Assessment of varied parameters of Avifauna diversity in Southern landscape of Kashmir valley, Jammu and Kashmir, India

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Abstract

The study was conducted in Southern landscape of Kashmir valley, India .During the current study in the selected transects spanning over a period of one year (August 2021to July 2022), n= 49 species of birds spread over 14 orders and 28 families were observed during the field investigation . In the entire landscape order passeriformes was found to be predominant order amongst all the orders with an overall representation of n=23 species and family Muscicapidae was found to be dominant family amongst all the families with an aggregation of n=7 species .Transect wise highest species diversity was recorded in transect Ⅱ with Shanon- weiner diversity index value of 2.77 followed by transect Ⅰ with a species diversity index of 2.74.The least species diversity was observed in transect Ⅳ with a diversity index value of 2.42. Statistical analysis through ANOVA showed no significant difference in the mean bird diversity between the transect (*F* = 0.59 , F *Crit* = 2.75 , *df = 3,62 , p-value* = 0.62 (> 0.05) . On comparing the mean avifauna diversity in different seasons by employing ANOVA , it was revealed that there is no statistically significant difference in the mean avifauna diversity in different seasons *(F*=3.14, F *Crit* = 3.49, *df = 3,12,* p-value 0.06) (p-value > 0.05) During the current study in the selected transects ,the most predominant species in terms of abundance in the entire landscape of South Kashmir valley were recorded to be *Passer Domesticus, Columba livia, Acridotheres tristis , Corvus splendens, Pycnonotus leucogenys* and *Hirundo rustica* .The predominance of these species has been established by other researchers during their field surveys in other parts of jammu and Kashmir and is thus ample clear that these species have successfully adapted to challenging environments and have thrived in extreme hostile conditions ranging from high altitude dominated forest habitat to highly urbanized settings and are also living in close proximity with human settlements

Key words:

Avifauna, Diversity, Relative abundance , Species richness , species evenness.

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INTRODUCTION

Bird community structure is considered as an inevitable component of vibrant ecosystem and is reflective of the quality of the habitats. Birds are truly considered as one of the best tools and parameters of environmental vitality of any ecosystem because of their sensitivity to various kinds of perturbances. Avian community composition exhibits variation across flora types and is dependent on stratification , elevation , covering , density ,time of year and disturbance (Das 2009; Jayson and Mathew 2003).Avian species diversity and richness varies greatly and not all species are uniformly distributed over a large ecological area because of varied nature of

topography, vegetation composition and structure and availability of food and other factors influence species occurrence . The Kashmir valley is home to many resident and migratory birds (Rahmani et al.2016). Kashmir valley is supremely blessed with rich avifauna diversity owing to its varied topography and climatic conditions .Kashmir valley is home to 187 species of breeding birds spread over 46 families and 16 orders (Shah and Qadri , 1988; Shah et al.2013) Heterogeneous geography, varied topography and climatic variability has rendered north western Himalayan region an biodiversity hot spots and represents one of the vital ecological amplitudes in the world (Korner 2000; Myers et al. 200).Jammu and Kashmir forms sensitive Endemic bird area (EBA 128) characterized by 11 restricted –range species (Stattersfield et al.1998) . Availability of basic requisites such as food, shelter , roosting and nesting sites primarily influence bird community organization (Vaclav et al .2003; Rompre et al 2007) and these basic requirements are not equally available throughout different seasons (Chauhan et al 2008; Kumar et al .2010) . Avian abundance is also affected by other factors such as migration, natality and mortality or due to changes in habitat structure and distribution pattern of food resources .Research data has pointed out strong patterns of association between bird community structure and the physical configuration of the environment .

Birds are inevitable predictors and determiners of integrity and function of habitats (Mukhopadhyay and Mazumdar 2019) ,ecosystem vibrancy and stress (MacArthur and MacArthur 1961; Taper et al .1995), richness and conservation significance (Pearman 2002; Bensizerare et al .2013).The accessibility of food and food exploitation trend (Rosenberg 1990; Palmer et al .2003) in a particular habitat govern distribution of birds (Evans and Dugan 1984) and community organization (Bonilla et al .2012) .Evaluation of foraging guilds and habitat preferences among avifauna are integral in decoding their responses to dynamic habitats and consequently their conservation policies (Lawton et al .1998; Sekercioglu 2006). Human influenced environment affects bird community structure in either positive or negative ways depending up on the resilience and biology of each functional group 9 Clough et al .2009)

Though Indian sub-continent contributes immensely to avian diversity and India alone accounts for 13% of world species richness (Javed and Koul 2000) and their taxonomy, distribution and general habitat characteristics are well documented in India. Contrary to well documented data, very scarce information is available regarding avian community structure and their dynamics in India. Analyzing and understanding the diversity and bird community organization is a vital parameter to delineate the significance of regional landscape for conservation of avifauna. The ultimate purpose of current study is to consolidate the avifauna data base in Southern landscape of Kashmir valley and becomes a base line for future research in the field of ornithology to effectively mitigate the challenges faced by biodiversity in general and avifauna in particular .

Materials and methods .

Study area

The study was conducted in Southern landscape of Kashmir valley, India. The central site of this study was selected as District Anantnag with geographical coordinates 33.7050^{o}N Latitude , 75.2479^{o}E longitude .The study area was divided into three transects .The district is one of the old established and historical district of jammu and Kashmir and is truly referred as district of springs .The district is home to famous Martand temple and Pilgrimage of Shri Amaranth ji. The prominent

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plant diversity in the study area include Abies pindrow, Acer caesium, Aesculus indica , Betula utilis, cedrus deodara,pinus wallichiana,Robina Morchella esculenta,oxyria digyna, Taraxacum officinale,Rheum emodi, Taxus baccata,Fraxinus floribunda, Populus deltoides, salix alba, Pyrus pashia, ulmus wallichiana,Juglans regia ,Urtica dioica,Platanus orientalis, Cyanodon dactylon Pyrus malus, ulmus wallichiana etc.The study area was divided in three transects .

Transects of study area

Study area	Name of the transect	Geographical coordinates
Southern landscape of Kashmir valley	Transect Ⅰ (Salia)	33.8086^{o} N latitude , 75.2714^{o} E Longitude
	Transect Ⅱ (Anchidora)	33.7417^{o} N Longitude, 75.1626^{o} E Longitude
	Transect Ⅲ (Akura)	33.77128^{o} N Latitude, 75.1866^{o} E
	Transect Ⅳ (Lal Chowk)	33.7303^{o} N Latitude, 75.1505^{o} E longitude

Data collection:

With an ultimate aim to showcase the features of avian community organization especially species diversity, richness and relative abundance, holistic and comprehensive field investigations were organized in the designated transects during the study period (August 2021 to July 2022).The peripheral extremities of the transects were also included in the survey exercise for opportunistic bird sighting .Sampling of data was executed by

1. Line Transect Method (Verner, 1985) : In line transect method , sampling was executed by walking through specific selected routes . Four transects of varying lengths (200m to 300 m) were demarcated to cover entire study area. Organized surveys were performed 1n 17 sampling units regarded as permanent line transects .These linear transects of varying dimensions were established based on the nature of the habitat , topography and accessibility to the site .

2. Point count method

The avifauna diversity in selected transects was also observed and recorded on the basis of point count method .The numbering of birds was done with in 200m radius of the transect. 13 point count stations were established based on varied features such as accessibility to site, habitat type and topography. The diagnosis of birds was facilitated primarily on the basis of external features such as size, shape, colour of feathers, wings, eyes, legs and other characteristics as meticulously projected by Ali (2012). The photographs clicked during the field survey were sophisticatedly cross checked with accurate precision with the images available in online repository such as that of Bird life international 2021 and birds of the world 2022 and to rule out any sort of laxity ,the pictures were double cross checked from Ali and Ripley(2001) and Grimmet et al (2011) . For biological categorization, we have followed

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Clements et al. (2017) in the current communication. In the selected transects readings were undertaken at an interval of three days accounting approximately two readings a week, except during harsh winter when the bird sighting was not a usual affair as the entire surface and structures remain covered with snow, the reading were taken on weekly basis. The timing of taking readings varied between seasons. In summer season, data was collected from 6.00-8.00 am in the morning or from 5.00 pm -8.00 pm in the evening .While as during winter, the data was recorded from 8.00 am-10.00 am or from 4.00-5.30 pm in the evening.

Bird Community organization

Field investigations were executed and observations were recorded in the selected transects.

Calculative estimations were done specifically for following parameters :

(a)**Species diversity** : Species diversity was measured using Shanon- Weiner index (H) as elaborated by Spellerberg and Fedor (2003) and Simpson's Diversity index (D).The formula of Shanon –weiner diversity index employed for diversity related calculations is

$$H= -\sum pi \ln pi.$$

Where pi represents proportion of *ith* avian species.

H represents 'Shannon's Diversity index'

The formula for calculating Simpson's Diversity index to measure avian diversity is

$$D=1-(\sum n(n-1)/N(N-1)$$

Where

n = total number of individuals of a particular species.

N = Total number of individuals of all the species.

∑ = the sum of

D = is Simpson's index.

The value of Simpson's diversity index(D) ranges between 0-1 With value close to 1 represents perfect species diversity and value close or near to 0 indicates poor species diversity.

(b)**Species richness** : Species richness represents total number of species in a given area .

Species richness was calculated using *Margalef's index* . This index estimates species richness of a sample . It has been chosen for its convenience in ease of calculation and its wide spread applicability (Magurran 2004) . Margalef's index is calculated by:

RI = S-1 /lnN Where S = Total number of species in a sample and N denotes total number of individuals in the sample.

(c)**Relative abundance** : The formula employed for calculating Relative abundance is

$$ni/N \times 100$$

Where *ni* denotes the number of ith species and N represents total number of birds seen in a given area.

(d)**Species evenness:** Species evenness is also known as Equitability and is denoted by letter E.The formula for calculating evenness is

$$E= H/H'max$$

Equatability = H/Hmax Or Hmax = ln(R), Where R is species richness

Or Equatability = H/ln®

Where

H represents observed species diversity or absolute species diversity.

H max is the log of total number of species richness (Krebs 1985)

Statistical Analysis:

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ANOVA was employed to compare the data and analyse if there is any significant difference in the mean diversity between the transects and consequently validate or reject Null hypothesis (H_o).

Null Hypothesis = There is no significant difference in the mean diversity of avifauna between the transects.

$$\mu_1 = \mu_2 = \mu_3 = 0$$

Alternate hypothesis = There is at least one significant difference in the mean diversity of avifauna between the transects.

$$\mu_1 = \mu_2 \neq \mu_3 \neq 0$$

The attributes of ANOVA that were measured included

F Distribution value , F *Crit, df and* p-value .

p-value was greater than 0.05 validates null hypothesis and p-value less than 0.05 led to rejection of null hypothesis. *F* distribution value higher than F *Crit* validates rejection of null hypothesis.

Avifauna Diversity observed in Transect Ⅰ.

In transect I n=27 species belonging to 6 orders spread over 15 families were observed during field investigation. Out of these 6 orders, order passeriformes (Table 1)was found to be the most predominant order comprising of n=19 species (70.4%), followed by order Piciformes (n=2, 7.4% species), Columbiformes (n=2, 7.4% species), Accipitriformes (n=2,7.4% In terms of family dominance, family Muscicapidae was found to be the most predominant family amongst all the observed families with a total aggregation of n=5 species (18.51%), followed by family Corvidae with n=4 species. (14.81%).

Table 1: Species diversity observed in transect Ⅰ.

Serial no.	*Scientific Name*	Common Name	Order	Family
1	*Passer Domesticus*	House sparrow	Passeriformes	Passeridae
2	*Acridotheres Tristis*	Common myna	Passeriformes	Sturnidae
3	*Columba livia*	Rock pigeon	Columbiformes	Columidae
4	*Corvus splendns zugmkayeri*	House crow	Passeriformes	Corvidae
5	*Pycnonotus Leucogenys*	White cheeked bulbul	Passeriformes	Pycnonotidae
6	*Corvus Macrorynchos*	Jungle crow	Passeriformes	Corvidae
7	*Saxicola Ferreus*	Grey Bushchat	Passeriformes	Muscicapidae
8	*Rhyacornis Fuliginosus*	Plumbeous Redstart	Passeriformes	Muscicapidae
9	*Corvus Mondula*	Western Jackdaw	Passeriformes	Corvidae
10	*Muophonus Caeruleus*	Blue whistling thrush	Passeriformes	Muscicapidae
11	*Motacilla Alba*	White wagtail	Passeriformes	Motacillidae

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12	*Dendrocopos Himalayensis*	Himalayan Woodpecker	Piciformes	Picidae
13	*Aquila chrysaetos*	Golden eagle	Accipitriformes	Accipitridae
14	*Ardea cinerea*	Grey heron	Pelecaniformes	Ardeidae
15	*Parus Major*	Great Tit	Passeriformes	Pridae
16	*Streptopelia orientalis*	Oriental turtle Dove	Columbiformes	Columidae
17	*Sturnus vulgaris*	Common starling	Passeriformes	Sturnidae
18	*Trochalopteron Lineatum*	Streaked laughing Thrush	Passeriformes	Leiothrichidae
19	*Emberiza Cia*	Rock Bunting	Passeriformes	Emberizidae
20	*Phoenicurus Leucocephalus*	White capped Redstart	Passeriformes	Muscicapidae
21	*Urocissa Flavirostris*	Yellow –billed Blue Magpie	Passeriformes	Corvidae
22	*Motacilla Flava*	Western Yellow Wagtail	Passeriformes	Motacillidae
23	*Lanius Schach*	Long tailed Shrike	Passeriformes	Laniidae
24	*Picus Squamatus*	Scaly Bellied woodpecker	Piciformes	Picidae
25	*Accipiter Nisus*	Eurasian Hawk sparrow	Accipitriformes	Accipitridae
26	*Enicurus Maculatus*	Spotted Fork tail	Passeriformes	Muscicapidae
27	*Upupa Epops*	Common Hoopoe	Buccrotiformes	Upupidae

Relative abundance of avifauna month wise in Transect Ⅰ

In transect Ⅰ, a total of 27 species of avifauna were observed during the study period .*Passer domesticus* (House sparrow) was observed to be most predominant in terms of abundance ,encompassing a relative abundance of 21% annually followed by Acridotheres tristis (common myna)with an annual relative abundance of 13% and Columba livia (Blue rock pigeon)being the third most abundant species with an annual relative abundance of 12.5%. Corvus splendns (House crow)with an annual relative abundance of 9.23% followed by Pycnonotus leucogenys (Himalayan bulbul)with an annual relative abundance of 6.37 % were also observed to be other dominant species in the designated transect .Enicurus maculatus (spotted fork tail) was found to be least abundant species with an annual relative abundance of 0.9 % and the second least abundant species was observed to be Motacilla alba (western yellow wagtail) with an annual relative abundance of 1.0%(Table 2).

Avian community characteristics of transect Ⅰ

Species diversity : Species diversity was recorded highest in the month of July with

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Shanon –Weiner diversity index value (H) of 2.92.The second highest avian diversity was recorded in the month of August with a diversity index value (H) of 2.87 followed by May , October , September and june with a diversity index value of 2.82, 2.77 , 2.75 and 2.68 respectively(Table 2). The lowest species diversity was observed in the month of February and January with a diversity index value of 1.87 and 1.98 respectively.

Species Richness: Species richness was highest recorded in the months of August, March, May and July with 27 species in each month .26 species were recorded in the month of September followed by October with 26 species. Month of june witnessed a total of 24 species .The least species richness was recorded in the months of January and February with 12 species in each . Species richness was also recorded lowest in the month of December with 13 species only.

Species evenness or Equitability (E): Species evenness was recorded highest in the month of July with evenness (E) of 0.88 followed by August with an evenness of 0.87. Evenness was also recorded high in the month of October with an evenness value of 0.86.The evenness in the month of May was recorded to be 0.85 .The lowest evenness was recorded in the months of January and February with an evenness value of 0.79 and 0.75 respectively .

Table 2: Relative abundance of avifauna species at transect Iof Southern landscape of Kashmir valley from August 2021 to July 2022

Scientific name	Common name	Relative abundance (%) month wise												Annual Abundance (%)
		Aug 2021	Sept.	Oct.	Nov.	Dec.	Jan 2022	Feb	Mar	Apr	May	Jun	Jul	
Passer Domesticus	House sparrow	19.23	23.00	19.0	24.65	27.00	21.6	17.14	15.25	24.35	18.68	22.59	18.67	21(%)
Acridotheres Tristis	Common myna	12.81	9.83	13.04	15.06	13.46	19	17.14	18.64	11.53	11.0	9.7	12	13(%)
Columba livia	Rock pigeon	10.25	16.39	10.14	10.9	17.0	16.2	17.14	15.25	11.53	12.08	9.7	10.67	12.5(%)
Corvus splendns	House crow	6.41	4.91	10.14	12.3	9.6	10.8	14.29	13.56	9.0	8.8	9.7	5.33	9.23(%)
Pycnonotus Leucogenys	White cheeked bulbul	6.41	4.91	7.24	8.2	8	10.8	8.60	5.08	2.57	6.6	7.52	4.0	6.37(%)
Corvus Macrorynchos	Jungle crow	3.84	3.27	2.90	4.10	11.53	5.40	5.72	5.08	3.84	5.5	6.45	5.33	5.11(%)
Saxicola Ferreus	Grey Bushchat	1.28	1.64	4.34	4.10	0	0	0	6.78	7.69	4.4	5.37	1.33	3.5(%)

Rhyacornis Fuliginosus	Plumbeous Redstart	1.28	1.64	4.34	2.73	1.92	0	0	3.38	3.84	3.3	3.22	2.67	2.62(%)
Corvus Mondula	Western Jackdaw	3.84	1.64	1.44	2.73	1.92	0	2.85	1.7	2.57	3.3	4.30	2.67	2.62(%)
Muophonus Caeruleus	Blue whistling thrush	2.57	1.64	2.90	2.73	1.92	2.7	2.85	3.38	3.84	1.1	1.07	1.33	2.24(%)
Motacilla Alba	White wagtail	1.28	1.64	1.44	2.73	1.92	0	0	1.7	2.57	1.1	2.15	2.67	1.74(%)
Dendrocopos Himalayensis	Himalayan Woodpecker	1.28	1.64	2.90	1.40	1.92	2.7	0	1.7	2.57	1.1	1.07	2.67	1.74(%)
Aquila chrysaetos	Golden eagle	2.57	1.64	1.44	1.40	0	0	2.85	1.7	1.28	2.19	1.07	2.67	1.62(%)
Ardea cinerea	Grey heron	2.57	1.64	1.44	1.40	0	0	0	1.7	1.28	2.19	2.15	2.67	1.62(%)
Parus Major	Great Tit	2.57	1.64	2.90	1.40	1.92	0	0	1.7	1.28	1.1	1.07	1.33	1.5(%)
Streptopelia orientalis	Oriental turtle Dove	2.57	3.27	0	0	0	0	0	0	2.57	1.1	2.15	2.67	1.37(%)
Sturnus vulgaris	Common starling	2.57	3.27	1.44	0	0	0	0	0	0	2.19	1.07	2.67	1.24(%)
Trochalopteron Lineatum	Streaked laughing Thrush	1.28	1.64	1.44	0	0	2.7	5.72	1.7	1.28	1.1	0	1.33	1.24(%)
Emberiza Cia	Rock Bunting	1.28	1.64	1.44	0	0	2.7	0	0	1.28	2.19	1.07	2.67	1.24(%)
Phoenicurus Leucocephalus	White capped Redstart	1.28	1.64	1.44	0	0	2.7	2.85	0	0	1.1	1.07	2.67	1.12(%)
Urocissa Flavirostris	Yellow – billed Blue Magpie	2.57	3.27	1.44	0	0	0	0	0	0	2.19	1.07	1.33	1.12(%)
Motacilla Flava	Western Yellow Wagtail	1.28	1.64	1.44	1.40	0	0	2.85	0	0	1.1	0	2.67	1(%)
Lanius Schach	Long tailed Shrike	2.57	1.64	1.44	0	0	0	0	0	0	1.1	2.15	1.33	1(%)
Picus Squamatus	Scaly Bellied woodpecker	2.57	0	1.44	0	0	2.7	0	0	1.28	1.1	1.07	2.67	1.12(%)
Accipiter Nisus	Eurasian Hawk sparrow	1.28	1.64	1.44	0	1.92	0	0	0	1.28	1.1	2.15	1.33	1.12(%)
Enicurus Maculatus	Spotted Fork tail	1.28	1.64	0	1.40	0	0	0	1.7	1.28	1.1	0	1.33	0.9(%)

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Upupa Epops	Common Hoopoe	1.28	1.64	1.44	1.40	0	0	0	0	1.28	2.19	1.07	1.33	1.12(%)
Shanon –Weiner Diversity Index (H) H= -∑pi ln pi.		2.87	2.75	2.77	2.4	2.13	1.98	1.87	2.42	2.60	2.82	2.68	2.92	2.74
Species Richness(R)		27	26	25	18	13	12	12	17	22	27	24	27	
Species Evenness or Equitability(E)		0.87	0.84	0.86	0.83	0.83	0.79	0.75	0.85	0.84	0.85	0.84	0.88	

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In transect II , which is an industrialized transect characterized by flowing of river lidder, a total of n=26 species of birds were observed (Table 3) belonging to 11 orders and 19 families. Order passeriformes was found to be the most dominant order amongst all the orders comprising a total of n=10 species (38.46%) followed by Charadriiformes n=3species (11.53%) and Columbiformes n=3 (11.53%). In terms of family dominance, Columbidae was found to be the most dominant over all other families and accounted for n=3 species with species percentage proportion of 11.5% followed by Corvidae with species proportion of 7.69%, Muscicapidae (7.69%) .

Table 3: Avian diversity in transect Ⅱ in Southern landscape of Kashmir Valley.

S.NO.	*Scientific name*	Common name	Order	Family
1	*Columba livia*	Rock pigeon	Columbiformes	Columidae
2	*Passer Domesticus*	House sparrow	Passeriformes	Passeridae
3	*Acredotheries tristis*	Common myna	Passeriformes	Sturnidae
4	*Corvus splendense*	House crow	Passeriformes	Corvidae
5	*Pycnonotus Leucotis*	White cheeked bulbul	Passeriformes	Pycnonotidae
6	*Hirundo rustica*	Common swallow	Passeriformes	Hirundinidae
7	*Corvus Mondula*	Western Jackdaw	Passeriformes	Corvidae
8	*Milvus migrans*	Black kite	Accipitriformes	Accipitridae
9	*Muophonus Caeruleus*	Blue whistling thrush	Passeriformes	Muscicapidae
10	*Ardea cinerea*	Grey heron	Pelecaniformes	Ardeidae
11	*Parus Major*	Great Tit	Passeriformes	Pridae
12	*Eudynamus scolopacea*	Asian koel	Cuculiformes	Cuculidae
13	*Tachybaptus ruficollis*	Little grebe	Podicipediformes	Podicipedidae
14	*Ardeola grayii*	Indian pond heron	Pelecaniformes	Ardeidae
15	*Vanellus indicus*	Red-wattled Lapwing	Charadriiformes	Charadriidae
16	*Halcyon smyrnensis*	White throated king fisher	Coraciiformes	Alcedinidae
17	*Streptopelia*	Little brown dove	Columbiformes	Columbidae

	senegalensis			
18	*Upupa Epops*	Common Hoopoe	Buccrotiformes	Upupidae
19	*Apus apus*	Common swift	Apodiformes	Apodidae.
20	*Streptopelia chinensis*	Spotted dove	Columbiformes	Columbidae
21	*Actitis hypoleucos*	Common sand piper	Charadriiformes	Scolopacidae
22	*Sturnus vulgaris*	Common starling	Passeriformes	Sturnidae
23	*Aythya farina*	Common pochard	Anseriformes	Anatidae
24	*Rhodonessa rufina*	Red crested pochard	Anseriformes	Anatidae
25	*Sterna aurantia*	River tern	Charadriiformes	Laridae
26	*Ficedula Subrubra*	Kashmir fly catcher	Passeriformes	Muscicapidae

Relative abundance of avifauna in transect Ⅱ

In transect Ⅱ , n=26 species were recorded . Columba livia was found to be most abundant species with an annual relative abundance of 14.78% in transect Ⅱ. Passer domesticus was observed to be second most abundant species with an annual relative abundance of 13.61%. Acridotheres tristis and Corvus splendens too had a dominant presence with an annual relative abundance of 11.59 % and 11.42 %respectively. The other dominant species included *Pycnonotus Leucogenys* and *Hirundo rustica* with an annual relative abundance of 6.89 % and 6.21 % respectively. The least abundant species were recorded to be *Sterna aurantia and Ficedula Subrubra* with an annual relative abundance of 0.33% followed by *Rhodonessa rufina and Aythya farina* with an annual relative abundance of 0.67 % and 0.84% respectively.

Avian community organization characteristics of transect Ⅱ

Species diversity

At transect Ⅱ, the Shanon –Weiner diversity index was found to be highest in the month of August with a diversity index value of H= 2.90.The second highest was observed to be in the month of June with a diversity index of H= 2,83. .In the month of September the diversity index value was found to be 2.82, followed by 2.71 in the month of October. The least diversity was observed in the months of February and January 2022 with a diversity index value 2.07 and 2.16 (Table 4)respectively.

Species Richness (R)

The species richness was highest recorded in the month of June with 24 species , followed by July and August with 23 species each .22 species were recorded in the months of September and October each .The lowest species richness was recorded in the month of February 2022 with 10 species followed by January and March with 11 species each.(Table 4)

Species Evenness or Equitability (E)

Evenness or Equitability was recorded to be highest in the month of August with a value of 0.92 followed by September and March

with similar evenness of 0.91.In the month of January the evenness value was found to be 0.9. An evenness value of 0.89 was recorded in the months of February, April, May, June and July. The lowest equitability of 0.87 was recorded in the months of October , November and December .

Table 4 : Relative abundance of avifauna species in transect Ⅱ of Southern landscape of Kashmir valley from August 2021 to July 2022

Scientific name	Common name	Relative abundance (%) month wise												Annual Abundance (%)
		Aug 2021	Sept.	Oct.	Nov.	Dec.	Jan 2022	Feb	Mar	Apr	May	Jun	Jul	
Columba livia	Rock pigeon	11.94	13.79	17.5	29.30	17.64	16.0	9.30	17.9	16.0	12.30	12.90	11	14.78
Passer Domesticus	House sparrow	8.95	10.3	14.03	17.07	17.64	20.0	20.94	14.28	16.0	14.04	12.90	8.21	13.61
Acredotheries tristis	Common myna	7.46	12.0	8.8	9.75	17.64	20.0	18.60	21.42	12	10.52	8.08	8.21	11.59
Corvus splendens	House crow	6	8.62	10.52	12.19	14.70	12.0	18.60	10.7	12	10.52	12.90	12.32	11.42
Pycnonotus Leucogenys	White cheeked bulbul	6	7	8.8	7.31	5.88	4.0	11.62	7.14	6.0	8.8	4.83	5.5	6.89
Hirundo rustica	Common swallow	13.4	5.17	1.75	0	0	0	0	0	8	7.01	8.08	15.1	6.21
Corvus Mondula	Western Jackdaw	4.5	7	5.30	4.9	2.94	4.0	4.65	0	6	5.26	6.5	5.5	5.04
Milvus migrans	Black kite	2.98	3.44	5.30	4.9	0	0	7.0	7.14	6	3.50	1.61	2.73	3.69
Muophonus Caeruleus	Blue whistling thrush	2.98	3.44	1.75	2.43	2.94	4.0	4.65	3.57	2	1.75	1.61	2.73	2.68
Ardea cinerea	Grey heron	4.5	3.44	3.50	2.43	0	0	2.32	0	2	1.75	1.61	2.73	2.35
Parus Major	Great Tit	2.98	1.72	1.75	2.43	0	0	0	7.14	4	1.75	1.61	2.73	2.18
Eudynamus scolopacea	Asian koel	2.98	3.44	1.75	0	0	0	0	0	2	5.26	1.61	2.73	2.01
Tachybaptus ruficollis	Little grebe	2.98	1.72	1.75	2.43	2.94	0	0	0	2	3.50	1.61	1.37	1.84
Ardeola grayii	Indian pond heron	1.49	1.72	1.75	2.43	2.94	0	0	3.57	0	1.75	3.22	2.73	1.84
Vanellus	Red-wattled	2.98	1.72	1.75	2.43	2.94	4.0	0	0	2	0	1.61	1.37	1.68

indicus	Lapwing													
Halcyon smyrnensis	White throated king fisher	1.49	1.72	1.75	0	2.94	4.0	0	0	2	1.75	3.22	1.37	1.68
Streptopelia senegalensis	Little brown dove	2.98	3.44	1.75	0	0	0	0	0	0	1.75	1.61	2.73	1.51
Upupa Epops	Common Hoopoe	2.98	1.72	3.50	0	0	0	0	0	0	1.75	1.61	2.73	1.51
Apus apus	Common swift	2.98	3.44	1.75	0	0	0	0	0	0	1.75	1.61	1.37	1.34
Streptopelia chinensis	Spotted dove	1.49	1.72	1.75	0	0	0	0	0	0	1.75	3.22	2.73	1.34
Actitis hypoleucos	Common sand piper	2.98	1.72	1.75	0	0	0	0	0	2	1.75	1.61	1.37	1.34
Sturnus vulgaris	Common starling	1.49	1.72	1.75	0	0	0	0	0	0	1.75	3.22	1.37	1.17
Aythya farina	Common pochard	0	0	0	0	2.94	8.0	2.32	3.57	0	0	0	0	0.84
Rhodonessa rufina	Red crested pochard	0	0	0	0	5.88	4.0	0	3.57	0	0	0	0	0.67
Sterna aurantia	River tern	1.49	0	0	0	0	0	0	0	0	0	1.61	0	0.33
Ficedula Subrubra	Kashmir fly catcher	0	0	0	0	0	0	0	0	0	0	1.61	1.37	0.33
Shanon –Weiner Diversity Index (H) H= -∑pi ln pi.		2.90	2.82	2.71	2.17	2.25	2.16	2.07	2.19	2.48	2.73	2.83	2.81	2.77
Species Richness(R)		23	22	22	12	13	11	10	11	16	21	24	23	
Species Evenness or Equitability(E)		0.92	0.91	0.87	0.87	0.87	0.90	0.89	0.91	0.89	0.89	0.89	0.89	

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Avian diversity in transect Ⅲ

In transect Ⅲ, which is a typical agrarian area a total of n=23 species of avifauna were observed belonging to 10 orders and spread over 18 families(Table 5) .Order passeriformes was found to be predominant order with a total aggregation of n=12 species (52.17%) , followed by Piciformes(8.69%) and Cucliformes (8.69%) with n=2 species each. Families Muscicapidae(8.69%) , Picidae(8.69%) , Motacillidae(8.69%) , Cuclidae(8.69%) and Corvidae(8.69%) were found to be dominant families representing n=2 species each.

Table 5:Avian diversity in transect Ⅲ of Southern landscape of Kashmir Valley

S.No	*Scientific Name*	Common Name	Order	Family
1	*Passer domesticus*	House sparrow	Passeriformes	Passeridae
2	*Corvus splendens*	House crow	Passeriformes	Corvidae
3	*Acridotheres tristis*	Common myna	Passeriformes	Sturnidae
4	*Columbia livia domestica.*	Blue rock pigeon	Columbiformes	Columbidae
5	*Holpestes (leucogenys)*	White cheeked bulbul	Passeriformes	Pycnonotidae
6	*Hirundo rustica*	Common swallow	Passeriformes	Hirundinidae
7	*Myophonus caeruleus*	Blue whistling thrush	Passeriformes	Muscicapidae
8	*Milvus migrans govinda*	Common pariah kite	Accipitriformes	Accipitridae
9	*Eudynamys scolopacea*	Asian koel	Cuculiformes	Cuculidae
10	*Picus squamatus*	Scaly Bellied wood pecker	Piciformes	Picidae
11	*Alcedo atthis*	Common kingfisher	Coraciiformes	Alcedinidae
12	*Parus major*	Great tit	Passeriformes	Paridae
13	*Upupa epops*	Common hoopoe	Bucerotiformes	Upupidae
14	*Saxicola torquatus*	Common stonechat	Passeriformes	Muscicapidae
15	*Dendrocopos himalayensis*	Himalayan wood pecker	Piciformes	Picidae
16	*Ibidorhyncha struthersii*	Ibis bill	Charadriiformes	Ibidorhynchidae
17	*Motacilla Flava*	Western Yellow Wagtail	Passeriformes	Motacillidae
18	*Bubo bengalensis*	Indian eagle owl	Strigiformes	Strigidae
19	*Motacilla Flava*	Western Yellow Wagtail	Passeriformes	Motacillidae
20	*Psittacula himalayana*	Slaty headed parakeet	Psittaciformes	Psittaculidae
21	*Pericocotus ethologus*	Long tailed minivet	Passeriformes	Campephagide

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22	*Urocissa flavirostris*	Yellow –billed magpie	Passeriformes	Corvidae
23	*Cuculus micropterus*	Indian cuckoo	Cucliformes	Cuclidae

Relative abundance of avifauna in transect Ⅲ

In transect Ⅲ, 23species of avifauna were observed and recorded during the study period. *Passer domesticus* was observed be the most abundant species with annual relative abundance of 19.44 % followed by Corvus splendens and *Acridotheres tristis* with annual relative abundance of 13.39% each.The other predominant species that were observed during the field investigation included *Columba livia* and *Pycnonotus leucogenys* with an annual relative abundance of 13.01% and 8.07% respectively. The least abundant species recorded in transect Ⅲ included *Cuculus micropterus with an annual relative* abundance of 0.73% .The other least abundant species observed were *Psittacula himalayana, Pericocotus ethologus* and *Urocissa flavirostris* with an annual relative abundance of 0.91 %.(Table 6)

Avian community organization characteristics of transect Ⅲ

Species Diversity

In transect Ⅲ, the Shanon –weiner Diversity index was observed highest in the month of September with a diversity index value of 2.83, followed by August and October with a diversity index value of 2.80 and 2.76 respectively. The least species diversity was recorded in the month of December with a species diversity index value of 1.90 followed by February and April with a species diversity index value of 2.08 and 2.10 respectively.(table 6)

Species richness

The species richness was documented to be highest in the month of August in transect Ⅲ with a species richness value of 23 species, followed by 22 species in the month of September. 21 species were recorded in the month of October and 19 species in the month May 2022.the least species richness was documented in the month of December with 9 species only , followed by 10 and 11 species in the months of January and March.

Species evenness or Equitability

Highest species evenness was recorded in the month of January 2022 with an evenness value of 0.92 followed by September with an evenness of 0.91.An evenness of 0.90 was recorded in the months of 0ctober , November 2021 and March 2022 . The least evenness was recorded in the month of February with an evenness of 0.81. An evenness of 0.84 was documented in the months of April and june 2022(Table 6).

Table 6: Relative abundance of avifauna in transect Ⅲ

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Scientific name	Common name	Relative abundance (%) month wise												Annual Abundance (%)
		Aug 2021	Sept.	Oct.	Nov.	Dec.	Jan 2022	Feb	Mar	Apr	May	Jun	Jul	
Passer domesticus	House sparrow	13.79	13.46	18.18	15.62	32.14	23.8	18.36	18.51	22.22	22.58	23.43	16.66	19.44%
Corvus splendens	House crow	15.51	13.46	11.36	12.5	10.71	14.28	16.32	18.51	11.11	9.67	12.5	16.66	13.39 %
Acridotheres tristis	Common myna	12.06	9.61	11.36	15.62	14.28	14.28	18.36	14.81	14.81	14.51	12.5	11.11	13.39 %
Columbia livia domestica.	Blue rock pigeon	6.89	7.69	6.81	15.62	17.85	14.28	24.48	14.81	24.07	11.29	9.37	9.25	13.01%
Pycnonotus leucogenys	White cheeked bulbul	6.89	7.69	6.81	9.37	10.71	9.52	4.08	11.11	7.40	11.29	9.37	5.55	8.07%
Hirundo rustica	Common swallow	5.17	5.76	4.54	0	0	0	0	0	3.70	8.06	7.81	7.40	4.40%
Myophonus caeruleus	Blue whistling thrush	3.44	3.84	2.27	6.25	3.57	4.76	4.08	3.70	3.70	1.61	4.68	5.55	3.85%
Milvus migrans govinda	Common pariah kite	3.44	3.84	2.27	0	0	4.76	2.04	3.70	3.70	1.61	6.25	5.55	3.30%
Eudynamys scolopacea	Asian koel	3.44	3.84	2.27	0	0	0	2.04	0	3.70	3.22	1.56	1.85	2.20%
Picus squamatus	Scaly Bellied wood pecker	3.44	0	4.54	3.12	3.57	0	2.04	0	1.85	0	1.56	1.85	1.83%
Alcedo atthis	Common kingfisher	3.44	1.92	0	3.12	3.57	0	2.04	3.70	1.85	0	0	3.70	1.83%
Parus major	Great tit	1.72	1.92	4.54	3.12	0	0	2.04	3.70	0	1.61	0	1.85	1.65%
Upupa epops	Common hoopoe	3.44	3.84	2.27	0	0	0	0	0	0	1.61	1.56	3.70	1.65%
Saxicola torquatus	Common stonechat	1.72	3.84	2.27	3.12	0	0	2.04	3.70	0	0	1.56	1.85	1.65%
Dendrocopos himalayensis	Himalayan wood pecker	1.72	1.92	2.27	3.12	0	0	2.04	3.70	0	1.61	0	1.85	1.46%
Ibidorhyncha struthersii	Ibis bill	1.72	3.84	4.54	3.12	0	0	0	0	0	1.61	1.56	0	1.46%

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Motacilla Flava	Western Yellow Wagtail	1.72	1.92	2.27	3.12	0	4.76	0	0	0	1.61	0	1.85	1.28%
Bubo bengalensis	Indian eagle owl	1.72	1.92	2.27	0	3.57	4.76	0	0	1.85	0	1.56	0	1.28%
Motacilla Flava	Western Yellow Wagtail	1.72	1.92	2.27	3.12	0	4.76	0	0	0	1.61	0	1.85	1.28%
Psittacula himalayana	Slaty headed parakeet	1.72	1.92	2.27	0	0	0	0	0	0	1.61	1.56	0	0.91%
Pericocotus ethologus	Long tailed minivet	1.72	1.92	2.27	0	0	0	0	0	0	1.61	0	1.85	0.91%
Urocissa flavirostris	Yellow – billed magpie	1.72	1.92	2.27	0	0	0	0	0	0	1.61	1.56	0	0.91%
Cuculus micropterus	Indian cuckoo	1.72	1.92	0	0	0	0	0	0	0	1.61	1.56	0	0.73%
Shanon –Weiner Diversity Index (H) H= -∑pi ln pi.		2.80	2.83	2.76	2.39	1.90	2.12	2.08	2.16	2.10	2.44	2.40	2.57	
Species Richness(R)		23	22	21	14	9	10	13	11	12	19	17	18	
Species Evenness or Equitability(E)		0.89	0.91	0.90	0.90	0.86	0.92	0.81	0.90	0.84	0.82	0.84	0.88	

Avifauna Diversity in transect Ⅳ

In transect Ⅳ, which is a highly urbanized transect catered least number of n=16 species(table 7) belonging to 6 orders and 12 families. Order passeriformes was found to be predominant order amongst all the orders with a total representation of n=9 species (56.25%) followed by the orders Piciformes (12.5%) and Psittaciformes (12.5%) both represented n=2 species each. In terms of family predominance ,Families Corvidae (12.5%), Psittaculidae, Picidae (12.5%) and Sturnidae (12.5%) were found to be predominant families and represented n= 2 species each.

Table 7 : Avifauna diversity in transect Ⅳ

Serial No.	*Scientific Name*	Common Name	Order	family
1	*Corvus splendens*	House crow	Passeriformes	Corvidae
2	*Acredotheries tristis*	Common myna	Passeriformes	Sturnidae
3	*Passer Domesticus*	House sparrow	Passeriformes	Passeridae
4	*Columba livia*	Rock pigeon	Columbiformes	Columbidae
5	*Milvus migrans*	Black kite	Accipitriformes	Accipitridae
6	*Pycnonotus Leucogenys*	White cheeked bulbul	Passeriformes	Pycnonotidae

7	*Corvus Mondula*	Western Jackdaw	Passeriformes	Corvidae
8	*Muophonus Caeruleus*	Blue whistling thrush	Passeriformes	Muscicapidae
9	*Parus Major*	Great Tit	Passeriformes	Pridae
10	*Dendrocopos Himalayensis*	Himalayan Woodpecker	Piciformes	Picidae
11	*Sturnus vulgaris*	Common starling	Passeriformes	Sturnidae
12	*Upupa Epops*	Common Hoopoe	Buccrotiformes	Upupidae
13	*Lanius Schach*	Long tailed Shrike	Passeriformes	Laniidae
14	*Psittacula krameri*	Rose ringed paraket	Psittaciformes	Psittaculidae
15	*Psittacula himalayana.*	Slaty headed parakeet	Psittaciformes	Psittaculidae
16	*Dendrocopos atratus*	Strip breasted wood pecker	Piciformes	Picidae

In transect Ⅳ n= 16 species were observed during the study period. The most abundant species was recorded to be *Corvus splendens* with an annual relative abundance of 16.72% . The second most predominant species observed in the transect was found to be *Passer domesticus* with an annual relative abundance of 14.02%.*Acridotheres tristis* and *Columba livia* were also found to be in abundance with an annual relative abundance of 13.80% and 13.34% respectively. The least abundant species observed were *Psittacula himalayana* and *Dendrocopos atratus* with an annual relative abundance of 1.13 % each.The other least abundant species recorded in transect Ⅳ included *Lanius Schach* and *Psittacula krameri* with a similar relative abundance of 1.58 % each.

Avian Community organization Characteristics of transect Ⅳ

Species Diversity

In transect Ⅳ, Shanon –weiner Diversity index was observed to be highest in the months of July and August with a similar diversity index value of 2.50 , followed by june with a diversity index value of 2.47.The least diversity was recorded to be in the month of January with a diversity index value of 1.93 followed by February with a diversity index value of 1.97.

Species Richness

In transect Ⅳ , the highest species richness was recorded in the months of ,June ,July August and October with 15 species each. The second highest species richness was recorded in the month of September with 14 species. In the month of may , the species richness was observed to 13 species. The least species richness was observed in the month of January with a species richness of 8 species followed by February with a species richness of 9 specie**s** (table 8)

Species Evenness or Equitability

In transect Ⅳ, species evenness was recorded to be highest in the month of February with an evenness value of 0,98 followed by December with an evenness value of 0.95.The third highest evenness was observed in the month of march with an evenness value of 0.94.The least evenness was recorded in the month of October with an evenness value of 0.89(Table 8).

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Table 8 : Month wise Relative abundance of avifauna in transect Ⅳ

Scientific name	Common name	Relative abundance (%) month wise												Annual Abundance (%)
		Aug 2021	Sept.	Oct.	Nov.	Dec.	Jan 2022	Feb	Mar	Apr	May	Jun	Jul	
Corvus splendens	House crow	16.27	13.51	15	17.64	17.39	16	21.05	14.28	19.51	15.90	16.32	17.02	16.72%
Acridotheres tristis	Common myna	11.62	13.51	7.5	20.58	13.04	24	18.42	9.52	17.07	11.36	12.24	10.63	13.80%
Passer Domesticus	House sparrow	11.62	16.21	10	8.82	13.04	16	18.42	19.04	17.07	13.63	14.28	12.76	14.02%
Columba livia	Rock pigeon	9.30	13.51	20	17.64	13.04	16	13.15	14.28	12.19	13.63	10.20	10.63	13.34%
Milvus migrans	Black kite	9.30	8.10	12.5	8.82	8.69	8	13.15	14.28	7.75	11.36	10.20	8.51	10.18%
Pycnonotus Leucogenys	White cheeked bulbul	9.30	5.40	7.5	8.82	8.69	12	7.89	9.52	4.87	9.09	6.12	8.51	7.91%
Corvus Mondula	Western Jackdaw	6.97	5.40	5	2.94	0	4	2.63	4.76	4.87	4.54	4.08	6.38	4.52%
Muophonus Caeruleus	Blue whistling thrush	4.65	5.40	2.5	5.88	4.34	0	2.63	4.76	4.87	4.54	2.04	4.25	3.84%
Parus Major	Great Tit	2.32	2.70	2.5	5.88	4.34	4	0	4.76	2.43	4.54	2.04	4.25	3.16%
Dendrocopos Himalayensis	Himalayan Woodpecker	2.32	2.70	2.5	2.94	8.69	0	2.63	4.76	4.87	0	4.08	0	2.71
Sturnus vulgaris	Common starling	2.32	2.70	5	0	0	0	0	0	0	2.27	6.12	4.25	2.26
Upupa Epops	Common Hoopoe	4.65	5.40	2.5	0	0	0	0	0	0	4.54	2.04	2.12	2.03
Lanius Schach	Long tailed Shrike	2.32	2.70	2.5	0	0	0	0	0	0	0	4.08	4.25	1.58
Psittacula krameri	Rose ringed paraket	4.65	0	2.5	0	4.34	0	0	0	0	2.27	2.04	2.12	1.58
Psittacula	Slaty	2.32	0	2.5	0	0	0	0	0	0	O	4.08	2.12	1.13

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himalayana.	headed parakeet													
Dendrocopos atratus	Strip breasted wood pecker	0	2.70	0	0	4.34	0	0	0	2.43	2.27	0	2.12	1.13
Shanon –Weiner Diversity Index (H) H= -∑pi ln pi.		2.50	2.42	2.43	2.12	2.28	1.93	1.97	2.17	2.17	2.36	2.47	2.50	
Species Richness(R)		15	14	15	10	11	8	9	10	11	13	15	15	
Species Evenness or Equitability(E)		0.92	0.91	0.89	0.92	0.95	0.92	0.98	0.94	0.90	0.92	0.91	0.92	

Transect wise highest species diversity was recorded in transect Ⅱ with Shanon- weiner diversity index value of 2.77 followed by transect Ⅰ with a species diversity index of 2.74.The least species diversity was observed in transect Ⅳ with a diversity index value of 2.42.Simpson's diversity index was observed to be highest in transect Ⅱ with an index value D= 0.91 followed by transect Ⅰ with a diversity index value of 0.90. The least Simpson's diversity index value was recorded in transect Ⅲ and Ⅳ with a same index value of 0.89 (Table 9).In terms of species evenness , the highest equitability or evenness was recorded in transect Ⅳ with an evenness value of 0.87 followed by transect Ⅱ with an evenness value of 0.85 .The least evenness value was recorded in transect Ⅲ with an evenness value of 0.82 . In terms of species richness the highest number of species were recorded in transect Ⅰ with 27 species followed by transect Ⅱ with a species richness of 26 species .The least species richness was recorded in transect Ⅳ with 16 species (Table 9)

Table 9: Species diversity , Species evenness and species richness transect wise in southern landscape of Kashmir valley.

Study area	Transect	Shanon-Weiner Diversity index	Simpson's Diversity index	Species evenness or Equitability	Species richness
	Ⅰ	2.74	0.90	0.83	27
	Ⅱ	2.77	0.91	0.85	26
	Ⅲ	2.59	0.89	0.82	23
	Ⅳ	2.42	0.89	0.87	16

ANOVA was employed to compare the mean avian diversity among four transects to ascertain if any significant difference in Mean bird diversity occurs or not and there by validate or reject null (H_o) .Statistical analysis through ANOVA showed no significant difference in the mean bird diversity between the transects(Table 10) (*F* = 0.59 , F *Crit* = 2.75 , *df = 3,62 , p-value* = 0.62 (> 0.05)) .The p-value = 0.62 (>0.05) validated acceptance of Null hypothesis that is no statistically significant difference in the mean bird diversity among the transects and thus led to rejection of Alternate hypothesis.

Table 10: Mean bird diversity in the selected transects of Southern landscape of Kashmir Valley.

Transect	Number of species recorded	Total number Birds of all the species	Mean ±S.E
Transect Ⅰ	27	801	29.6±7.4
Transect Ⅱ	26	595	22.8± 4.9
Transect Ⅲ	23	545	23.69± 6.0
Transect Ⅳ	16	442	27.6± 6.09
Statistical Analysis ANOVA	*F* = 0.59 , F *Crit* = 2.75 , *df = 3,62 , p-value* = 0.62 (> 0.05)		

On comparing the mean avifauna diversity in different seasons by employing ANOVA , it was revealed that there is no statistically significant difference in the mean avifauna diversity in different seasons *F*=3.14, F *Crit* = 3.49, *df = 3,12,* p-value 0.06(p-value > 0.05) (Table 11) . The p-value was found to be 0.06 (p-value > 0.05) which signifies that there is no significant difference in the mean avian diversity in different seasons in the selected transects of the study area and is thus a powerful validation of acceptance of null hypothesis (H_o**).** *F* Distribution value (3.14) was recorded to be less than the F *Crit value* (3.49) and thus equally corroborates in the acceptance of null hypothesis (H_o**)** and rejection of alternate hypothesis (H_a**).**

Table 11 : Seasonal Diversity of Avifauna in Southern landscape of Kashmir Valley

Season / Transect	Winter (Dec to Feb)	Mean±S.E	Spring (March to May)	Mean±S.E	Summer (June to Aug)	Mean**±S.E**	Autumn (Sept to Nov)	Mean**±**S.E
Transect Ⅰ	124	41.3**±**5.36	228	76**±**9.29	246	82**±**5.56	203	67.6**±**3.52
Transect Ⅱ	102	34±5.19	135	45**±**8.7	202	67.33**±**3.17	156	52**±**5.5
Transect Ⅲ	98	32.66**±** 8.4	143	47.66**±**10.58	176	58.66**±**2.9	128	42.66**±** 5.8

Transect Ⅳ	86	28.66±4.7	106	35.33±7.2	139	46.33±1.76	111	37±1.73
Statistical Analysis ANOVA	*F*=3.14, F *Crit* = 3.49, *df = 3,12,* p-value 0.06(p-value > 0.05) No statistically significant difference in the diversity of birds between seasons.							

Discussion

During the current study in the selected transects of Southern landscape of Kashmir valley n= 49 species of birds were observed during the field investigation spanning over a period of one year , belonging to 14 orders and 28 families.. In the entire landscape order passeriformes was found to be predominant order amongst all the orders with an overall representation of n=23 species and family Muscicapidae was found to be dominant family amongst all the families with an aggregation of n=7 species in the Southern landscape. The results of Kichloo et al (2018) are on expected lines with the current study who have also established predominance of order Passeriformes over other orders during their field investigations to ascertain the avian abundance and richness in vegetation rich new campus of University of Jammu. These findings are equally supported by the findings of other avian researchers like Kait et al .(2014) , Kumar and Sahi (2014) and Singh et al .(2013) . Bhat and Singh ((2019) during their field survey to explore the birds of Rajpora Pulwama , Jammu and Kashmir , India reported the occurrence of 30 species belonging to 19 families and 07 orders .As per their observation ,order passeriformes was observed to be dominant order and family Muscicapidae was recorded to be dominant family .Out of 30 species ,23 species were residents , 04 species were summer visitors , 02 species were passage migrants and 01 species as winter visitor .The only bird survey conducted till date in the entire landscape of South Kashmir was in Overa –Aru wild life sanctuary established in world famous tourist resort Pahalgam by Khan et al have reported the occurrence of 702 individual birds representing 29 species spread over 22 families and five orders. They have also pointed out the supreme predominance of order passeriformes over all other orders which is in sync with the findings of our study. However their findings related to dominant family is not in tune with the findings of the current study and have documented that family Motacillidae is the dominant family in the overa –Aru wild life sanctuary but in the current study family Muscicapidae has been found to be a dominant family in the selected transects of the under study.

Transect wise highest species diversity was recorded in transect Ⅱ with Shanon- weiner diversity index value of 2.77 followed by transect Ⅰ with a species diversity index of 2.74.The least species diversity was observed in transect Ⅲ with a diversity index value of 2.59.The highest species diversity in transect Ⅱ is largely attributed to its unique habitat features. On one side the transect provides safe passage to the avifauna as it is an industrialized area and has huge occupancy of multi storyed establishments in the form of factories and industries which provide ample nesting opportunities to the avifauna and that is the main reason birds prefer to inhabit this transect in comparison to other two transects. So the nature of habitat greatly influences species diversity of a region. This transect is also traversed by a mighty river lidder which too becomes an attractive hot spot for huge aggregation of aquatic birds .The results of Haq et

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al during their field survey on species diversity of University of Kashmir Campus, Srinagar, Jammu and Kashmir, India to larger extent support the findings of the current study that nature of habitat has a huge influence on species diversity of a region. They documented that species diversity was recorded highest in mixed vegetation habitat with Shanon –Weiner diversity index value of 2.706 followed by Chinar dominated area with a diversity index value of 2.322 . They observed that least diversity was found in grass dominated region with a diversity index value of 1.962.Their recorded Shanon-weiner diversity index values ranged between 1.962 to 2.706 which quite similar to our range of diversity index value (2.59 to 2.77) . Khan et al (2012) during their field survey in Overa –Aru wild life sanctuary recorded that the species diversity index fluctuated between 0.097 at site 1 to 0.064 at site 5 and concluded that highest diversity was recorded in site 1 and lowest diversity was recorded in site 5 and thus corroborated the findings of the current study that type of habitat influences the species diversity of a region. Sharma et al during their research on effect of landscape heterogeneity on diurnal raptor community richness and diversity in Jammu Shiwaliks, Jammu and Kashmir ascertained that there is significant variation in bird abundance in different habitat types with farmland habitat catering more number of species followed by pure forests, water bodies and forest –farmland interfaces. During the current study , it was revealed that the distribution and abundance of bird species is greatly influenced by the type of vegetation and was found to be an integral component of the habitat inhabited by different species. Lee and Rotenberry (2005) have made similar observations and have concluded that change in vegetation along complex biological and environmental gradients impacts bird abundance and a particular species can appear, increase or decrease in number or is completely wiped out as the habitat changes. Seto et al .(2004) , Kallimanis et al (2010) ,Fjeldsa et al (2012) have projected similar findings and have established that high species richness is largely attributed to the structural complexity and varied habitat types as heterogeneous habitats are more likely to ensure shelter and refuge to avifauna and there by stimulate avifauna persistence. Noor et al (2014) further elaborated that species diversity is also influenced by other factors such as the level of anthropogenic interference during their work on species diversity and density of some common birds in relation to human disturbance along the bank of Dal lake , Srinagar , J & K, India. They have put forth some what similar finding on various avian diversity indices figured out that Shanon –weiner diversity index was highest in medium level disturbed habitat with a value of H =2.27 which is some what similar to the diversity index value that surfaced during the current study .As per their finding , the least diversity index value of H = 1.87 was recorded in the transect which has highest degree of anthropogenic interference .

During the current study species evenness or equitability varied across transects under study. Species evenness was recorded to be highest in transect Ⅱ with an evenness value of 0.85 followed by transect Ⅰ with an evenness value of 0.83. The lowest evenness was recorded in transect Ⅲ with an evenness value of 0.82. Noor et al (2014) recorded highest evenness value of 0.87 in the transect which had moderate anthropogenic interference and is very close to value of evenness recorded in transect Ⅱ with an evenness value of 0.85 during the current study.

During the current study in the selected transects ,the most predominant species in terms of abundance in the entire landscape of South Kashmir valley were recorded to be *Passer Domesticus, Columba livia, Acridotheres tristis , Corvus splendens, Pycnonotus leucogenys* and *Hirundo rustica* .The predominance of these

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species has been established by other researchers during their field surveys in other parts of jammu and Kashmir and is thus ample clear that these species have successfully adapted to challenging environments and have thrived in extreme hostile conditions ranging from high altitude dominated forest habitat to highly urbanized settings and are living in close proximity with human settlements which is an added feature because in human settlements round the year availability of diverse food resources is ensured especially during extreme winter conditions when the entire landscape remains covered with snow and is impossible for the birds in the region to fetch food ingredients for themselves and in such tiring circumstances humans come to the rescue by scattering food grains and other novel food items either on concrete flat surfaces or on the tin roofs of their houses to make it certain that birds in their settlement are provided with nutritional requirements to just survive in such unfavourable conditions of extreme and hostile winter .

Passer domesticus was recorded to be the most predominant species in terms of abundance in transect Ⅲ ,which as per our understanding and opinion is attributed to easy accessibility of food grains as the transect is an agrarian transect characterized by huge tracts of agricultural lands typically used for cultivation of paddy. Noor et al.(2014) had came up with similar findings during their avifauna survey on species Diversity and Density of some common birds along the Bank of Dal lake , Srinagar that Passer domesticus was a predominant species in the transect which was characterized by presence of agricultural fields and that might have been the reason for large aggregation of Passer domesticus in the said transect due easy accessibility of food resources.

In transect Ⅳ, which is highly urbanized transect , the aggressive species such as Corvus splendens and Milvus migrans were observed to be highly dominant species and outnumbered all other species in the transect. Although Pycnonotus Leucogenys was found to be one of the dominant species in other three transects , but it was observed to be least in abundance in transect Ⅳ as its nests , eggs and hatchlings were found to be more prone to predation by aggressive predators especially Corvus splendens as their nests are usually located on low lying areas such as , on the canopy of evergreen plants, Golden junifer and other medium sized plants and are thus more in visual sight to predators and there by a soft target in comparison to other common birds such as Acridotheres tristis and Passer domesticus who successfully acclimatized by making their nests in the crevices and walls of concrete buildings which are in rare visual sight for predators and are thus able to with stand the challenge posed by aggressive birds in an urbanized setting. The finding of other researchers too corroborate the current findings as they also validate that less aggressive species try to avoid urban setting and species with pronounced phenotypes thrive in an urbanized habitat. Beissinger and Osborne (1982), Marzluff (2008), Chace and Walsh have reported that in exceptional and rare cases, some species seem to thrive in the urbanized area, and these urban – dwelling species often show prominent phenotypic differences e.g., marked change in behavior, physiological and morphological characteristics. Thus it is quite evident and ample clear that due to increased rate of urbanization and the rapid loss of wild habitats, urban areas are now viewed as challenging ecosystems for sustaining biotic communities.

Conclusion

Scarce and unorganized information on avifauna diversity in Southern landscape of Kashmir valley is currently available and thus there is enormous scope to further consolidate the avifauna data base from this part of the world to effectively mitigate the management and conservation of avifauna .Concept of Conservation of birds will hardly materialize and

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conceptualize unless all the stake holders have sound understanding of avifaunal diversity at the regional level. To effectively safeguard avifauna , a multipronged strategy needs to be devised at every level to conserve these ecologically sensitive and fragile creatures and every stakeholder has to take onus of protecting and restoring the past glory of glorified reptiles(aves).With this aim , an depth avifauna survey was conducted to explore the unexplored avifaunal diversity of Southern landscape of Kashmir Valley , so as to collaborate and authentic the already existing research data in the relevant field .This is possibly the first exclusive bird survey executed in a natural setting in this part of the world. Current piece of study provides baseline information on the avifauna parameters such as species diversity, relative abundance, species richness and equitability and recommends execution of research work on other important avian parameters such as nesting , foraging and feeding . roosting and breeding biology to further broaden the knowledge horizon pertaining to birds which will go a long way in safeguarding these indispensable components of biotic community.

Conflict of Interest Declaration

As Corresponding author , I on behalf of all the authors mentioned in this manuscript ,do state that there is no any conflict of interest involved in the research paper.

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