of the vegetation but also by the diversity of the flora that represents the forests (Chettri *et al.*, 2001; Rodewald and Abrams, 2002). Since our study was at the local scale, thus vegetation structure was a principal component upon the spatial pattern of bird species richness. In the present study, the tree density (TD), plant species diversity (PSD), and foliage height diversity (FHD) was highly significant and positively correlated, as 70% to 80% of the variation in BSD and BSR could be explained by these variables of vegetation structure. The TD account for 70% to 80% variation in the BSR and BSD in the forest site. Other studies also suggest that the presence of different tree species allows different opportunities for foraging, nesting, and shelter (Terborgh, 1985 and Lee and Rotteberry, 2005). On a large scale, different forest ecosystems offer widely varying habitat because of diverse tree species. Foliage height diversity (FHD), canopy cover (CC) and plant species diversity (PSD) also accounted for high variation of 60% to 80% in BSD and BSR in forest habitat. This pattern is attributed to the greater numbers of niches provided by forest owing to their higher

canopy cover and complexity of strata (Allen and Connor, 2000). It is also noted that complex vegetation structure and floristic composition heterogeneity increases niche diversity, which is thought to increase the avian diversity (Diaz, 2006). In a landmark study, MacArthur and MacArthur (1961) established a linear relationship between FHD (which described as the arrangement of foliage within different vertical strata) and BSD and this is supported by other subsequent studies (Karr and Roth, 1971; Ambuel and Temple, 1983). This has encouraged the use of FHD as a measure of forest structure and its acceptance by some authors as a reliable indicator of biodiversity (Daniels, 1992; Tanabe *et al.*, 2001), although there is a little evidence to suggest that FHD can explain differences in the diversity of faunal groups other than birds. The present study also does not provide any evidence in support of MacArthur and MacArthur's observation.

Canopy height (CH) also accounts for 70% to 80% variation in BSD and BSR in forest landscapes. Some studies noted that older trees provided more food availability for foliage and trunk gleaner as well as more breeding sites for bird's nesting in tree holes (Thomson *et al.*, 1999 and Keller *et al.*, 2003). Bird species, which diversity was found to be correlated with tree species was also demonstrated by Peck (1989) for British forest birds. About 50 years ago Margalef (1958)

suggested a sigmoid relation between diversity and cover. The grass layer also adds slightly to avian diversity. With the addition of the first shrub cover, diversity increases more rapidly. However, if more coverage is added, diversity decreases as it restricts the mobility of the avifauna in the very dense foliage. An increase in structural complexity and floristic composition quite often are related to the enrichment of associated bird communities since more heterogeneity allows more species to create niches (Shochat *et al.*, 2001; Poulsen, 2002; Laiolo, 2002; Machtans and Latour, 2003). These results were also in conformity with Karr and Roth (1971). Blair (1996) and Henning's and Edge (2003) put a similar argument that bird species richness and diversity peaked in areas with moderate canopy cover.

In the present study low diversity and richness was found in high elevation in comparison to low and mid elevation forest site. Some studies also emphasized that low bird density and diversity at higher elevations are due to the fact that such areas act as ecological islands (Prodon *et al.*, 2002; Kattan and Franco, 2004; Diaz, 2006). Apart from these reasons, the higher altitudes had dense canopy cover which may be one of the factors that affect both bird species richness and diversity negatively. However, present study showed that canopy cover positively and significantly correlated with BSD and BSR in the forest sites.

CONCLUSION

This study concluded that vegetation structure variables are important in determining avian species diversity and richness, as these were highly correlated in different forest sites at the regional level.

This study has conservation implications for forest habitat management by maintaining the vegetation structure in terms of vertical stratification and the cover. Also, the variations in beta diversity values among study sites suggesting the distinctiveness of avian community at local scale, which need to be conserved in their natural habitats.

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Appendix 1. List of the avian species observed in the study area.

Family/Scientific name	Common name	Residential Status	Abundance	IUCN Status*
PHASIANIDAE				
<i>Pavo cristatus</i>	Indian Peafowl	R	C	Least Concern
<i>Gallus gallus</i>	Red Junglefowl	R	F	Least Concern
<i>Lophura leucomelanos</i>	Kalij Pheasant	R	F	Least Concern
<i>Francolinus francolinus</i>	Black Francolin	R	R	Least Concern
<i>Francolinus pondicerianus</i>	Grey Francolin	R	U	Least Concern
<i>Perdica asiatica</i>	Jungle Bush Quail	R	U	Least Concern
PICIDAE				
<i>Micropternus brachyurus</i>	Rufous Woodpecker	R	r	Least Concern
<i>Dendrocopos macei</i>	Fulvous-breasted Woodpecker	R	f	Least Concern
<i>Dendrocopos canicapillus</i>	Grey-capped Pygmy Woodpecker	R	c	Least Concern
<i>Dendrocopos hyperythrus</i>	Rufous-bellied Woodpecker	R	f	Least Concern
<i>Picus chlorolophus</i>	Lesser Yellownape	R	r	Least Concern
<i>Picus canus</i>	Grey-headed Woodpecker	R	f	Least Concern
<i>Chrysophlegma flavinucha</i>	Greater Yellownape	R	r	Least Concern
<i>Picus xanthopygaeus</i>	Streak-throated Woodpecker	R	r	Least Concern
<i>Dinopium benghalense</i>	Black-rumped Flameback	R	c	Least Concern
<i>Dinopium shorii</i>	Himalayan Flameback	R	r	Least Concern
<i>Chrysocolaptes lucidus</i>	Greater Flameback	R	u	Least Concern
RAMPHASTIDAE				
<i>Psilopogon zeylanicus</i>	Brown-headed Barbet	R	c	Least Concern
<i>Psilopogon virens</i>	Great Barbet	R	r	Least Concern
<i>Psilopogon asiaticus</i>	Blue-throated Barbet	R	f	Least Concern
<i>Psilopogon haemacephalus</i>	Coppersmith Barbet	R	r	Least Concern
<i>Psilopogon lineatus</i>	Lineated Barbet	R	r	Least Concern
BUCEROTIDAE				
<i>Ocyrceros birostris</i>	Indian Grey Hornbill	R	c	Least Concern
UPUPIDAE				
<i>Upupa epops</i>	Common Hoopoe	R	c	Least Concern
CORACIIDAE				
<i>Coracias benghalensis</i>	Indian Roller	R	f	Least Concern
<i>Eurystomus orientalis</i>	Dollarbird	R	r	Least Concern
ALCEDINIDAE				
<i>Alcedo atthis</i>	Common Kingfisher	R	f	Least Concern
<i>Pelargopsis capensis</i>	Stork-billed Kingfisher	R	r	Least Concern
<i>Halcyon smyrnensis</i>	White-throated Kingfisher	R	c	Least Concern
<i>Ceryle rudis</i>	Pied Kingfisher	R	f	Least Concern
<i>Megaceryle lugubris</i>	Crested Kingfisher	WM	r	Least Concern
MEROPIIDAE				
<i>Merops orientalis</i>	Green Bee-Eater	R	c	Least Concern
<i>Nyctornis athertonii</i>	Blue-bearded Bee-Eater	R	r	Least Concern

<i>Merops leschenaulti</i>	Chestnut-headed Bee-Eater	R	f	Least Concern
CUCULIDAE				
<i>Hierococcyx varius</i>	Common Hawk Cuckoo	RAM	f	Least Concern
<i>Taccocua leschenaultii</i>	Sirkeer Malkoha	SM	r	Least Concern
<i>Eudynamys scolopaceus</i>	Asian Koel	R	c	Least Concern
<i>Centropus sinensis</i>	Greater Coucal	R	u	Least Concern
PSITTACULIDAE				
<i>Psittacula eupatria</i>	Alexandrine Parakeet	R	f	Near Threatened
<i>Psittacula krameri</i>	Rose-ringed Parakeet	R	c	Least Concern
<i>Psittacula himalayana</i>	Slaty-headed Parakeet	RAM	u	Least Concern
<i>Psittacula cyanocephala</i>	Plum-headed Parakeet	R	c	Least Concern
STRIGIDAE				
<i>Glaucidium cuculoides</i>	Asian Barred Owlet	R	r	Least Concern
<i>Glaucidium radiatum</i>	Jungle Owlet	R	u	Least Concern
<i>Otus sunia</i>	Oriental Scops Owl	R		
CAPRIMULGIDAE				
<i>Caprimulgus macrurus</i>	Large-tailed Nightjar	R	r	Least Concern
COLUMBIDAE				
<i>Streptopelia orientalis</i>	Oriental Turtle Dove	RAM	f	Least Concern
<i>Streptopelia tranquebarica</i>	Red Collared Dove	SM	r	Least Concern
<i>Chalcophaps indica</i>	Emerald Dove	R	r	Least Concern
<i>Treron sphenurus</i>	Wedge-tailed Green Pigeon	RAM	r	Least Concern
<i>Treron phoenicopterus</i>	Yellow-footed Green Pigeon	RAM	r	Least Concern
<i>Treron apicauda</i>	Pin-tailed Green Pigeon	R	u	Least Concern
RALLIDAE				
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	R	r	Least Concern
SCOLOPACIDAE				
<i>Actitis hypoleucos</i>	Common Sandpiper	WM	r	Least Concern
<i>Tringa ochropus</i>	Green Sandpiper	WM	r	Least Concern
CHARADRIIDAE				
<i>Vanellus duvaucelii</i>	River Lapwing	R	f	Near Threatened
<i>Vanellus indicus</i>	Red-wattled Lapwing	R	c	Least Concern
ACCIPITRIDAE				
<i>Pernis ptilorhynchus</i>	Oriental Honey-buzzard	R	u	Least Concern
<i>Elanus caeruleus</i>	Black-shouldered Kite	R	f	Least Concern
<i>Milvus migrans</i>	Black Kite	RAM	c	Least Concern
<i>Neophron percnopterus</i>	Egyptian Vulture	R	u	Endangered
<i>Gyps bengalensis</i>	White-rumped Vulture	R	r	Critically Endangered
<i>Gyps himalayensis</i>	Himalayan Griffon	WM	r	Near Threatened
<i>Spilornis cheela</i>	Crested Serpent Eagle	WM	u	Least Concern
<i>Accipiter badius</i>	Shikra	R	f	Least Concern
<i>Accipiter nisus</i>	Eurasian Sparrow hawk	WM	u	Least Concern
<i>Accipiter gentilis</i>	Northern Goshawk	WM	r	Least Concern
<i>Butastur teesa</i>	White-eyed Buzzard	R	u	Least Concern
<i>Nisaetus cirrhatus</i>	Changeable Hawk Eagle	SM	u	Least Concern

FALCONIDAE				
<i>Falco tinnunculus</i>	Common Kestrel	WM	r	Least Concern
PHALACROCORACIDAE				
<i>Microcarbo niger</i>	Little Cormorant	R	u	Least Concern
ARDEIDAE				
<i>Egretta garzetta</i>	Little Egret	WM	f	Least Concern
<i>Ardea intermedia</i>	Intermediate Egret	WM	r	Least Concern
<i>Bubulcus ibis</i>	Cattle Egret	R	c	Least Concern
<i>Ardeola grayii</i>	Indian Pond Heron	R	r	Least Concern
PITTIDAE				
<i>Pitta brachyura</i>	Indian Pitta	SM	r	Least Concern
EURYLAIMIDAE				
<i>Psarisomus dalhousiae</i>	Long-tailed Broadbill	SM	r	Least Concern
IRENIDAE				
<i>Chloropsis hardwickii</i>	Orange-bellied Leafbird	WM	r	Least Concern
<i>Chloropsis aurifrons</i>	Golden-fronted Leafbird	R	u	Least Concern
LANIIDAE				
<i>Lanius cristatus</i>	Brown Shrike	WM	u	Least Concern
<i>Lanius schach</i>	Long-tailed Shrike	R	c	Least Concern
<i>Lanius tephronotus</i>	Grey-backed Shrike	WM	r	Least Concern
CORVIDAE				
<i>Urocissa erythrorhyncha</i>	Red-billed Blue Magpie	RAM	u	Least Concern
<i>Cissa chinensis</i>	Common Green Magpie	R	r	Least Concern
<i>Dendrocitta vagabunda</i>	Rufous Treepie	R	c	Least Concern
<i>Dendrocitta formosae</i>	Grey Treepie	RAM	f	Least Concern
<i>Corvus splendens</i>	House Crow	R	c	Least Concern
<i>Corvus macrorhynchos</i>	Large-billed Crow	R	c	Least Concern
ORIOLIDAE				
<i>Oriolus oriolus</i>	Eurasian Golden Oriole	SM	r	Least Concern
<i>Oriolus xanthornus</i>	Black-hooded Oriole	R	f	Least Concern
<i>Oriolus traillii</i>	Maroon Oriole	RAM	r	
CAMPEPHAGIDAE				
<i>Coracina javensis</i>	Large Cuckooshrike	R	u	Least Concern
<i>Lalage melaschistos</i>	Black-winged Cuckooshrike	RAM	r	Least Concern
<i>Lalage melanoptera</i>	Black-headed Cuckooshrike	R	f	Least Concern
<i>Pericrocotus roseus</i>	Rosy Minivet	SM	r	Least Concern
<i>Pericrocotus cinnamomeus</i>	Small Minivet	R	f	Least Concern
<i>Pericrocotus ethologus</i>	Long-tailed Minivet	RAM	f	Least Concern
<i>Pericrocotus flammeus</i>	Scarlet Minivet	RAM	r	Least Concern
VANGIDAE				
<i>Tephrodornis pondicerianus</i>	Common Woodshrike	R	f	Least Concern
<i>Chelidorhynch hypoxanthus</i>	Yellow-bellied Fantail	RAM	f	Least Concern
RHIPIDURIDAE				
<i>Rhipidura albicollis</i>	White-throated Fantail	R	c	Least Concern
DICRURIDAE				
<i>Dicrurus macrocercus</i>	Black Drongo	R	c	Least Concern

<i>Dicrurus leucophaeus</i>	Ashy Drongo	WM	r	Least Concern
<i>Dicrurus caerulescens</i>	White-bellied Drongo	R	r	Least Concern
<i>Dicrurus aeneus</i>	Bronzed Drongo	RAM	r	Least Concern
<i>Dicrurus hottentottus</i>	Spangled Drongo	RAM	f	Least Concern
MONARCHIDAE				
<i>Hypothymis azurea</i>	Black-naped Monarch	R	r	Least Concern
<i>Terpsiphone paradise</i>	Asian Paradise-flycatcher	RAM	f	Least Concern
AEGITHINIDAE				
<i>Aegithina tiphia</i>	Common Iora	R	r	Least Concern
CINCLIDAE				
<i>Cinclus pallasi</i>	Brown Dipper	R	r	Least Concern
MUSCICAPIDAE				
<i>Monticola cinclorhynchus</i>	Blue-capped Rock Thrush	SM	r	Least Concern
<i>Monticola solitarius</i>	Blue Rock Thrush	WM	r	Least Concern
<i>Myophonus caeruleus</i>	Blue Whistling Thrush	RAM	c	Least Concern
<i>Muscicapa sibirica</i>	Dark-sided Flycatcher	WM	f	Least Concern
<i>Muscicapa dauurica</i>	Asian Brown Flycatcher	SM	r	Least Concern
<i>Anthipes monileger</i>	Rufous-gorgeted Flycatcher	WM	r	Least Concern
<i>Ficedula parva</i>	Red-breasted Flycatcher	WM	r	Least Concern
<i>Ficedula westermanni</i>	Little Pied Flycatcher	R	f	Least Concern
<i>Ficedula tricolor</i>	Slaty-blue Flycatcher	WM	r	Least Concern
<i>Eumyias thalassina</i>	Verditer Flycatcher	RAM	f	Least Concern
<i>Niltava sundara</i>	Rufous-bellied Niltava	RAM	u	Least Concern
<i>Cyornis unicolor</i>	Pale Blue Flycatcher	WM	r	Least Concern
<i>Cyornis rubeculoides</i>	Blue-throated Flycatcher	SM	f	Least Concern
<i>Culicicapa ceylonensis</i>	Grey-headed Canary-Flycatcher	RAM	c	Least Concern
<i>Saxicolini</i>	White-tailed Rubythroat	WM	r	Least Concern
<i>Luscinia pectoralis</i>	Bluethroat	WM	f	Least Concern
<i>Luscinia svecica</i>	Oriental Magpie Robin	R	c	Least Concern
<i>Copsychus saularis</i>	White-rumped Shama	R	r	Least Concern
<i>Copsychus malabaricus</i>	Indian Robin	R	c	Least Concern
<i>Saxicoloides fulicata</i>	Blue-capped Redstart	WM	r	Least Concern
<i>Phoenicurus coeruleocephalus</i>				
<i>Phoenicurus ochruros</i>	Black Redstart	WM	f	Least Concern
<i>Chaimarrornis leucocephalus</i>	White-capped Water Redstart	WM	f	Least Concern
<i>Rhyacornis fuliginosus</i>	Plumbeous Water Redstart	WM	f	Least Concern
<i>Enicurus maculatus</i>	Spotted Forktail	R	r	Least Concern
<i>Saxicola torquata</i>	Common Stonechat	WM	f	Least Concern

<i>Saxicola caprata</i>	Pied Bushchat	R	f	Least Concern
TURDIDAE				
<i>Turdus bouboul</i>	Grey-winged Blackbird	RAM	u	Least Concern
<i>Geokichla citrine</i>	Orange-headed Thrush	SM	r	Least Concern
STURNIDAE				
<i>Sturnus malabaricus</i>	Chestnut-tailed Starling	RAM	f	Least Concern
<i>Acridotheres fuscus</i>	Jungle Myna	R	c	Least Concern
SITTIDAE				
<i>Sitta castanea</i>	Chestnut-bellied Nuthatch	R	u	Least Concern
<i>Sitta frontalis</i>	Velvet-fronted Nuthatch	R	u	Least Concern
<i>Tichodroma muraria</i>	Wallcreeper	WM	u	Least Concern
CERTHIIDAE				
<i>Certhia himalayana</i>	Bar-tailed Treecreeper	WM	r	Least Concern
PARIDAE				
<i>Parus major</i>	Great Tit	R	c	Least Concern
<i>Parus monticolus</i>	Green-backed Tit	RAM	u	Least Concern
<i>Machlolophus xanthogenys</i>	Black-lored Tit	R	r	Least Concern
AEGITHALIDAE				
<i>Aegithalos concinnus</i>	Black-throated Tit	R	r	Least Concern
HIRUNDINIDAE				
<i>Riparia paludicola</i>	Plain Martin	R	u	Least Concern
PYCNONOTIDAE				
<i>Pycnonotus melanicterus</i>	Black-crested Bulbul	RAM	r	Least Concern
<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	R	u	Least Concern
<i>Pycnonotus leucogenis</i>	Himalayan Bulbul	R	c	Least Concern
<i>Pycnonotus cafer</i>	Red-vented Bulbul	R	c	Least Concern
<i>Hypsipetes leucocephalus</i>	Black Bulbul	RAM	f	Least Concern
CISTICOLIDAE				
<i>Prinia crinigera</i>	Striated Prinia	WM	u	Least Concern
<i>Prinia flaviventris</i>	Yellow-bellied Prinia	WM	r	Least Concern
<i>Prinia hodgsonii</i>	Grey-breasted Prinia	R	c	Least Concern
<i>Prinia socialis</i>	Ashy Prinia	R	f	Least Concern
<i>Prinia inornata</i>	Plain Prinia	R	f	Least Concern
ZOSTEROPIDAE				
<i>Zosterops palpebrosus</i>	Oriental White-eye	R	c	Least Concern
SCOTOCERCIDAE				
<i>Hemitesia pallidipes</i>	Pale-footed Bush Warbler	WM	u	Least Concern
CISTICOLIDAE				
<i>Orthotomus sutorius</i>	Common Tailorbird	R	c	Least Concern
PHYLLOSCOPIIDAE				

<i>Phylloscopus collybita</i>	Common Chiffchaff	WM	f	Least Concern
<i>Abrornis inornatus</i>	Yellow-browed Warbler	WM	r	Least Concern
<i>Abrornis humei</i>	Hume's Warbler	WM	u	Least Concern
<i>Seicercus trochiloides</i>	Greenish Warbler	RAM	u	Least Concern
<i>Seicercus reguloides</i>	Blyth's Leaf Warbler	WM	r	Least Concern
<i>Seicercus burkii</i>	Golden-spectacled Warbler	WM	u	Least Concern
<i>Seicercus xanthoschistos</i>	Grey-hooded Warbler	RAM	f	Least Concern
LEIOTHRICHIDAE				
<i>Garrulax albogularis</i>	White-throated Laughingthrush	R	u	Least Concern
<i>Garrulax leucolophus</i>	White-crested Laughingthrush	RAM	u	Least Concern
<i>Trochalopteron lineatum</i>	Streaked Laughingthrush	R	u	Least Concern
PELLORNEIDAE				
<i>Pellorneum ruficeps</i>	Puff-throated Babbler	RAM	u	Least Concern
TIMALIIDAE				
<i>Mixornis gularis</i>	Stripied Tit-Babbler	RAM	c	Least Concern
<i>Erythrogonys erythrogonys</i>	Rusty-cheeked Scimitar Babbler	RAM	u	Least Concern
<i>Pomatorhinus schisticeps</i>	White-browed Scimitar Babbler	RAM	u	Least Concern
<i>Cyanoderma pyrrhops</i>	Black-chinned Babbler	R	f	Least Concern
LEIOTHRICHIDAE				
<i>Leiothrix lutea</i>	Red-billed Leiothrix	RAM	f	Least Concern
<i>Siva cyanouroptera</i>	Blue-winged Minla	R	r	Least Concern
SYLVIIDAE				
<i>Curruca curruca</i>	Lesser Whitethroat	WM	u	Least Concern
ALAUDIDAE				Least Concern
<i>Alauda gulgula</i>	Oriental Skylark	WM	r	Least Concern
DICAEIDAE				
<i>Dicaeum erythrorhynchus</i>	Pale-billed Flowerpecker	R	f	Least Concern
<i>Dicaeumignipectus</i>	Fire-breasted Flowerpecker	WM	r	Least Concern
NECTARINIIDAE				
<i>Nectarinia asiatica</i>	Purple Sunbird	R	c	Least Concern
<i>Aethopyga siparaja</i>	Crimson Sunbird	R	f	Least Concern
<i>Aethopyga ignicauda</i>	Fire-tailed Sunbird	WM	u	Least Concern
PASSERIDAE				
<i>Passer cinnamomeus</i>	Russet Sparrow	R	r	Least Concern
<i>Gymnoris xanthocollis</i>	Chestnut-shouldered Petronia	R	f	Least Concern
MOTACILLINAE				
<i>Motacilla alba</i>	White Wagtail	WM	f	Least Concern
<i>Motacilla maderaspatensis</i>	White-browed Wagtail	R	f	Least Concern

<i>Motacilla citreola</i>	Citrine Wagtail	WM	r	Least Concern
<i>Motacilla flava</i>	Yellow Wagtail	WM	u	Least Concern
<i>Motacilla cinerea</i>	Grey Wagtail	RAM	u	Least Concern
PLOCEIDAE				
<i>Ploceus philippinus</i>	Baya Weaver	R	f	Least Concern
ESTRILDIDAE				
<i>Lonchura striata</i>	White-rumped Munia	WM	r	Least Concern
<i>Lonchura punctulata</i>	Scaly-breasted Munia	R	f	Least Concern
FRINGILLIDAE				
<i>Serinus pusillus</i>	Fire-fronted Serin	WM	r	Least Concern
<i>Carpodacus erythrinus</i>	Common Rosefinch	WM	f	Least Concern

Abbreviations: **R**, Resident; **SM**, Summer Migrant; **WM**, Winter Migrant; **RAM**, Resident altitudinal migrant; **c**, Common; **u**, Uncommon; **f**, fair; **r**, rare.

***IUCN:** IUCN Red List data for observed species according to IUCN version 2018-2.