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Study of Bird Diversity in Ghamot National Park Azad Jammu and Kashmir, Pakistan

Muhammad Jahangeer*[1], Muhammad Siddique Awan[1], Muhammad Altaf[2]*, Riaz Aziz Minhas[1] and Usman Ali[3]

[1]*Department of Zoology, University of Azad Jammu and Kashmir, Muzaffarabad*
[2]*Institute of Forest Sciences, The Islamia University of Bahawalpur, Bahawalpur, Punjab, Pakistan*
[3]*Department of Zoology, Mirpur University of Science and Technology, Azad Jammu and Kashmir, Pakistan*

ABSTRACT

Bird species diversity and distribution research is important for conservation efforts in various protected areas. However, the richness and distribution of birds in Ghamot National Park are unknown. Based on land cover attributes, the research region was divided into five habitat categories. During 2020-21, a point transect count was used softly up to 30-50 m radius with a random sample approach. One-way ANOVA was used to evaluate the data. This research discovered a total of 38 families totaling 127 species. Muscicapidae was numerically the dominant family (n=18; 14.17%) Highest number of individuals (n=938; 24.26%) was recorded from Agricultural crop zone (along the surgan stream; elevation ranges between 2750-3050m) Minimum number of individuals was recorded in alpine pasture, alpine meadows and wetland (n=113; 2.92%) at an elevation ranges between 3950-4400m. 47 (37%) species were recorded summer migrant, 59 (46.45%) were residential of study area, 3 (2.36%) species were recorded irregular year round migrant and 18 (14.17%) species were winter migrant. It was recorded that maximum number of species (n=90; 70.86%) breed (+) in study area however least number (n=37; 29.13%) does not breed (-) in study area. Maximum (n=117) birds species of study area were listed into least concern (LC) status, however the status of two species *Tragopan melanocephalus* and *Ficedula subrubra* is vulnerable (VU) and three species *Gypaetus barbatus, Gyps himalayensis, Circus macrourus* of family Accipitridae are listed as near threatened (NT). Highest biodiversity of birds (H'=4.5) was recorded in riparian forest habitat. Lowest diversity (H'=2.9) was recorded in high alpine pasture. The distribution of species across habitat types did not differ substantially (p>0.05, df =5, f=46.21) between the four habitat types (ACZ, SLZ, RZ, FZ). However, there was a significant difference (p0.5) between riparian, scrub land, forest habitat, and alpine meadows, wet land at high elevation. The highest distribution was found in riparian woodland environment (7.380.51), while the lowest was found in high alpine meadows (0.890.21).

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MJ designed study, collected data and wrote the manuscript. MSA supervised the study. MA, RAM and UA critically reviewed the manuscript.

Key words
Birds, Diversity, Kashmir, Pakistan, Himalaya

INTRODUCTION

The most successful vertebrate group is birds. Flying offers them rapid and direct access to practically any point on the earth. They can eat a variety of things and nest in an unlimited number of places. Most birds serve people by supplying meat and eggs for sustenance, facilitating pollination, disseminating seed and fruits, and biologically controlling insect pests such as grasshoppers, mosquitoes, and others (Singh *et al*., 2018). Birds can also serve as markers of biodiversity and environmental change, such as pollution levels and environmental effect (Abie *et al*., 2019). Birds are good indicators of the ecological state of any given ecosystem since they play a significant part in the food chain in the natural ecological unit (Hossain and Baki, 2015). Various researches have attempted to simulate species habitat interactions, while others have observed diversity structures along elevation gradients in order to understand the mechanisms behind those patterns. Nonetheless, agreement on the generality of processes and trends remains a source of disagreement (Rahbek *et al*., 2007), with the majority of studies focusing on species richness and distribution variation. Because elevation influences both the physical environment and the types and amounts of resources available for nesting and feeding, the composition and structure of bird populations can alter along an elevation gradient (Altaf *et al*., 2018). A wide variety of bird species may be found in Pakistan. Over 668 species have been recognized so far (Mirza and Wasiq, 2007). Wintering birds spend the majority of winter

* Corresponding authors: altaf_mughal450@yahoo.com; khushikhlaqjahangeer@gmail.com
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season in Pakistan, as well as migratory birds that travel through in the spring and fall in the Indus flyway route (Grimmett *et al*., 2008; Bibi *et al*., 2013).

Azad Jammu and Kashmir is located in the Himalayan foothills. It is located between 2°-17` and 36°-58` north latitude and 73°-6` and 80°-30` longitude (Awan *et al*., 2012). Azad Kashmir's forest types range from tropical thorn forest to cold desert forest. The climate varies across the territory due to the diverse ecological zones. In this area, various biotopes provide suitable habitat for wildlife species. Azad Kashmir's fauna includes both Palearctic and Oriental elements (Roberts, 1991). The study area is in the Neelum valley, which is part of the Western Himalayas Endemic Bird Area (Awan *et al*., 2012). The diversity and dispersion of birds is the most important aspect of Ghamot National Park. Despite the fact that various bird species exist in the study region, there has been no scientific research on the variety and abundance of birds. Furthermore, ecologists and biologists employ species diversity and abundance to analyse community organization, which is crucial for conservation efforts (Altaf, 2010; Abie *et al*., 2019). Given these considerations, surveying these bird species was an apparent focus for our research. The research goal was to determine the variety and dispersal of bird species in the studied region.

MATERIALS AND METHODS

Study area

Ghamot National Park (GNP) is situated 170 kilometers north of Muzaffarabad, the capital of Azad Jammu and Kashmir, in the upper Neelum valley, a region of the inner Himalayas. The study area lies within latitude 35° 24' N and longitude 73° 57' E at an altitude ranging from 2439–4949 m above sea level. The park is located on the edge of Surgan Nullah, at a distance of about 25 km from Sharda. On its western side lies the Kaghan Valley in the Khyber Pakhtunkhwa (KP), while on its eastern side is Indian-occupied Jammu and Kashmir. The road from Sharda to Ghamot National Park is a seven-kilometer carpeted road up to Surgan, a small town at the Surgan-valley's entrance, and a further 16 to 18-kilometer stretch of Jeep-able roads from Surgan village to Ghamot village, a small settlement at the park's boundary. The climate of the area varies with altitude, but generally, the forest areas of the study area fall into moist temperate forest, dry temperate forest, sub-alpine scrub, and alpine pastures. Winters are extremely cold, with deep snow. Summers are extremely pleasant and cool. Snow may remain on high peaks until June or even later (on glaciers) (Fig. 1). The meteorological data record for Neelum Valley is not available at the Pakistan Meteorological Department (Qamar *et al*., 2012).

The study area is positioned at the confluence of three famous mountain systems, i.e., the Hindu Kush, Karakorum, and Himalayas. This uniqueness of the mountain's arrangement results in strong floral and faunal biodiversity. Aside from hundreds of economically important animal and plant species, the study area is home to some rare and globally valuable and threatened wildlife species, including snow leopard *Uncia uncia,* common leopard *Panthera pardus,* Himalayan ibex *Capra ibex,* musk deer *Moschus chrysogaster,* black bear *Ursus thibetanus,* brown bear *Ursus arctos*, and monal pheasant *Lophophorus impejanus*. The important plant species are deodar *Cedrus deodara,* blue pine/kail *Pinus willichiana*, silver fir *Abies pindrow,* spruce *Picea smithiana*, horse chestnut *Aesculus indica,* veined-leaf viburnum *Viburnum nervosum* and costus root *Saussurea lappa* (Ahmad *et al*., 2016; Ali *et al*., 2018).

Methodologies

Before conducting the survey zonation of study area was done on the basis of topographic features, vegetation characteristics, elevation, aspect and slope of study area. The study area was stratified into five different zones i.e., forest zone, (FZ, elevation ranges between 2400-3300m), scrubland zone (SLZ, 2800, 3200m), high alpine pasture zone (APZ, 3400-4400m), riparian zone (RZ, 2400-3600m) and agricultural crop land zone (ACZ, 2300-2700m) (Fig. 1). These five zones were further divided into twenty different localities, all localities in the same zone had similar vegetation characteristics but with different elevation, slop and aspect. Forest zone was divided into 5 localities (FZL1-FZL5), scrubland zone into three localities (SLZL1-SLL3), alpine pasture zone into four localities (APZL1-APZL4), riparian zone into five localities (RZL1-RZL5) and agricultural zone into three localities (ACZ1-ACZ3) (Table I).

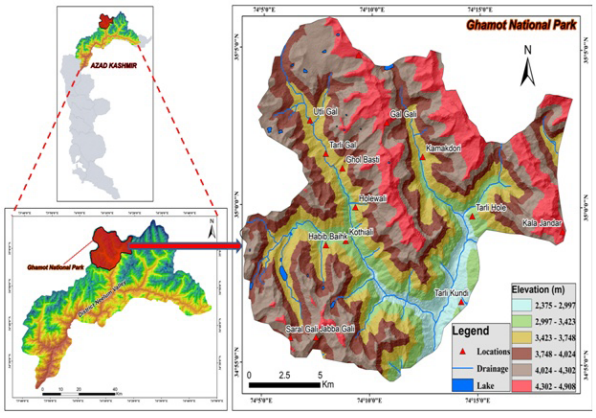

Fig. 1. Location map of study area.

Data collection

Sampling survey was carried out from April 2020 to March 2021. Field sampling was started in the early morning (5:00-10:00 a.m.) and in the evening (4:00-6:00 p.m.). Birds were surveyed using line transect with point count method. A total of 42 transects (total area covered 11.4km) with 166 point count (4 in each transect) were laid. To avoid double counting of same individuals, each point count in transect was at least 50 m far away from each other. Length of transect varied from locality to locality on the basis of habitat type. On the basis of habitat type, three different types of transects were laid: type 1 for open habitat (300m x 200m), type 2 for dense forest habitat (300mx50m) and type 3 for riparian forest habitat (300m x 100m) (along the streams). Out of total fourteen transect (300m x 50m) were laid in BLI and BL2 (riparian habitat), 12 (300m x 100m) in BL4 and BL6 (Open habitat type) and 16 (300m x 200m) were laid in BL3, BL4, BL5 and BL6 (Table I).

Observations at each point transect were made by standing in the middle of point transect and observing up to a distance of 30-50 m radius, direct observation was aided by a cannon binoculars (7×50mm and 8×40 mm). Direct observation at each point lasted for 10-15 min. Each point transect was visited 4 times during the study period. All observed individuals characteristics such as color, shape, size, beak, legs, tail, song and calls were recorded on a prepared datasheet. Bird species were identified and taxonomically classified using bird guide books and other available references (Roberts, 1991, 1992; Grimmett *et al*., 2008).

Data analysis

The Shannon diversity index abbreviated as H′ was calculated using statistical software known as past. This study uses proportions rather than absolute abundance data to minimize the influence of order of magnitude changes in bird populations between species. The evenness of the proportion of each species found inside squares is measured by this index. J′ = H′ ln(S), where J' is the evenness index, H' is the Shannon-Wiener index calculated using formula (H′); and S is the species richness. Relative abundance (RA) = n/N 100, where n is the number of individuals recorded for a specific species and N is the total number of individuals for the species.

RESULTS

Overall, a total of 60 transects with 240 point counts resulted a sum of 3865 individuals of birds belonging to 38 families belonging to 127 species were recorded from the study area. Family Muscicapidae was numerically the dominant family represented with 18 species accounting for 14.17% of all the identified species. The co-dominant families included Paridae (n=8, 6.29%), Phylloscopidae (n=8, 6.29%), Phasianidae (n=7, 5.51%) and Emberizidae (n= 6, 4.72). The least dominant families included Estrildidae, Zosteropidae, Sittidae, Rhipiduridae, Regulidae, Oriolidae, Monarchidae and Cinclidae represented by one species each and collectively account for 6.29% of the total identified species. In term of relative abundance the Muscicapidae family represented maximum (14.28%) individuals (n = 552) followed by Emberizidae (n = 355, 9.18%), Fringillidae (n = 270, 6.98%), Phylloscopidae (214, 5.53%) and least number of individuals represented by Oriolidae (n = 3, 0.07%) (Fig. 2).

Table I. Stratified zones detail of laid transect in study area.

Locality name (Code)	Elevation	Coordinates		#Transect and length (m)			Total area covered (km)	#Point count	
		N	E	300x50	300x100	300x200		50 m (radius)	30 m (radius)
Forest zone 2400-3500m	2980	34°59'50.29	74°14'11.19	8	0	0	2.4	14	18
Riparian zone 2300-300m	3495	35°00'11.83	74°13'01.22	6	0	0	1.8	16	8
Scrub land zone 2300-2800m	3050	34°58'10.39	74°12'08.13	0	0	6	1.8	12	12
Agricultural zone 2400-2800m	2850	34°11'16.99	74°13'14.24	0	8	4	1.2	30	18
Alpine pasture zone 3400-4400m	4210	34°56'30.55	74°13'01.87	0	0	2	0.6	5	3
	4010	34°59'50.29	74°14'11.19	0	4	4	3.6	15	17
				14	12	16	11.4	92	76

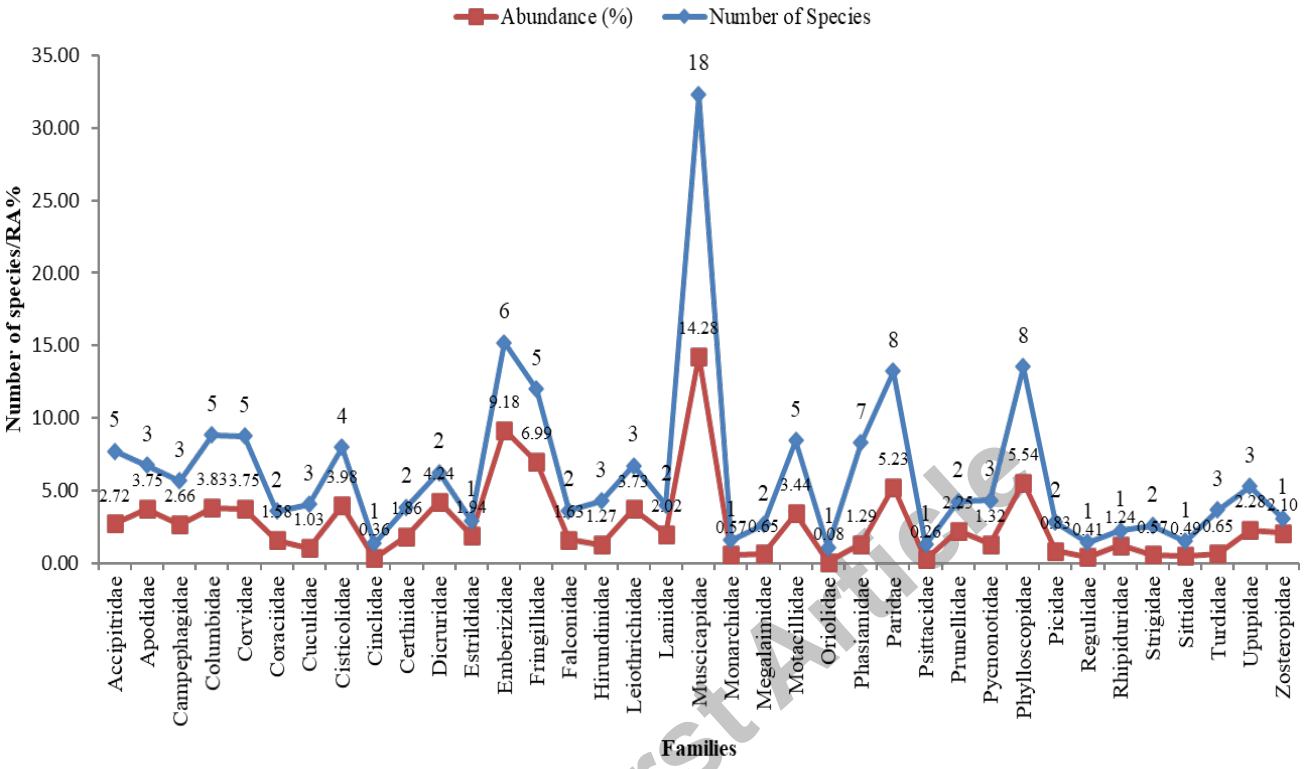

Fig. 2. Diversity of bird families in Ghamot National Park.

Table II. Comparison of diversity indices of birds in Ghamot National Park.

Localities	Individuals	No. of species	Diversity (H)	Equitability (J)	Evenness
ACZ	928	107	4.4	0.95	0.8
SLZ	879	110	4.4	0.95	0.81
RZ	938	116	4.5	0.96	0.85
FZ	890	113	4.5	0.96	0.83
AZL1, 2	70	22	2.9	0.97	0.93
AZL,3	113	21	2.9	0.96	0.91

ACZ, agricultural crop zone; SLZ, scrubland zone; RZ, riparian zone; FZ, forest zone; APZ, alpine zone.

Highest number of individuals (n=938, 24.26%) was recorded from ACZ (along the surgan stream; elevation ranges between 2750-3050m) and nearly similar number of individuals (n=928, 24.01%) was recorded in SLZ. The second highest number of individuals was recorded in RZ (n=890, 23.02%), and followed by FZ (n=879, 22.74%). Minimum number of individuals was recorded in alpine pasture, alpine meadows and wetland (n=113, 2.92%) at an elevation ranges between 3950-4400m (Table III).

Out of total recorded bird species, 47 (37%) species were summer migrants, 59 (46.45%) were residents in the study area, 3 (2.36%) species were irregular year round migrants and 18 (14.17%) winter migrants. The maximum number of species (n=90, 70.86%) were breeding (+) in study area however least number (n=37, 29.13%) do not breed (-) in the study area (Table III).

Table III. Localities with no significant difference (p>0.05, df =5, f=46.21) and alpine zone with significant difference (p<0.5) with other four localities in Ghamot national park.

Localities	Individuals	No. of species	Mean	Std. error	Stand. dev	Variance
ACZ	929	107	7.3	0.62	7.04	49.64
SLZ	879	110	6.92	0.56	6.38	40.78
RZ	938	116	7.38	0.51	5.75	33.14
FZ	890	113	7.00	0.52	5.93	35.27
AZL1, 2	70	22	0.92	0.21	2.38	5.68
AZL,3	113	21	0.89	0.21	2.46	6.09

SE, standard error; SD, standard deviation. For details of localities, see Table II.

Table IV. Check list of birds in Ghamot National Park.

Scientific name (Common name)	Localities/# individuals observed (transect point count)						Abun-dance	AP	Habit	Breed-ing	IUCN	LCS
	ACZ	SLZ	RZ	FZ	APZ							
Accipitridae												
Gyps himalayensis (Himalayan griffon vulture)	12	0	6	6	0	0	24	0.62	I	-	NT	R
Aquila chrysaetos (Golden eagle)	2	0	1	8	0	0	11	0.28	SM	-	LC	R
Accipiter nisus (Eurasian sparrow hawk)	8	4	7	11	0	0	30	0.78	SM	+	LC	R
Gypaetus barbatus (Bearded vulture)	2	1	0	13	0	0	16	0.41	I	-	NT	R
Circus macrourus (Pallid harrier)	6	0	2	16	0	0	24	0.62	SM	-	NT	R
Apodidae												
Apus apus (Common swift)	18	4	6	12	8	4	52	1.35	SM	+	LC	C
Apus pacificus (Fork-tailed swift)	15	8	6	8	6	2	45	1.16	SM	+	LC	C
Apus affinis (House swift / little swift)	22	11	15	0	0	0	48	1.24	R	+	LC	C
Campephagidae												
Pericrocotus ethologus (Long-tailed minivet)	12	0	14	8	0	0	34	0.88	R	+	LC	BR
Pericrocotus roseus (Rosy minivet)	8	4	9	4	0	0	25	0.65	SM	+	LC	R
Pericrocotus flammeus (Scarlet minivet)	12	13	16	3	0	0	44	1.14	SM	+	LC	C
Columbidae												
Streptopelia decaocto (Collard dove)	7	6	4	2	0	0	19	0.49	R	+	LC	R
Streptopelia tranquebarica (Red turtle dove)	2	1	3	23	0	0	29	0.75	R	+	LC	R
Spilopelia chinensis (Spotted dove)	1	0	4	24	0	0	29	0.75	R	+	LC	R
Columba livia (Blue rock pigeon)	8	11	7	19	0	0	45	1.16	R	-	LC	C
Streptopelia orientalis (Oriental turtle dove)	4	2	0	21	0	0	27	0.70	R	+	LC	R
Corvidae												
Urocissa flavirostris (Yellow-billed blue magpie)	0	6	0	13	0	0	19	0.49	SM	-	LC	R
Nucifraga caryocatactes (Nutcracker)	0	2	4	6	0	0	12	0.31	SM	+	LC	R
Pyrrhocorax graculus (Yellow-billed chough)	3	2	8	8	4	2	27	0.70	W	-	LC	R
Pyrrhocorax pyrrhocorax (Red-billed chough)	4	2	4	7	5	4	26	0.67	W	-	LC	R
Corvus macrorhynchos (Jungle crow)	32	11	14	4	0	0	61	1.58	R	+	LC	C
Coraciidae												
Coracias garrulous (Kashmir roller)	11	13	16	8	0	0	48	1.24	R	+	LC	C
Coracias benghalensis (Indian roller)	2	3	5	3	0	0	13	0.34	R	+	LC	R
Cuculidae												
Cacomantis passerines (Plaintive cuckoo)	6	2	0	2	0	0	10	0.26	R	+	LC	R
Clamator jacobinus (Pied crested cuckoo)	2	1	0	7	0	0	10	0.26	SM	+	LC	R
Eudynamys scolopacea (Koel)	2	5	6	7	0	0	20	0.52	R	+	LC	R
Cisticolidae												
Prinia inornata (Plain prinia)	8	11	14	16			49	1.27	R	+	LC	C
Cisticola juncidis (Streaked fantail warbler)	22	13	8	2	0	0	45	1.16	SM	+	LC	C
Prinia criniger (Brown hill warbler)	13	10	8	4	0	0	35	0.91	R	+	LC	BR
Orthotomus sutorius (Common tailorbird)	6	7	4	8	0	0	25	0.65	W	-	LC	R

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Scientific name (Common name)	Localities/# individuals observed (transect point count)						Abun-dance	AP	Habit	Breed-ing	IUCN	LCS
	ACZ	SLZ	RZ	FZ	APZ							
Cinclidae												
Cinclus pallasii (Brown dipper)	2	4	5	3	0	0	14	0.36	W	-	LC	R
Certhiidae												
Certhia himalayana (Himalayan tree creeper)	8	4	6	02	0	0	20	0.52	SM	-	LC	R
Certhia familiaris (Common tree-creeper)	11	13	12	16	0	0	52	1.35	W	-	LC	C
Dicruridae												
Dicrurus macrocercus (Black drongo)	28	22	11	14	0	0	75	1.94	SM	+	LC	C
Dicrurus leucophaeus (Ashy drongo)	19	23	27	21	0	0	90	2.33	R	+	LC	A
Estrildidae												
Lonchura punctulata (Scaly-breasted munia)	24	25	19	7	0	0	75	1.94	W	-	LC	C
Emberizidae												
Emberiza cia (Rock bunting)	21	23	26	4	0	0	74	1.91	SM	+	LC	C
Melophus lathami (Crested bunting)	5	4	9	9	8	4	39	1.01	R	+	LC	C
Emberiza fucata (Chestnut-eared bunting)	6	4	12	5	2	2	31	0.80	R	+	LC	R
Emberiza leucocephalos (Pine bunting)	24	11	17	4	2	4	62	1.60	R	+	LC	C
Emberiza stewarti (White-capped bunting)	17	19	13	2	0	0	51	1.32	R	+	LC	C
Garrulax lineatus (Himalayan laughing-thrush)	18	21	23	8	4	8	82	2.12	W	-	LC	A
Garrulax variegates (Variegated laughing-thrush)	5	4	7	0	0	0	16	0.41	W	-	NE	R
Fringillidae												
Callacanthis burtoni (Red-browed finch)	4	11	14	6	0	0	35	0.91	R	+	LC	R
Carduelis spinoides (Himalayan greenfinch)	13	14	16	11	8	4	66	1.71	R	+	LC	SR
Carpodacus erythrinus (Common rose finch)	8	7	14	14	6	5	54	1.40	R	+	LC	C
Carpodacus nipalensis (Dark-breasted rose finch)	23	17	21	5	0	0	66	1.71	R	+	LC	C
Carpodacus rhodochrous (Pink-browed rose finch)	11	12	16	11	0	0	50	1.29	R	+	LC	C
Falconidae												
Falco subbuteo (Northern hobby)	7	4	3	13	0	0	27	0.70	SM	-	LC	R
Falco tinnunculus (Common kestrel)	11	7	4	14	0	0	36	0.93	SM	+	LC	BR
Hirundinidae												
Delichon dasypus (Kashmir house martin)	8	13	4	7	0	0	32	0.83	R	+	LC	BR
Riparia riparia (Collard sand martin)	2	4	0	2	0	0	8	0.21	SM	+	LC	R
Hirundo rustica (Barn swallow)	0	4	5	0	0	0	9	0.23	W	-	LC	R
Leiothrichidae												
Garrulax albogularis (White-throated laughing thrush)	7	4	8	6	0	0	25	0.65	R	+	LC	R
Garrulax lineatus (Himalayan laughing-thrush)	23	21	0	27	0	0	71	1.84	W	-	LC	C
Garrulax variegates (Variegated laughing-thrush)	8	11	13	12	0	0	44	1.14	W	-	NE	C
Laniidae												
Lanius excubitor (Great grey shrike)	0	12	14	3	0	0	29	0.75	SM	+	LC	R
Lanius schach (Rufous-backed shrike)	17	11	13	8	0	0	49	1.27	SM	+	LC	C
Muscicapidae												
Tarsiger cyanurus (Orange-flanked bush robin)	4	8	4	3	0	0	19	0.49	R	+	LC	R

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Scientific name (Common name)	Localities/# individuals observed (transect point count)						Abundance	AP	Habit	Breeding	IUCN	LCS
	ACZ	SLZ	RZ	FZ	APZ							
Rhyacornis fuliginosus (Plumbeous redstart)	13	21	14	12	9	0	69	1.79	R	+	LC	C
Muscicapa striata (Spotted flycatcher)	16	11	14	9	0	0	50	1.29	SM	+	LC	C
Muscicapa thalassina (Verditer flycatcher)	2	4	7	3	0	0	16	0.41	SM	+	LC	R
Chaimarrornis leucocephalus (White-capped redstart)	2	8	7	11	0	0	28	0.72	R	+	LC	R
Saxicola torquata (Stonechat)	0	2	4	0	0	0	6	0.16	SM	-	LC	R
Saxicola caprata (Pied bush-chat)	8	11	7	6	0	0	32	0.83	W	-	LC	BR
Saxicola ferrea (Grey bush-chat)	11	14	8	7	0	0	40	1.03	W	-	LC	C
Monticola rufiventris (Chestnut-bellied rock thrush)	0	0	4	5	0	0	9	0.23	SM	+	LC	R
Monticola solitarius (Blue rock thrush)	4	5	7	9	0	0	25	0.65	SM	+	LC	R
Monticola cinclorhyncha (Blue-capped rock thrush)	8	11	4	6	0	0	29	0.75	R	+	LC	R
Luscinia pectoralis (West Himalayan ruby throat)	8	7	4	3	0	0	22	0.57	SM	+	NE	R
Enicurus maculatus (Spotted fork tail)	13	11	21	18	0	0	63	1.63	SM	+	LC	C
Enicurus scouleri (Little fork tail)	2	0	1	0	0	0	3	0.08	SM	+	LC	R
Ficedula subrubra (Kashmir red-breasted flycatcher)	4	3	7	2	0	0	16	0.41	SM	+	VU	R
Ficedula tricolor (Slaty-blue flycatcher)	6	4	8	3	0	0	21	0.54	SM	+	LC	R
Ficedula westermanni (Little pied flycatcher)	6	4	6	0	0	0	16	0.41	SM	+	LC	R
Phoenicurus phoenicurus (Common redstart)	23	25	19	21	0	0	88	2.28	R	+	LC	A
Monarchidae												
Terpsiphone paradisi (Asian paradise flycatcher)	4	7	6	5	0	0	22	0.57	SM	+	LC	R
Megalaimidae												
Psilopogon asiaticus (Blue-throated barbet)	1	2	4	6	0	0	13	0.34	SM	-	LC	R
Megalaima virens (Great barbet)	0	4	5	3	0	0	12	0.31	R	+	LC	R
Motacillidae												
Motacilla alba (White wagtail)	8	7	4	9	0	0	28	0.72	SM	+	LC	R
Anthus sylvanus (Upland pipit)	0	6	4	11	0	0	21	0.54	W	-	LC	R
Motacilla cinerea (Grey wagtail)	6	4	11	13	0	0	34	0.88	SM	+	LC	BR
Motacilla citreola (Yellow-headed wagtail)	0	0	12	16	0	0	28	0.72	SM	+	LC	R
Motacilla flava (Yellow wagtail)	4	5	7	6	0	0	22	0.57	SM	+	LC	R
Oriolidae												
Oriolus oriolus (Golden oriole)	0	2	1	0			3	0.08	SM	-	LC	R
Lophophorus impejanus (Himalayan monal)	0	0	1	1	2	1	5	0.13	R	+	LC	R
Lerwa lerwa (Snow partridge)	0	0	2	0	8	4	14	0.36	R	+	LC	R
Pucrasia macrolopha (Koklas pheasant)	1	0	1	0	0	0	2	0.05	R	+	LC	R
Alectoris chukar (Chukar)	0	1	1	0	4	6	12	0.31	R	+	LC	R
Tetraogallus himalayensis (Himalayan snow cock)	0	1	0	2	4	6	13	0.34	R	+	LC	R
Lophura leucomelanos (Kalij pheasant)	2	0	0	1	0	0	3	0.08	R	+	LC	R
Tragopan melanocephalus (Western tragopan)	0	0	1	0	0	0	1	0.03	I	-	VU	R
Paridae												
Parus major (Great tit)	8	7	4	5	4	6	34	0.88	R	+	LC	BR

Table continued on next page.....

Scientific name (Common name)	Localities/# individuals observed (transect point count)						Abundance	AP	Habit	Breeding	IUCN	LCS
	ACZ	SLZ	RZ	FZ	APZ							
Parus monticolus (Green-backed tit)	3	2	1	4	2	8	20	0.52	W	-	LC	C
Cephalopyrus flammiceps (Fire-capped tit)	0	4	0	9	2	6	21	0.54	R	+	LC	SR
Parus melanolophus (Crested black tit)	8	11	9	4	4	4	40	1.03	R	+	LC	C
Parus rufonuchalis (Black crested tit)	6	4	9	2	0	0	21	0.54	R	+	LC	R
Parus xanthogeny (Yellow-cheeked tit)	2	1	4	2	2	4	15	0.39	R	+	LC	R
Passer domesticus (House sparrow)	6	2	1	3	0	0	12	0.31	R	+	LC	R
Passer rutilans (Russet sparrow)	10	11	8	11	0	0	40	1.03	R	+	LC	C
Psittacidae												
Psittacula krameri (Rose-ringed parakeet)	4	0	6	0	0	0	10	0.26	SM	-	LC	R
Prunellidae												
Prunella collaris (Alpine accentor)	0	2	6	8	12	16	44	1.14	R	+	LC	C
Prunella strophiata (Rufous-breasted accentor)	0	7	8	4	11	13	43	1.11	SM	-	LC	C
Pycnonotidae												
Pycnonotus cafer (Red-vented bulbul)	2	1	4	3	0	0	10	0.26	R	+	LC	R
Hypsipetes madagascariensis (Black bulbul)	7	11	6	3	0	0	27	0.70	R	+	LC	R
Pycnontus leucogenys (White-cheeked bulbul)	2	4	5	3	0	0	14	0.36	R	+	LC	R
Phylloscopidae												
Seicercus xanthoschistos (Grey headed flycatche warbler)	7	8	6	11	0	0	32	0.83	SM	+	LC	R
Phylloscopus proregulus (Lemon-rumped leaf warbler)	2	6	4	3	0	0	15	0.39	W	-	LC	R
Phylloscopus magnirostris (Large-billed leaf warbler)	4	4	6	3	0	0	17	0.44	W	-	LC	R
Sitta leucopsis (White-cheeked nuthatch)	4	5	6	8	0	0	23	0.60	SM	+	LC	R
Phylloscopus affinis (Tickell's leaf warbler)	4	7	6	9	0	0	26	0.67	W	+	LC	R
Phylloscopus collybita (Common chiffchaff)	7	4	6	3	0	0	20	0.52	R	+	LC	R
Phylloscopus inornatus (Yellow-browed warbler)	8	11	13	14	0	0	46	1.19	R	+	LC	C
Phylloscopus trochiloides (Greenish warbler)	11	12	12	0	0	0	35	0.91	R	+	LC	BR
Picidae												
Picus squamatus (Scally-bellied woodpecker)	8	8	8	2	0	0	26	0.67	SM	+	LC	R
Dendrocopos himalayensis (Himalayan pied woodpecker)	0	0	2	4	0	0	6	0.16	R	+	LC	R
Regulidae												
Regulus regulus (Gold crest)	2	4	7	3	0	0	16	0.41	W	-	LC	R
Rhipiduridae												
Rhipidura albicollis (White-throated fantail flycatcher)	6	11	14	17	0	0	48	1.24	SM	+	LC	C
Strigidae												
Strix leptogrammica (Brown wood owl)	4	2	1	1	0	0	8	0.21	R	+	LC	R
Glaucidium cuculoides (Himalayan barred owlet)	12	0	0	2	0	0	14	0.36	R	-	LC	R
Sittidae												
Sitta cashmirensis (Kashmir nuthatch)	8	6	3	2	0	0	19	0.49	R	+	LC	R

Table continued on next page.....

Scientific name (Common name)	Localities/# individuals observed (transect point count)						Abundance	AP	Habit	Breeding	IUCN	LCS
	ACZ	SLZ	RZ	FZ	APZ							
Turdidae												
Turdus philomelos (Song thrush)	0	2	4	5	0	0	11	0.28	R	+	LC	R
Turdus unicolor (Tickell's thrush)	2	5	4	3	0	0	14	0.36	R	+	LC	R
Turdus viscivorus (Mistle thrush)	1	0	0	0	0	0	0.3	0.00	R	+	LC	R
Upupidae												
Upupa epops (Common hoopoe)	1	0	8	12	0	0	21	0.54	R	+	LC	R
Acridotheres tristis (Common myna)	8	4	11	0	0	0	23	0.60	SM	+	LC	R
Sturnus vulgaris (Common starling)	10	12	9	13	0	0	44	1.14	R	+	LC	C
Zosteropidae												
Zosterops palpebrosa (Oriental White-eye)	26	31	8	16	0	0	81	2.10	SM	-	LC	A
	929	879	938	890	70	113	3819	100				

ACZ, agricultural crop zone; SLZ, scrubland zone; RZ, riparian zone; FZ, forest zone; APZ, alpine zone; AP, abundance percentage; LCS, local conservation status; A, abundant; C, common; BR, becoming rare; R, rare; IUCN, international union for conservation of nature; NE, not elevated; LC, least concern; NT, near threatened; VU, vulnerable; R, resident; W, wintering; I, irregular year-round visitor; SM, summer migrant. +, breed in the area; -, does not breed in the area.

According to IUCN red list status (2022) maximum (n=117) birds species of study area are listed in least concern (LC) category, however the status of two species *Tragopan melanocephalus, Ficedula subrubra* is vulnerable (VU) and three species *Gypaetus barbatus, Gyps himalayensis, Circus macrourus* of family Accipitridae are listed as near threatened (NT). Four species *Dicrurus leucophaeus* (RA=2.33%), *Phoenicurus phoenicurus* (RA=2.28%), *Garrulax lineatus* (RA=2.12%) and *Zosterops palpebrosa* (RA=2.10% was reported abundant (A) bird species of the study area. Out of total reported species 44 were reported common (C) in study area however 47 species were rare (BR). Thirty-one species were categorized as rare species of the study area including *Gypaetus barbatus* (RA=0.41%), *Ficedula subrubra* (RA=0.4%), *Lophophorus impejanus* (RA=0.13%), *Pucrasia macrolopha* (RA=0.05%) and *Lophura leucomelanos* (RA=0.08%) (Table III).

Highest biodiversity of birds (H'=4.5, 4.4) was recorded in riparian forest habitat, scrubland, dense vegetation in RZ, FZ, SLZ, ACZ respectively. Lowest biodiversity (H'=2.9) was recorded in high alpine pasture and wetland habitat. Highest evenness (J=0.97), was also recorded in high alpine pasture (BL5), however lowest value of evenness (J=0.95) was recorded in ACZ and SLZ (Table III).

Distribution of species across habitat types was not significantly different ($p>0.05$, df =5, f=46.21) between four habitat type (ACZ, SLZ, RZ, FZ). However, a significant difference ($p<0.5$) was recorded between riparian, scrub land, forest habitat and alpine pastures, and wet land at high elevation. Highest distribution was recorded in riparian forest habitat (7.38±0.51) while lowest distribution was recorded in high alpine pastures (0.89±0.21). Highest species richness (n=116) was recorded in RZ, while the AZ showed the lowest species richness (n=21) (Table III).

DISCUSSION

Overall a total of 38 familes representing 127 birds species were recorded. Result revealed that the study area was home to a large number of bird's provisim of diverse and heterogeneous habitat may attract birds in the area. Establishment of national park saved forest and other habitat from destruction, while most of the surrounding areas are transformed into agricultural fields and disturbed habitats. Present study also revealed that two near threatened species of Accipitridae (*Gyps himalayensis* and *Gypaetus barbatus)* were inhabited in the study area, while 57 migratory species in the area indicated importance of conservation priority of study area. The diversity in bird species could be due to the diverse habitat condition, availability of sufficient food, and breeding season of the species (Mengesha and Bekele, 2008; Altaf, 2016; Ali et al., 2020; Rahman, 2021). No significant difference was recorded between four localities; this could be due to same type of vegetation characteristics of localities and elevation. Two localities in alpine pastures showed significant difference, this dissimilarity could be due to habitat changes, harsh climate condition and high elevation. The abundance and richness were also high at lower elevation as compared with higher elevation. Hence it could be concluded that at lower elevations habitat condition could be favorable for bird species in term of shelter, food and cover as well as other availability of requirements. The higher richness and abundance at lower elevations may be attributed to the heterogeneous nature

of habitats. Various studies also documented a general decrease in species richness and abundance along an elevation gradient (McCain, 2009; Mughal *et al*., 2020). On the other hand, the decrease in species abundance and richness at higher altitudes attributes to homogeneous habitat type, lack of fruiting trees, and threat of predation. A study conducted by Shochat *et al*. (2010) explained that birds abundance increased with increase in habitat heterogeneity. Scientists documented that bird abundance decreases with canopy cover closure in a well-developed forest; anthropogenic activities is altering the habitat of birds, and negatively impacts abundance and richness of avian species. The existence of a range of food items, water, and cover led to the increased species diversity, richness, and evenness in this habitat during the research period (McWethy *et al*., 2009; Girma *et al*., 2017; Jadoon *et al*., 2019; Altaf, 2021). As a consequence of the study's findings, the location is home to a varied range of bird species and is an important conservation priority region.

CONCLUSION

According to the findings, the GNP is an ideal habitat for a wide range of bird species, including many endemic, near-endemic, globally threatened, rare, and migratory species. As a result, GNP is an important location with diverse habitats for the conservation of bird species. As a result, the area qualifies as an important bird area in Pakistan. As a result, the study area should be subjected to additional conservation measures in order to preserve the diversity of existing bird species. Furthermore, because this was the first investigation, there may have been a limitation in discovering cryptic and nocturnal bird species, hence additional research is needed to discover more bird species.

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IRB approval

The survey-based research on birds adhered to ethical protocols specific to this study, without requiring IRB approval.

Ethical statement

The data was gathered through direct observation, utilizing both the naked eye and binoculars. The collection process strictly adhered to established ethical principles and guidelines.

Statement of conflict of interest

The authors have declared no conflict of interest.

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