PATTERNS OF BIRD RELATIVE ABUNDANCE, DIVERSITY INDICES AND CONSERVATION STATUS IN SHEIKH BADIN NATIONAL PARK, D. I. KHAN, PAKISTAN

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Abstract. Determining the bird assemblages is utmost important to identify the adequacy and efficiency of habitats. The line transect method was used to determine patterns of bird relative abundance, diversity indices, and conservation status in Sheikh Badin National Park from November 2017 to December 2019. In total, 7,919 individuals (2,592 migrants and 5,327 inhabitants) representing 42 species and 25 families were enlisted. Of 42 species, 27 were native (i.e., 67.26%) utilizing the study area throughout the year, while the remaining 15 species were migrant (e.g., 32.73%) that used the study area during the winter. *Passer domesticus* (0.06%), *Merops persicus* (0.05%), *Tachymarptis melba*, and *Ploceus philippinus* (each 0.04%) were the overwhelming bird species. In contrast, *Francolinus francolinus* (0.02%), *Falco tinnunculus* (0.008%), and *Alectoris chukar* (0.005%) were the rarest bird species. All species were identified as "Least Concern" based on IUCN RedList. Diversity results showed birds were assorted a diverse, i.e. H' = 3.608 (resident birds; H' = 3.608 and migratory birds; H' = 2.543), rich; i.e. D = 0.031 (resident birds; D = 0.046 and migratory birds D = 0.093) and evenly distributed J = 0.965 (resident birds, J = 0.967 and migratory birds, J = 0.939). The perceptions of local inhabitants and personnel observation shown that bird species are facing confronting threats due to human endeavor, such as illegal hunting, habitat loss due deforestation, and uncontrolled grazing.
Keywords: *bird, diversity, richness, conservation status, Sheikh Badin, distribution*

Introduction

Birds are vital components of the biosphere (Abbas et al., 2019), i.e. they provide ample services for the well beings and survival of human beings (Lepczyk and Warren, 2012) and are bioindicators of dwelling habitats (Drever et al., 2008; Fraixedas et al., 2020; Nelson et al., 2020). The occurrence and distribution of the bird species within a specific zone reflects the local biodiversity resources. Birds are of critical importance to

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the ecological functions and fundamental components of biodiversity that play a critical role in ecosystem functions. Birds are closely associated with vegetation structure (Cueto and Casenave, 1999; Lomolino, 2001) and habitat productivity (food resources, especially amphibians, reptiles, small mammals and invertebrates). They are an integral part of the food chain and food web, and this balances the ecosystem through dispersing seeds (Gracia et al., 2010; Martinez-Lopenz et al., 2019), pollinating plants (Mistry et al., 2008), bioindicator of the human footprint and climate change (Sharma, 1982; Amano et al., 2010) and environmental pollution (Gole, 1984; Talukdar, 1997; Radhouani et al., 2012; Pollack et al., 2017).

In an ecosystem, bird species plays a critical role in sustaining its health (Briggs, 2017; Law, 2019). Birds occupy a wonderful place among other species, since they are much appreciated by humans. They play a vital role in contributing to the consideration of the public with respect to natural habitats (Gascon et al., 2015; Donazar et al., 2016). Avian species are considered barometers of an ecosystem. Recent studies have shown that many bird populations are declining worldwide, while some are locally extinct due to degradation and fragmentation (Hewson et al., 2007).

Sibley and Monroe (1990) indicated that there are approximately 9702 avian species belonging to 1800 genera worldwide, including 1300 bird species in the Indian region (Manakadan and Pittie. 2001). Pakistan hosts 742 bird species that belongs to three zoogeographic areas, namely, Ethiopian, Palaeartic and Asian (Mirza and Wasiq, 2007; Lepage, 2014). The Indus (Green Migration Route) of which Pakistan is a part supports millions of migratory birds from northern latitudes in winter and from southern altitudes to breeding (summer visitors). The Indus flyway (green migratory route) of which Pakistan is a part supports millions of migratory birds from northern altitudes to overwinter and from southern altitudes to breed (summer visitors).

The population of bird species in Pakistan has declined as a result of the loss and degradation of habitat, illegal hunting and trapping, water pollution, food scarcity, inter–specific interactions and global warming (Kushlan, 1993; Hetrick and Sieving, 2012). Some of them have become threatened, vulnerable, endangered, critically endangered, or even extinct (Birdlife International, 2004; Yasué and Dearden, 2006). As such, information on the bird population structure (diversity, density, and conservation status) is essential to improve the future conservation and management of Sheikh Badin National Park. Thus, determining bird diversity, distribution, and conservation status is of critical importance to understanding productivity, threats. Therefore, important measures should be taken to protect and conserve the biodiversity especially bird population. As a result, this study looked at bird populations and habitat structure in Sheikh Badin National Park in Dera Ismail Khan, Pakistan.

Materials and methods

Study area

The Sheikh Badin National Park (NP) Dera Ismail Khan is located within 32.297534°N, 70.805227°E in the southern part of Khyber Pakhtunkhwa (KP), Pakistan (*Fig. 1*). The National Park is surrounded by Sheikh Badin Hills, an eastern extension of Sulaimon Mountains at an elevation of 1400 m above mean sea level and ranged from 300 m to 1400 m. The NP covers an area of 15,540 ha. The vegetation of Shaikh Badin national park is comprised of trees (Phulai – *Acacia modesta,* Indian olive – *Olea ferruginea*, Gum Arabic tree – *Vachellia nilotiea,* Athel tamarisk – *Tamarix aphylla*, Ghaf

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– *Prosopis cineraria*, Tree of heaven – *Ailanthus altissima*, Rohida – *Tecomella undulata* and Indian jujube – *Ziziphus mauritiana*), shrubs (Karira – *Capparis decidua*, Apple of sodom – *Calotropis procera*, Mazari palm – *Nannorrhops ritchiana*, Kannada – *Periploca aphylla*, Dwarf shrub – *Rhazya stricta*, Royle's spike thorn – *Maytenus royleana*) bushes and grasses (Kapok bush – *Aerva javanica*, Slender amaranth – *Amaranthus viridis*, wild sunflower – *Carthamus oxyacantha*, European milkvetch – *Astragalus hamosus*, red hogweed – *Boerhavia procumbens* and needle grass – *Aristida adscensionis*).

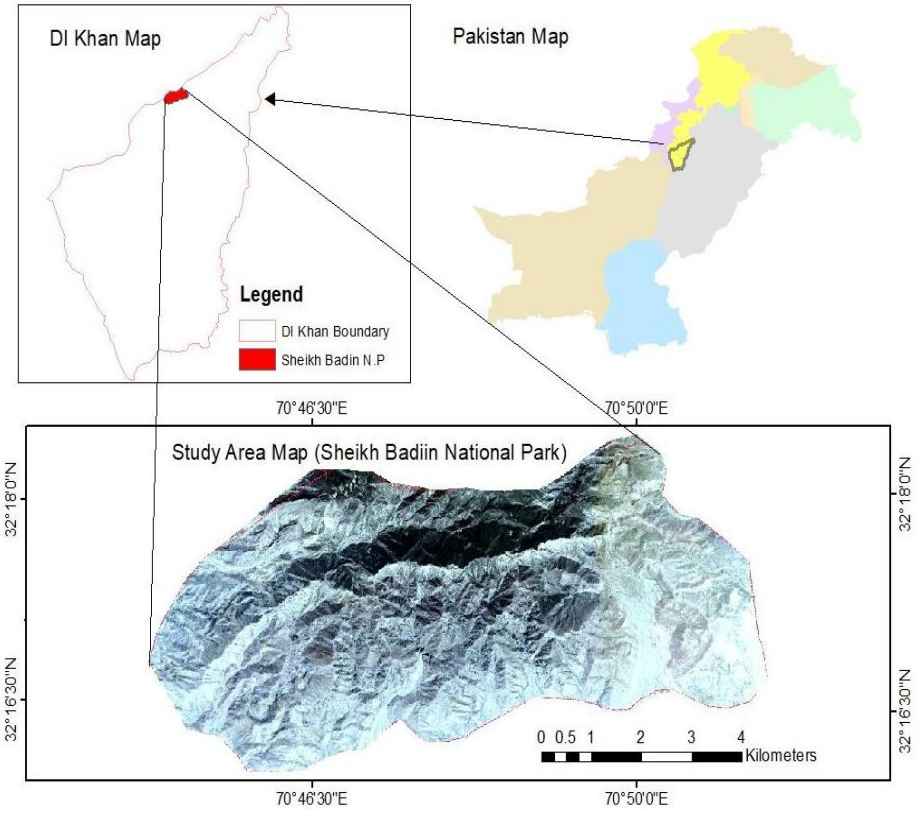

Figure 1. *A GIS-based map showing the location of the study area*

Precipitation at Sheikh Badin National Park ranged from 200 mm to 280 mm/year. The rainy season has a duration of 3.9 months. Most rainfall occurs during the monsoon season between June and September (*Fig. 2*). The winter is severe cold (a certain freezing weather) and the summer is warm 44.6 °C. The winter season lasts 2.9 months (December to February) and hottest season lasts 4.4 months (April to September). The average temperature may vary between 6.1 °C and 40.6 °C (*Fig. 3*). Its topography is hilly, hilly and mountainous.

Bird survey

Distance sampling line transect method was used for the detection of avian species for 26 consecutive months, from November 2017 to December 2019. The birds were recorded from 07:00–09:00 and 17:00–19:00 when they were most active in multiple activities. The birds were observed using binoculars (42 × 10 mm) to confirm the identity

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of the species and occasionally photographed with the Nikon D7200 (Sigma lens 150–600 mm). Overall, 100 point count stations were established randomly to avoide the double counting of the same bird individuals The methodology was followed according to Buckland et al. (2004).

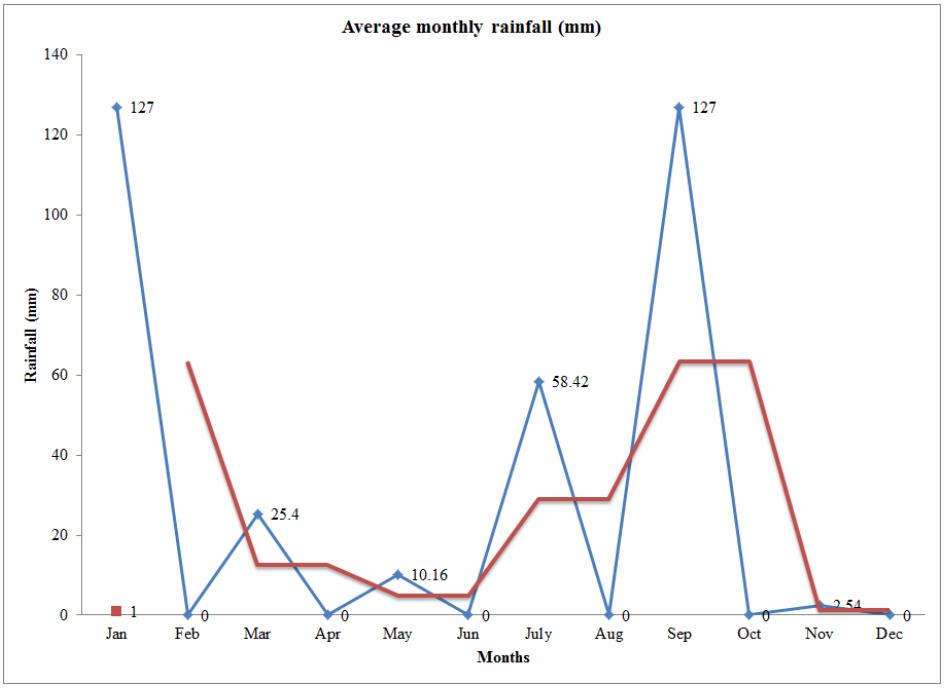

Figure 2. *Precipitation pattern throughout the year. (Source: https://weatherspark.com/y/148960/Average-Weather-at-Dera-Ismail-Khan-Year-Round)*

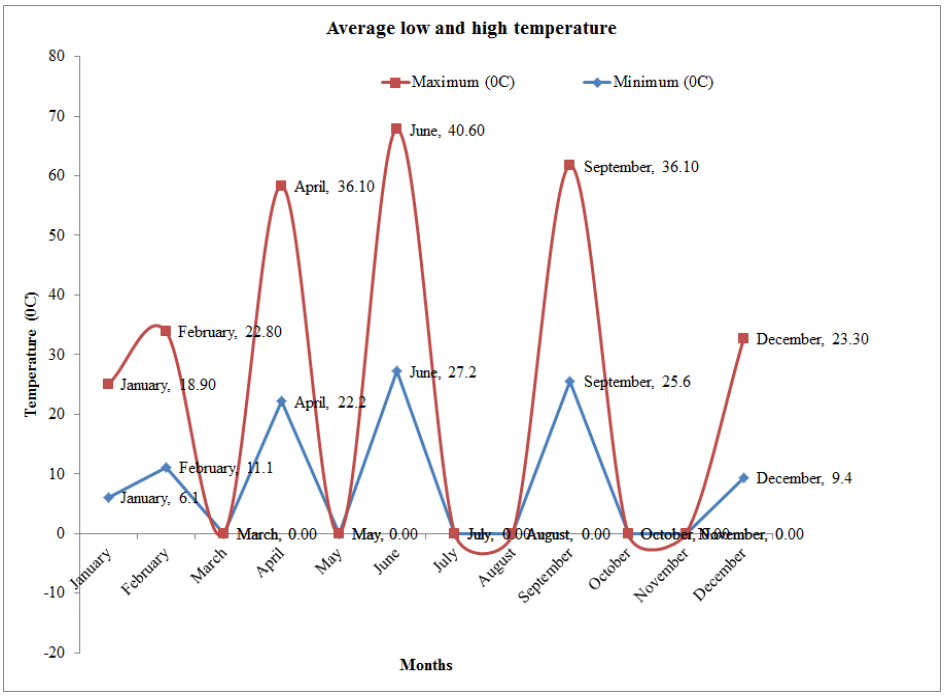

Figure 3. *Average low and high temperature throughout the year. (Source: https://weatherspark.com/y/148960/Average-Weather-at-Dera-Ismail-Khan-Year-Round)*

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Vegetation survey

The vegetation of the Sheikh Badin National Park was surveyed employing quadrant method (10 × 10 m for trees, 5 × 5 m for shrubs and 1 × 1 m for grasses) to identify the existing native flora to understand the habitat suitability, food resources and foraging sites for wide range of bird species. In total, 100 sampling sites were selected randomly at the simultaneously at same locations where bird species were documented. During vegetation inventory, the flora was divided into trees, shrubs and grasses. These sampling sites represented the entire area of the national park. The methodology was followed as described by Gandiwa and Kativu (2009), Zeh et al. (2019), Luna-Kamyshev et al. (2020).

Data analysis

Relative abundance

Relative abundance of bird species of the area was determined using *Equation 1:*

$$R.A = n/N \quad \text{(Eq.1)}$$

where: R.A: Relative Abundance, n = total number of individuals of a bird species and N = total number of individuals sighted of all bird species recorded during the surveys.

Diversity indices

Diversity reflects the heterogeneity of bird species in Sheikh Badin National Park. Diversity is an index that integrates the number of bird species found within a given habitat and the relative abundance that provides information on the scarcity and triviality of bird species. The Community Analysis Package Version 4.0 (Henderson and Seaby, 2007) has been used to determine diversity indices, i.e. species diversity, wealth and homogeneity in Sheikh Badin National Park.

Bird diversity

Shannon-Weiner Index (H′) was calculated in order to know the species diversity based on species abundance using *Equation 2* as given below:

$$H' = \sum[(pi) \times \ln(pi)] \quad \text{(Eq.2)}$$

where: H' designates diversity, S indicates the number of species, *i* specifies the abundance of species, *N* is the total number of all individuals, p_i is the relative abundance of each species, and ln is the natural logarithm.

In this study, the *Simpson Diversity Index* is a measure of bird diversity that takes into account the number of species occupied the national park, as well as the relative abundance of each particular species. The Simpson Diversity Index was calculated using *Equation 3* given below:

$$D = \Sigma n(n - 1) / N(N - 1) \quad \text{(Eq.3)}$$

where: n = the total number of individuals of a particular bird species and N = the total number of bird individuals detected in the national park of all species.

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Bird species evenness

Evenness is the distribution aspect of bird species in a Sheikh Badin National Park. How bird species have occupied the National Park was calculated using *Equation 4:*

$$J = H' / H_{max} \quad \text{(Eq.4)}$$

where: H' = diversity index and H_{max} = natural log of the total number of all bird species.

Comparison of feeding guilds among bird species

All enlisted bird species were divided into different feeding groups based on similar foraging behavior, food consumptions and habitat preferences. The methodology was followed as described (Lopez de Casenave et al., 2008; Liordos, 2010; Zakaria and Rajpar, 2010; Parajapati and Parajapati, 2013; Ding et al., 2019).

Results

Bird species composition and relative abundance

In total, 7,919 individuals representing 42 species encompassing 15 migratory species (2,574 individuals; 32.504%) and 27 resident species (5,345 individuals; 67.496%) of 10 orders and 23 families were detected between November 2017 to December 2019 within the National Park (*Table 1; Fig. 4a* and *b*).

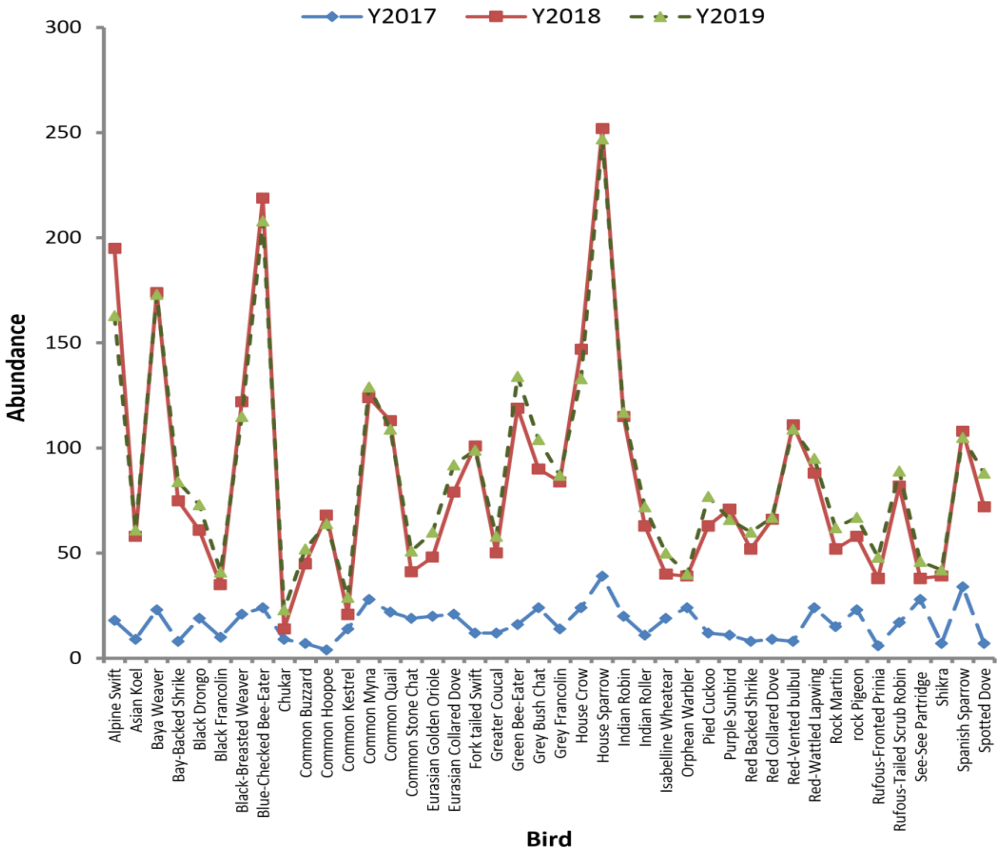

Figure 4a. *Bird relative abundance from 2017–2019*

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Muscicapidae (11.087%) and Meropidae (9.092%) were the leading families with five and two species respectively. By contrast, Cisticolidae (1.111%) and Falconidae (0.818%) were the rarest families to be found. Blue-cheeked flycatchers (5.695%) and Alpine Swifts (4.748%) were the two most abundant migratory bird species. House sparrow (6.794%) and Baya's weaver (4.672%) were the most plentiful resident bird species. The Chukor (0.581%) was the rarest residing bird. All bird species have been classified as Least Concern (*Table 1*).

Table 1. *Relative abundance of bird species detected in the Sheikh Badin National Park*

Family	Scientific name	Common name	National status	Total detections	%	IUCN status
Meropidae	*Merops persicus*	Blue-cheeked Bee-eater	M	451	5.695	LC
Apodidae	*Tachymarptis melba*	Alpine Swift	M	376	4.748	LC
Passeridae	*Passer hispaniolensis*	Spanish Sparrow	M	247	3.119	LC
Phasianidae	*Coturnix coturnix*	Common Quail	M	244	3.081	LC
Laniidae	*Lanius vittatus*	Bay-backed Shrike	M	167	2.109	LC
Cuculidae	*Clamator jacobinus*	Pied Cuckoo	M	152	1.919	LC
Hirundinidae	*Ptyonoprogne fuligula*	Rock Martin	M	129	1.629	LC
Oriolidae	*Oriolus oriolus*	Eurasian Golden Oriole	M	128	1.616	LC
Laniidae	*Lanius collurio*	Red-backed Shrike	M	120	1.515	LC
Muscicapidae	*Oenanthe isabellina*	Isabelline Wheatear	M	109	1.376	LC
Accipitridae	*Buteo buteo*	Common Buzzard	M	104	1.313	LC
Sylviidae	*Sylvia hortensis*	Orphean Warbler	M	103	1.301	LC
Cisticolidae	*Prinia buchanani*	Rufous-fronted Prinia	M	92	1.162	LC
Accipitridae	*Accipiter badius*	Shikra	M	88	1.111	LC
Falconidae	*Falco tinnunculus*	Common Kestrel	M	64	0.808	LC
Passeridae	*Passer domesticus*	House Sparrow	R	538	6.794	LC
Ploceidae	*Ploceus philippinus*	Baya Weaver	R	370	4.672	LC
Corvidae	*Orvus splendens*	House Crow	R	304	3.839	LC
Sturnidae	*Acridotheres tristis*	Common Myna	R	281	3.548	LC
Meropidae	*Merops orientalis*	Green Bee-eater	R	269	3.397	LC
Ploceidae	*Ploceus benghalensis*	Black-breasted Weaver	R	258	3.260	LC
Muscicapidae	*Copsychus fulicatus*	Indian Robin	R	252	3.182	LC
Pycnonotidae	*Pycnonotus cafer*	Red-vented Bulbul	R	228	3.637	LC
Muscicapidae	*Saxicola ferreus*	Grey Bush Chat	R	218	2.753	LC
Apodidae	*Apus pacificus*	Fork-tailed Swift	R	212	2.677	LC
Charadriidae	*Vanellus indicus*	Red-wattled Lapwing	R	207	2.614	LC
Columbidae	*Streptopelia decaocto*	Eurasian Collared Dove	R	192	2.425	LC
Muscicapidae	*Cercotrichas galactotes*	Rufous-tailed Scrub Robin	R	188	2.374	LC
Phasianidae	*Francolinus pondicerianus*	Grey Francolin	R	185	2.336	LC
Columbidae	*Spilopelia chinensis*	Spotted Dove	R	167	2.109	LC
Dicruridae	*Dicrurus macrocercus*	Black Drongo	R	153	1.932	LC
Nectariniidae	*Cinnyris asiaticus*	Purple Sunbird	R	148	1.869	LC
Columbidae	*Columba livia*	Rock Pigeon	R	148	1.869	LC
Coraciidae	*Coracias benghalensis*	Indian Roller	R	146	1.845	LC
Columbidae	*Streptopelia tranquebarica*	Red-collared Dove	R	142	1.793	LC
Upupidae	*Upupa epops*	Common Hoopoe	R	136	1.717	LC
Cuculidae	*Eudynamys scolopacea*	Asian Koel	R	128	1.616	LC
Cuculidae	*Centropus sinensis*	Greater Coucal	R	120	1.515	LC
Phasianidae	*Ammoperdix griseogularis*	See-see Partridge	R	112	1.414	LC
Muscicapidae	*Saxicola rubicola*	Common Stone Chat	R	111	1.402	LC
Phasianidae	*Francolinus francolinus*	Black Francolin	R	86	1.086	LC
Phasianidae	*Alectoris chukar*	Chukor	R	46	0.581	LC
		TOTAL		**7919**		

R = Resident, M = Migrant, LC = Least concerned

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The results of Wards Method indicated that branch lengths and topological changes of dendrogram revealed that bird diversity overall, resident and migrant species may vary in Sheikh Badin National Park (*Fig. 4b; A, B, C*).

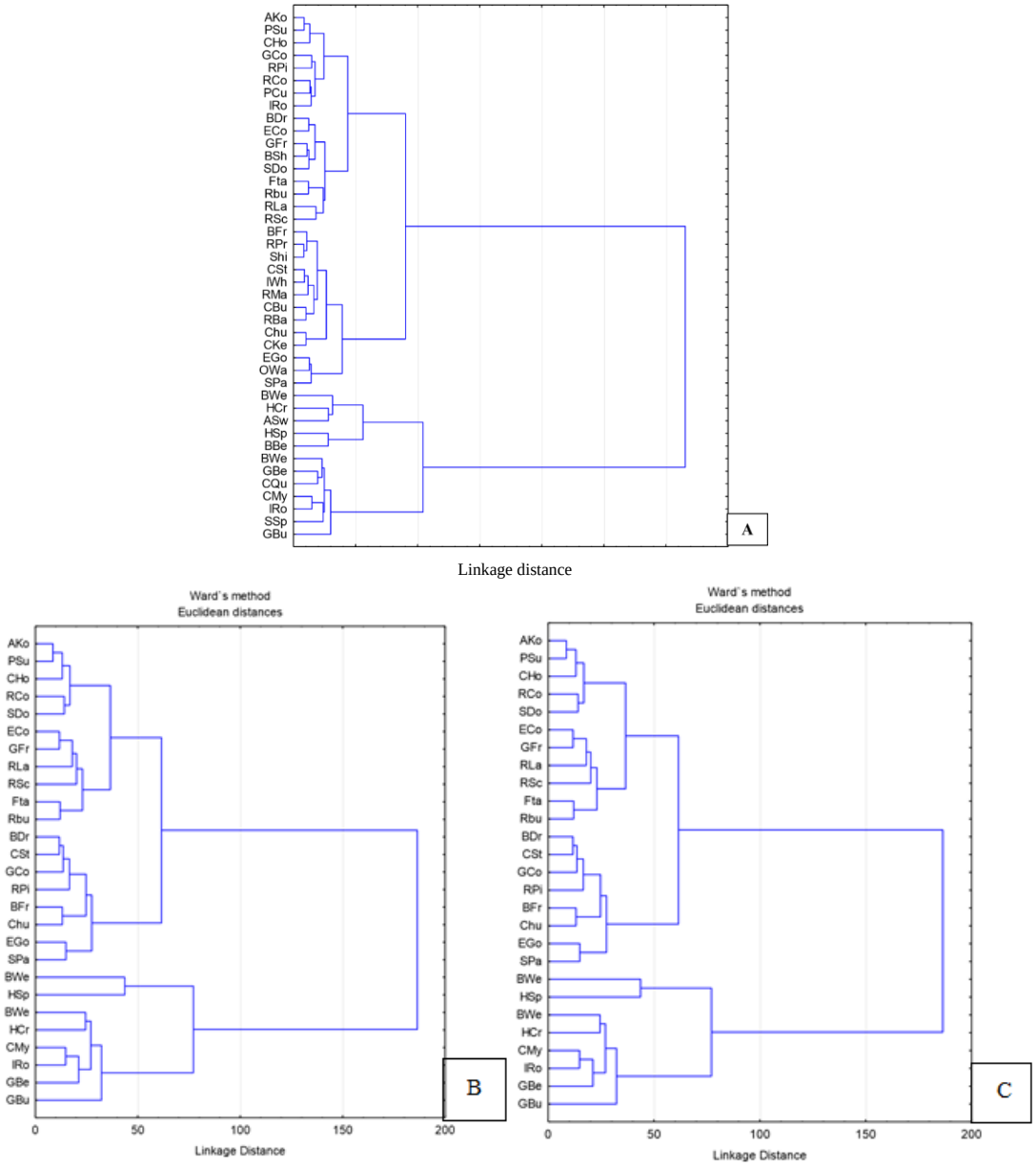

Figure 4b. *Dendrogram reflecting (A) the overall bird diversity, (B) resident bird diversity and (C) migrant bird diversity in Sheikh Badin National Park*

Bird species diversity indices

The overall Shannon Diversity Index (H' = 3.608) and Simpsons abundance (D = 0.031) have been recorded. Additionally, the Shannon Diversity Index (H' = 3.186) and Simpsons Diversity Index (D = 0.031) were related to resident birds and (H' = 2.543 and (D = 0.093) to migratory birds. Overall, the homogeneity of the species (H/In S = 0.965) was found in the study area. The species' homogeneity was found in resident

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birds E = 0.967 and E = 0.940 in migratory birds (*Tables 2* and 3). In *Figure 5* (A) graphically has shown richness S, in 2 (B) Shannon diversity index, 2 (C) Lambda (Simpsons index, l) and in 2 (D) Evenness.

Table 2. *Comparison of resident and migratory bird diversity indices from 2017 to 2019 detected in the Sheikh Badin National Park*

Diversity	Year	Resident birds	Migratory birds	Total
Shannon index = H'	2017	3.1915	2.5803	3.6236
	2018	3.1580	2.4866	3.5712
	2019	3.1886	2.5566	3.6138
	2017 – 2019	**3.1859**	**2.5426**	**3.6076**
Simpsons diversity index = D	2017	0.0446	0.0843	0.0292
	2018	0.082	0.1021	0.0327
	2019	0.0458	0.0901	0.03041
	2017 – 2019	**0.04614**	**0.09262**	**0.03080**
Evenness index = J	2017	0.9683	0.9528	0.9695
	2018	0.958	0.9182	0.9555
	2019	0.9675	0.9441	0.9669
	2017 – 2019	**0.9666**	**0.9389**	**0.9652**

Table 3*. Comparison of species composition, relative abundance, and diversity indices of resident and migratory birds from 2017 to 2019*

Year	Status	No of bird species	Total detection of bird individuals	Shannon diversity index	t-value	P-value
2017	Resident species	27	471	3.1915	16.72**	0.0000
	Migratory species	15	229	2.5803		
2018	Resident species	27	2368	3.1589	30.36**	0.0000
	Migratory species	15	1162	2.4866		
2019	Resident species	27	2488	3.1886	34.27**	0.0000
	Migratory species	15	1201	2.5566		
2017-19	Resident species	27	5327	3.1859	49.09**	0.0000
	Migratory species	15	2592	2.5426		

**Highly significant (P < 0.01)

Scatter plots of the bird species encountered

The purpose of the dispersion diagram is to show the distribution of different species according to their frequency and variance covariance matrices. The dispersal diagram of the bird species observed showed that most of the bird species were grouped, which clearly distinguishes them from others. Nine different bird species that distinguished themselves during the study were Domestic Sparrow (HSp), Baya's Weaver (BWe), Grey Brush Cat (GBu) and Partridge (Spa). Additionally, (BBe) Blue-cheeked Bee Feeder, (ASw) Alpine Swift, (SSp) Spanish Sparrow, (CQu) Common Quail and (OWa) Orpheus Warbler of Migratory Birds (*Fig. 6A-I*).

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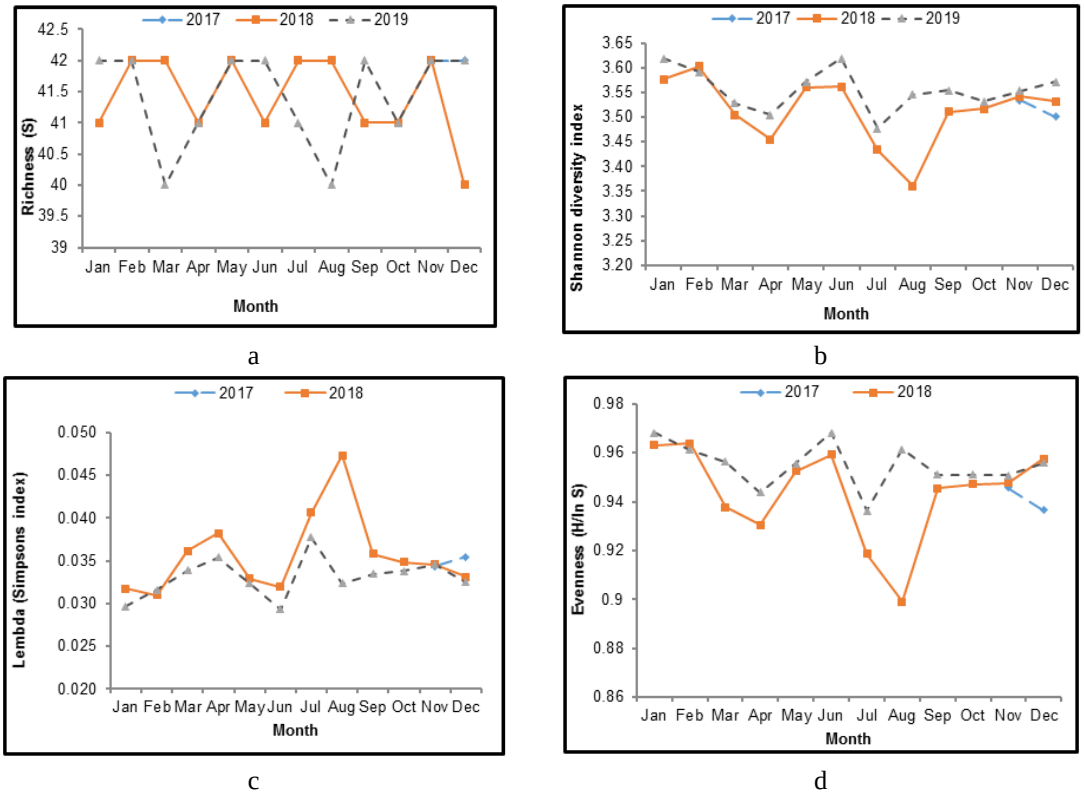
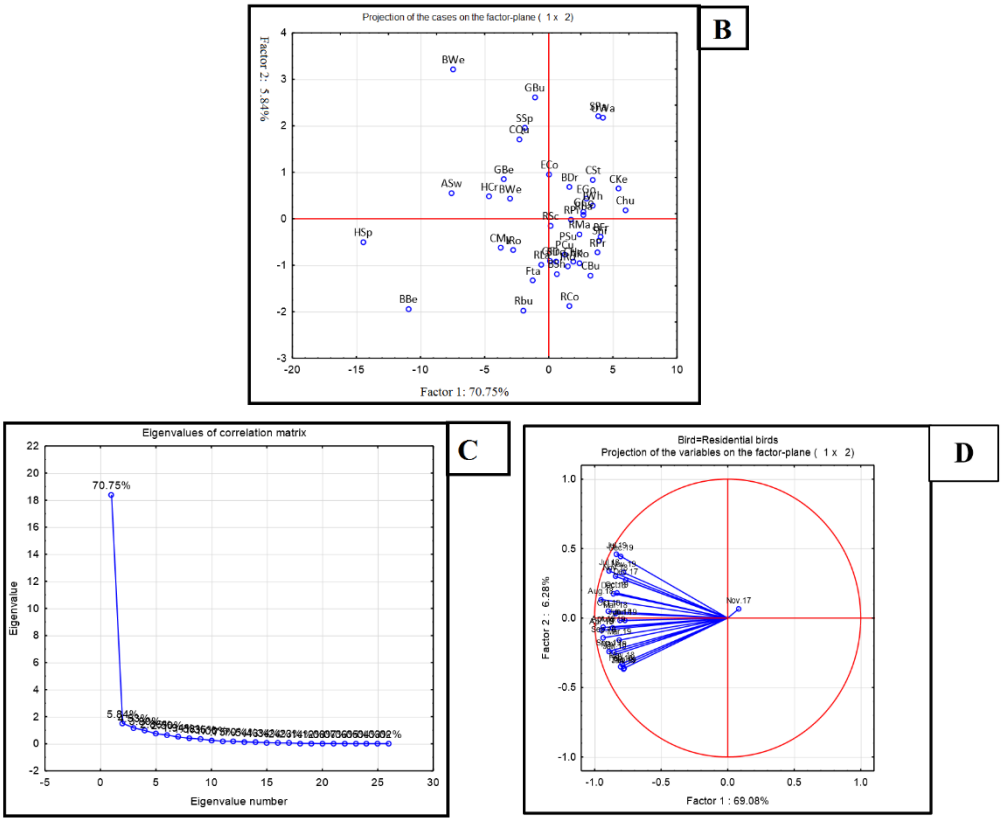


Figure 5. *Graphically showing (a) richness S, (b) Shannon variety index, (c) Lambda (Simpsons index, λ) and (d) regularity of birds*



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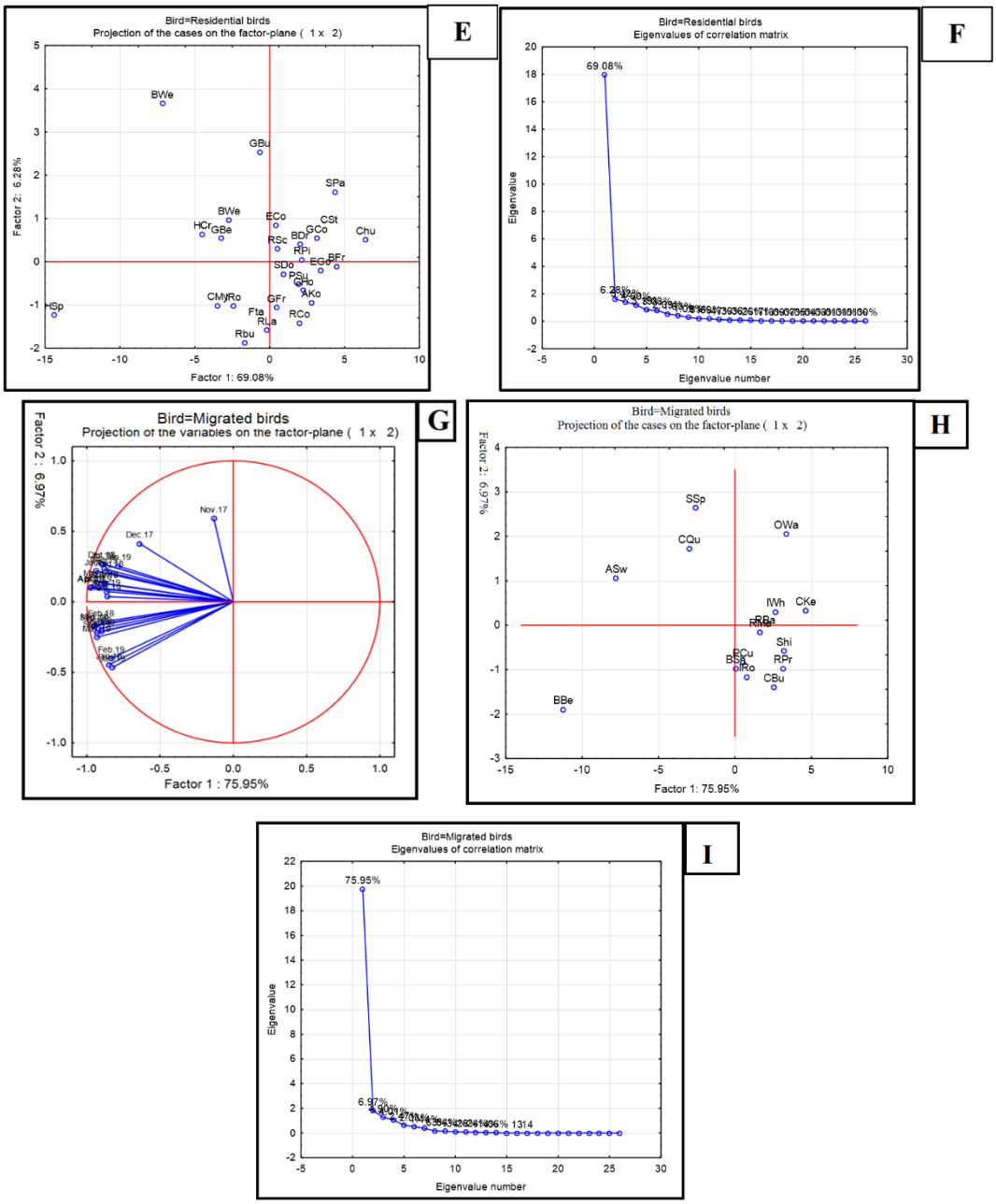

Figure 6. *Scatter plots of the bird species encountered in the study area (A-I)*

Vegetation structure and avian species composition in Sheikh Badin National Park

Vegetation of Sheikh Badin National Park is diverse and encompasses trees, shrubs, herbs, grasses, bushes and climbers. A total of 20 tree species (13 families), 21 shrub species (17 families), 36 herb species (21 families), 3 species of bushes (3 families) and 3 species of climbers (3 families) (*Table 4*).

Feeding guilds

The bird species were divided into nine feedings guilds. Insectivore (44.879%) was the most abundant guild based on number of detections and Frugivore (1.616%) was

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the rarest guild in the study area. In comparison between resident and migrant bird species, it was observed that Insectivore (24.801%) and Granivore/Insectivore (23.020%) were two most dominant resident bird species and Insectivore (20.078%) was the foremost abundant migrant bird species. However, no feeding guilds of resident carnivore and four guilds, namely; Carnivore/Insectivore, Frugivore, Nectarivore/Insectivore and Omnivore of migrant bird species were did not detected in the national park (*Table 5*).

Table 4. *Vegetation structure and composition of study area*

Family name	Scientific name	Common name
Trees		
Anacardiaceae	*Pistacia chinensis*	Chinese Pistachio
Arecaceae	*Phoenix dactylifera*	Date Palm
Bignoniaceae	*Tecomella undulata*	Roheda
Boragingaceae	*Cordia myxa*	Assyrian Plum
Fabaceae	*Prosopis juliflora*	Mesquite
	Acacia modesta	Phulai
	Vachella nilotica	Gum Arabic Tree
	Dalbergia sissoo	Shisham
	Prosopis cineraria	Jand or Ghaf
Meliaceae	*Melia azedarach*	Chinaberry
Moraceae	*Ficus carica*	Common Fig
	Ficus palmata	Wild Himalayan Fig
	Morus alba	White Mulberry
	Morus nigra	Black Mulberry
Myrtaceae	*Eucalyptus lanceolatus*	River Red Gum
Oleaceae	*Olea ferruginea*	Kahu
Rhamnaceae	*Ziziphus mauritiana*	Indian Jujube
Salvadoraceae	*Salvadora oleoides*	Vann, Peelu
Simaroubaceae	*Ailanthus altissima*	Tree of Heaven
Tamaricaceae	*Tamarix aphylla*	Ghaz, Athel Tamarisk
Shrubs		
Apocynaceae	*Calotropis procera*	Aak, Apple of Sodom
	Nerium oleander	Oleander
	Periploca aphylla	Kannada
	Rhazya stricta	Rhazya
Arecaceae	*Nannorrhops ritchiana*	Mazari Palm
Asparagaceae	*Agave sisalana*	Sisal
Boragingaceae	*Ehretia obtusifolia*	Stamper wood
Capparaceae	*Capparis decidua*	Karira
Celastraceae	*Maytenus royleana*	Royle's Spike Thorn
Euphorbiaceae	*Ricinus communis*	Caster Bean
Fabaceae	*Sophora mollis*	Soft Sophora
Lamiaceae	*Isodon rugosus*	Codd
	Otostegia limbata	Koi Booi
Lythraceae	*Punica granatum*	Pomegranate
Malvaceae	*Grewia optiva*	Bhimal or Bihul
Rhamnaceae	*Ziziphus nummularia*	Jhar Beri
Rosaceae	*Cotoneaster nummularius*	Coinwort Cotoneaster

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Sapindaceae	*Dodonaea viscoa*	Sanatha
Sapotaceae	*Monotheca buxifolia*	Gurguri
Solanaceae	*Datura metel*	Devil's Trumpet
Zygophyllaceae	*Tribulus terrestris*	Harmal Bindii
Herbs		
Amaranthaceae	*Amaranthus viridis*	Selender Amarantha
	Chenopodium album	Pig Weed
Amaryllidaceae	*Allium griffithianum*	Wild Onion
Asparagaceae	*Asparagus capitatus*	Blue Dicks
Asphodelaceae	*Aloe vera*	Indian Aloe
Asteraceae	*Carthamus oxyacantha*	Wild Safflower
	Conyza stricta	Horse Weed
	Echinops echinatus	Indian Globe Thistle
	Filago hurdwarica	Cud Weed
	Launaea procumbens	Creeping Launaea
	Saussurea heteromalla	Saw wort Kaliziri
Boragingaceae	*Heliotropium strigosum*	Bristly Heliotrope
Brassicaceae	*Eruca sativa*	Argula plant
Convolvulaceae	*Convolvulus arvensis*	Field Bindweed
Euphorbiaceae	*Euphorbia helioscopia*	Sun Spurge
	Euphorbia prostrata	Prostate Sandmat
Fabaceae	*Trigonella monantha*	Medick
Geraniaceae	*Erodium cicutarium*	Red Stem Filaree
Lamiaceae	*Mentha sylvestris*	Wild Mint
	Phlomis stewartii	Jerusalem Sage
	Withania coagulans	Paneer
	Withania somnifera	Winter Cherry
Zygophyllaceae	*Fagonia indica*	Indian Fagona
Grasses		
Asphodelaceae	*Asphodelus tenuifolius*	White Asphodel
Brassica	*Farsetia jacquemontii*	Boan
	Sisymbrium irio	London Rocket
Cannabaceae	*Cannabis sativa*	Hemp
Cyperaceae	*Cyperus rotundus*	Nut Grass
Fabaceae	*Astragalus hamosus*	European Milkvetch
Lamiaceae	*Lallemantia royleana*	Balangu
Poaceae	*Aristida adsensionsis*	Common Needle Grass
	Bromus japonicus	Japanese Brome
	Cenchrus ciliaris	Buffel-grass
	Cymbopogon jwarancusa	Khawi Oil Grass
	Cynodon dactylon	Khabbal Scuth Grass
	Eragrostis minor	Lesser Love Grass
	Saccharum bengalense	Kana Munj or Sweet cane
Bushes		
Amaranthaceae	*Aerva javanica*	Kapok Bush
Apocynaceae	*Caralluma edulis*	Pimpa
Fabaceae	*Alhagi maurorum*	Camel Thorn
Climbers		
Cucurbitaceae	*Citrullus colocynthis*	Bitter Apple
Fabaceae	*Vicia hirsuta*	Tiny Vetch
Solanaceae	*Solanum surattense*	Yellow-fruit Nightshade

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Table 5. *Comparison of feeding guilds of bird species recorded in Sheikh Badin National Park*

Guild name	Overall		Resident bird species		migrant bird species	
	N	%	N	%	N	%
Carnivore	256	3.232	0	0	256	3.232
Carnivore/insectivore	327	4.129	327	4.129	0	0
Frugivore	128	1.616	128	1.616	0	0
Frugivore/insectivore	356	4.495	228	2.879	128	1.616
Granivore	581	7.336	142	1.793	247	3.119
Granivore/insectivore	1984	25.053	1823	23.020	353	4.457
Insectivore	3554	44.879	1964	24.801	1590	20.078
Nectarnivore/insectivore	448	5.657	148	1.868	0	0
Omnivore	585	7.387	585	7.387	0	0
Grand total	7919		5,345		2,574	

N = total number of bird individuals

Discussion

It is of the utmost important to determine and understand the habitat avian community parameters in habitat relevance and productivity that a better plan can be made to enhance population and conserve their habitat. As habitat loss and degradation is a major anthropogenic factor, the bird population has decreased. The detection of 42 species representing 25 families reveals that Sheikh Badin National Park is a suitable and productive habitat for wide range of bird species. The indicated that vegetation structure and composition significantly attracted a wide array of bird species to utilize this productive habitat in order perform multiple activities.

Notably, 83 floral species, including 20 tree species, 21 shrub species, 36 grass species, and b climber species were recorded from Sheikh Badin National Park. This demonstrated that national park is rich and diverse in vegetation structure and composition. Previously, 107 plant species (26 trees, 20 shrubs, 53 herbs and 8 grasses) were also enlisted by Ullah et al. (2016). We recorded little bit less flora as compared to previous study. The reason might be application of different survey method or higher number of sample plots. The diversity of flora has created multilayered vegetation strata that established heterogeneous habitats and make this national park as a productive habitat (rich in food resources). Mengesha and Bekele (2008) stated that floral diversity and richness of food resources are the primary drivers that harbored a wide array of avian species. Likewise, Hanzelka and Reif (2016) reported that vegetation heterogeneity significantly enhances bird diversity. Furthermore, Kiros et al. (2018) also illustrated that vegetation composition is the key factor affecting chick survival, distribution of food sources and providing shelter from weather and predators. In the end, has an impact on feeding behavior, habitat preference, predation rate and population structure.

Strikingly, recording of migrant bird species revealed that the Sheikh Badin National Park is not only suitable habitat for resident birds, but also for migrant visitors. The reason is that, this national park fulfills the basic needs (i.e. living place, food, shlter, and breeding grounds) of avian species. The migrant bird species used this national park as refuge until weather conditions in northern/southern latitudes become favorable for them.

The feeding guild results showed that insect eating bird, i.e. bee-eater, swiftlets, shrikes, hoopoes, rollers, drongos, bushchats, robins, prinias, etc had densely occupied the national

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park. The occupation of higher number of insect eating bird could be richness and diversity of insect species. The occurring of wide range insect could be due to availability of wide array of floral species that bears flowers and fruits that had attracted them to utilize this habitat. However, the feeding guilds of resident and migrant species varied. It has been reported that environmental factors and land use changes significantly effects on vegetation characteristics that may influence on bird food selection (Tharme et al., 2001; Pearce-Higgins and Grant. 2006). Previously, such types of findings also have been reported by De Bonilla et al. (2012) and Panda et al. (2021).

Diversity indices suggest that bird species in Sheikh Badin National Park are diversified, rich and uniformly distributed. The results of this study are nearly identical to those of (Ali et al., 2011) at the Taunsa Dam, a wildlife sanctuary in Punjab, Pakistan. They stated that the Shannon Weiner Diversity Index values are typically between 1.5 and 3.5; however, under rare circumstances, it may exceed 4.5. The presence of a variety of avian species could be richness and diversity of food resources (insects, fruits, flowers, amphibians, reptiles, and small passerine birds for raptors) and heterogeneous vegetation layers that constituted multiple microhabitats. Thus, proving an ideal, productive and less disturb habitat that provides shelter from harsh weather and predators, offer suitable foraging and breeding grounds for a wide array of avian species.

Threats to avian species

Identifying the human footprint of wildlife and its habitat can provide a strong foundation for a better understanding of ecological models and processes. The results of this study identified the following major threats in Sheikh Buddin National Park to avifauna (*Fig. 7*).

Illegal hunting and trapping

Illegal hunting is the key factor that can cause bird species to decline or disperse. Bird species in the study area are illegally hunted by rifles and trapped by nets, resulting in a declining bird population every day. In addition, the breeding areas has also been disturbed by intensive livestock grazing on key breeding areas. Similar findings were also reported by Khan and Ali (2015).

Habitat loss and degradation

The second most serious threat identified was habitat loss and degradation as a result of land-use change. Habitat loss and degradation can cause the removal of vegetation and make it less productive and suitable for avian use. As a result of habitat loss and degradation, bird species migrate to less productive areas in the vicinity. e.g., agricultural fields for food, shelter and reproduction, where they are hunted by local people and easily preyed by predators due visibility. In addition, some bird species become victim of pesticides, die or become less productive. In addition, some bird species become victim of pesticides, die or become less productive.

Uncontrolled grazing

Livestock grazing is a major issue in this area, i.e. destruction of eggs and nesting sites by cattle hooves. Livestock roaming in basic habitat poses a major threat to bird breeding and the survival of avian species Khan and Ali (2015).

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Figure 7. *Threats to avifauna at Sheikh Badin National Park*

Conclusion

Sheikh Badin National Park is an attractive habitat for a broad range of avian species. However, low management, altered land use, illegal hunting, trapping, and grazing pose a serious threat to bird species. Based on the results, it is highly recommended that the relevant concerned department take immediate action to control illegal activities in the study area and strictly enforce the legislation. We also recommend that detailed future research be undertaken to explore biodiversity resources to improve future conservation and management measures. The Wildlife Department should coordinate with universities for research and training purposes. Local community awareness campaigns should also be conducted to highlight the importance of natural resource conservation.

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