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# Bioecology, Diversity and Distribution of Avian Fauna in Bajaur Valley, Khyber-Pakhtunkhwa, Pakistan

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## ABSTRACT

In Bajaur valley avian bioecology, diversity and distribution were explored in (from January to December) 2021. For the authentication and data recording, the study area was categorized into three reflective habitats (i) mountainous, (ii) agricultural, and (iii) residential. The survey was established twice a day at dawn (from 06:00 am to 11:00 am) and dusk (from 02:30 pm to 07:00 pm), respectively. Both direct observations and indirect proofs were recorded from all habitats through line transect and point count methods. A total of eighty-three bird species were reported that belonged to 15 orders and 40 families; of these, the Passeriformes was the dominant order. However, the habitat having the richest average avian diversity was; agriculture at 51.42% (540.85±25) followed by residential at 42.61% (706.78±32) and low at mountains at 5.96% (165.87±36). Regarding feeding habits, most bird species were insectivores (49.39%) followed by omnivores (20.48%) and carnivores (18.07%) while the low number of bird species were granivores (7.22%), and second low frugivores (4.81%). Based on migration status, the highest diversity of bird species was residential (36.14%) followed by summer visitors (25.30%) and winter visitors (19.27%). Out of 83 species, 10 were the most insightful and had significantly ($P<0.05$) rich population density as house sparrow (15464±92), common myna (2954.33±23), red-vented bulbul (1671±11), afghan babbler (1181±66), long-tailed shrike (1126±11), chakor partridge (1019.5±10), bank swallow (1073±27), bank myna (568.33±58), house crow (806±20) and common chiffchaff (1128±00). The avifauna is going to decline because of heavy intimidation like scarcity, the toxicity of their diets and drinking water, illegal and merciless killing, rapid urbanization and road constructions, deforestation, habitat deterioration, predation, disease, and harsh environmental conditions. The valley of Bajaur would maintain its beauty gifted by birds chirping if awareness about birds' ecological value is made public and operationalized and implementation of wildlife legislation is made successful.

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**This is the Ph.D. research work of RUK, supervised by KG. RUK collected data, wrote and formatted the manuscript. KG analyzed and reciewed the manuscript.**

**Key words**
**Avifauna, Bajaur, Bioecology, Birds species, Diversity, Feeding, Habitat, Order**

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## INTRODUCTION

Bajaur valley is a district of Khyber-Pakhtunkhwa, Pakistan. It is located in the middle of the Oriental and Palearctic region (Roberts, 1991). It contains rich wildlife and various bird species, especially chukars in the mountains and skylarks and bulbuls in the agricultural lands (Gabol and Khan, 2021; Khan and Gabol, 2021; Khan *et al*., 2021, 2022a, b). Birds are egg-laying warm-blooded vertebrates belonging to the class Aves that have bills, two wings, and the whole body is covered by feathers (Govender, 2021). The reflective system of birds like skeletal, digestive, and respiratory systems has been gifted with creations suited for flight. Further water birds have some structures to swim (Yonezawa *et al*., 2017). Broadly birds are categorized into two subdivisions Palaeognathae and Neognathae mainly includes flightless and flight birds respectively (Platt *et al*., 2021) which are distributed throughout the world. While, many birds are endemic and live-in particular regions of the world and habitats (Roberts, 1991). The body sizes are varied ranging from a 55 (mm) hummingbird (*Mellisuga helenae*) to 2800 (mm) ostrich (*Struthio camelus*) (Field *et al*., 2009). Birds inhabit all possible habitats which fulfill their basic life requirements such as banks of water bodies, cultivated lands, rural-urban areas, grasslands, forests and mountainous territories at various altitudes (Yonezawa *et al*., 2017; Umar *et al*., 2018).

Regards the feeding birds may be granivores, frugivores, omnivores and carnivores (Sadam *et al*., 2021a). In normal environmental conditions, birds perform their breeding activities. They make their nests on trees, bushes, grasses, rocks, trees, natural cavities, and open land. The female lay about 2 to 26 eggs which incubate for 1 to a few weeks to hatch (van der Hoek *et al*., 2017; Khan

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*et al*., 2022a).

At present, worldwide there are about 9040 bird species (Ripley, 1961; Ali *et al*., 1987). Fortunately, Pakistan has all possible ecosystems that support rich diversity of bird species (Khan *et al*., 1996; Grimmett and Inskipp, 2001; Kazam *et al*., 2022). In Pakistan, there are about 660 to 670 bird species that belonging to 74 families and 272 genera (Roberts, 1991; Mirza and Wasiq, 2007; Grimmett *et al*., 2008).

Rapid urbanization and the establishment of factories and trade centers greatly affect and threaten global avifauna. The insightful threats to the birds are loss of habitat, pollution, expansion of infrastructure, and harsh environmental conditions (McKinney, 2002).

They are pollution-sensitive indicators. Birds devour large number of harmful insects, as well as their larvae and eggs, hence serving as biological control agents keeping insect pest populations in check and thus being good friends of farmers (Steven *et al*., 2021). It is not too fanciful a metaphor to consider Pakistan as lying at the crosswords of Asia's major Palearctic bird migration route. Apart from resident birds, there is an influx of winter visitors from northern breeding grounds, or summer breeding visitors both from the northern mountainous regions and from the Indus plains to warmer southern latitudes (Roberts, 1991). The heterogeneous uniqueness of the natural environment is one of the important factors that has increased avian diversity (D'Amen *et al*., 2017). The current study aimed to know the bioecology, current status and associated threats of the avifauna in Bajaur valley.

## MATERIALS AND METHODS

*Study areas*

The study was conducted in Bajaur valley; the newly merged district of Khyber-Pakhtunkhwa Pakistan lying between 34˚38-46 North latitudes and 71˚20-39 East longitudes, 1117 to 2400-meter elevation (Fig. 1). The region has a hot to cold and semi-arid climate that avails four seasons in a year.

Data were collected from three main habitats: (i) Mountainous belts throughout the Bajaur valley, on the northern side is the Durand line, the border with Afghanistan, on the south is the district Mohmand, and in the East and West are districts Dir and Mohmand respectively) (Khan *et al*., 2021), (ii) Agricultural lands in Nawagai, Charmang, Khar, Mamund I and II, Arung, Barung and Salarzia with comparatively low human population of farmers. The agricultural lands mainly contain seasonal crops, different types of herbs, grasses, bushes and trees that provide feeding and breeding sites for avifauna (Khan *et al*., 2022a) (iii) Residential areas comprising main towns in Bajaur. Data were collected from the main towns of Nawagai, Charming, Khar, Mamund I and II, Arung, Barung and Salarzia. The range is well-covered and densely populated with orchards vegetation, and little ornamental vegetation (Khan *et al*., 2022b).

*Fieldwork method and confirmation of bird species*

The field survey for this study was conducted from January to December 2021 in all the three major habitats. A total of 90 sampling plots 30 in each habitat were explored by the point count method and line transect method as described by Bibby *et al*. (1992) and Buckland *et al*. (2001), twice a month.

In each plot, a single point was of 50 m radius and 500 (m) apart from another point. While for line transect 500 m long transect with 100 m radius and 200 (m) apart from each other. Both direct and indirect data about bird activities were recorded for a period of about 5 to 10 min for the point count method and 15-20 minutes for the line transect method (Khan *et al*., 2021). Bird species outside of the plots were not counted to minimize data-dependent issues. Within the range of 50 m point count and 100 m line transect, individual bird sources of detection were denoted symbolically, whether they were recorded by calling and singing (cs), directly observed (o), and flying in the air (f). Each location was surveyed twice a month throughout the year both morning (from 6:00 am to 11:00 am) and afternoon (from 2:30 pm to7:00 pm), respectively. But during unfavorable conditions, data were not collected (Bibby *et al*., 1992).

All the relevant information regarding population density, threats, diversity, management, identification, feeding habits and habitat was recorded by direct visual estimation throughout the data collection. To confirm identification Binoculars (Bushnell 7 x 50 Russian made) Spotting scope (40 x 60) were used. Field books were also consulted (Roberts, 1991, 1992; Sala *et al*., 2000; Grimmett *et al*., 2008; Grant and Booth, 2009; Kéry and Royle, 2020).

Classification of bird species according to a similar diet was based on Anderies *et al*. (2007). Species were allocated into their respective families and orders according to the guidelines and descriptions (Callaghan *et al*., 2018). Along with these birds monitoring protocols of Hill *et al*. (2016) for mountainous birds and Siegel (2000) for land birds were followed.

*Statistical analysis*

For comparison of avifauna in different habitats, Shannon Diversity Index and ANOVA were applied. Results are presented as means ± standard deviations (Mean±SD) and as percentages (%) (Mahboob, 2009; Khan *et al*., 2021).

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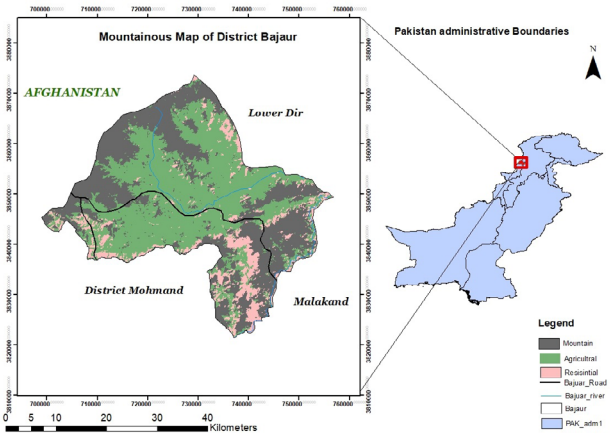


Fig. 1. Map of Bajaur showing mountainous, agricultural and residential areas.

## RESULTS

Bioecology, diversity and distribution of 83 bird species belonging to 40 families and 15 orders (Tables I and III) were recorded. The most abundant bird species by the order were house sparrow (15464±92) common myna (2954.33±23) red-vented bulbul (1671±11), afghan babbler (1181±66), long-tailed shrike (1126±11), chukar partridge (1019.5±10) bank swallow (1073±27), bank myna (568.33±58), house crow (806±20) and common chiffchaff (1128±00) (Table II).

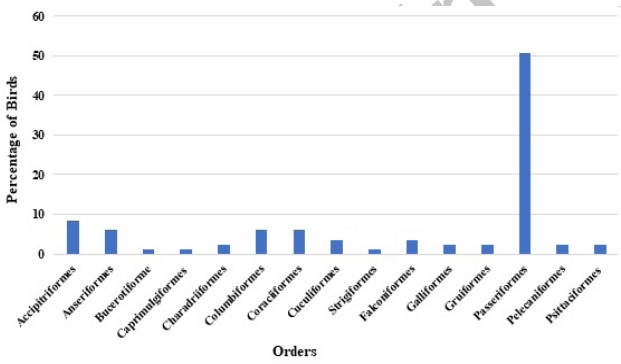


Fig. 2. Percentage of birds species in each order.

*Avifauna bioecology and distribution*

In the study area birds' bioecology like feeding habits migration status, diversity, abundance and distribution were recorded with some variability. Avifauna was recorded in all habitats however; more diversity of bird species was recorded in agricultural lands while abundant species were in residential areas. In mountainous areas, low diversity was recorded but the two species common quail and chukar existed abundantly (Table II and Fig. 3). Based on special distribution the agricultural areas had (51%) followed by residential (39.97%) and mountains (9.023%) bird species (Fig. 4). Of 15 orders the Passeriformes was a highly diverse and dispersed order that contained 22 families and 42 species, while the rest 14 orders ranged from 01 to 03 families and 1 to 7 bird species (Tables I and III, Fig. 2).

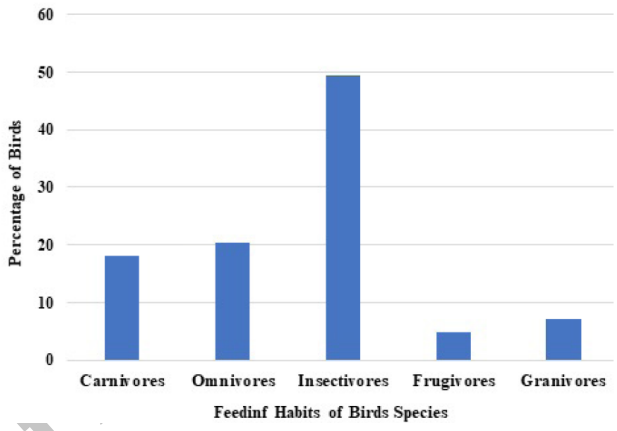


Fig. 3. Percentage of birds species in each feeding category.

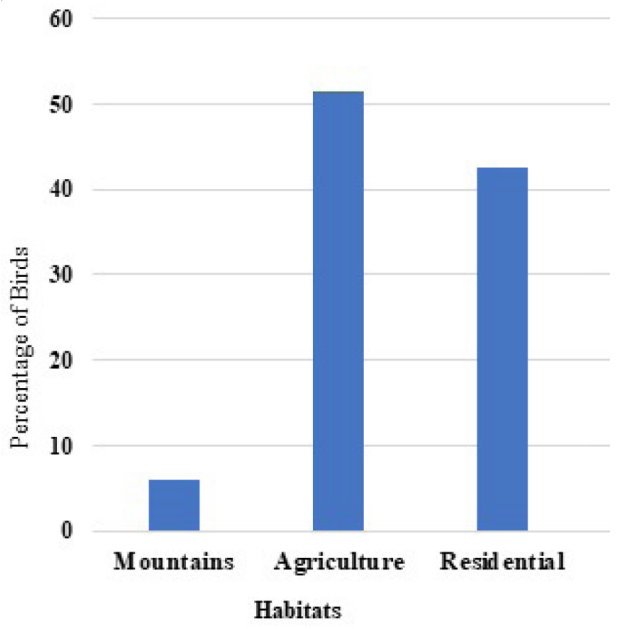


Fig. 4. Habitat wise percentage of birds species in Bajaur.

Most of the species were founded to be insectivores (49.39%), followed by omnivores (20.48%) and carnivores (18.07%), a few were granivores (7.22%) and frugivores (4.81%) (Fig. 3).

**Table I. List of bird species with their status and feeding behaviour in Bajaur valley 2021.**

| Order/ Family/ Scientific name (Common name) | Status | Feeding |
|---|---|---|
| **Order: Accipitriformes** | | |
| Family: Accipitridae | | |
| *Milvus migrans* (Black Kite) | PM | Carnivorous |
| *Accipiter badius* (Shikra) | PM | Carnivorous |
| *Accipiter nisus* (Sparrowhawk) | SV | Carnivorous |
| *Aquila chrysaetos* (Golden eagle) | PM | Carnivorous |
| *Aquila heliacal* (Eastern imperial eagle) | WV | Carnivorous |
| *Clanga hastata* (Indian spotted eagle) | WV | Carnivorous |
| *Buteo rufinus* (Long-legged buzzard) | PM | Carnivorous |
| **Order: Anseriformes** | | |
| Family: Anatidae | | |
| *Anas platyrhynchos* (Mallard) | WV | Omnivorous |
| *Anas crecca* (Eurasian teal) | WV | Omnivorous |
| *Anas acuta* (Northern pintail) | WV | Omnivorous |
| *Aythya nyroca* (White-eyed pochard) | WV | Omnivorous |
| *Mareca penelope* (Eurasian wigeon) | WV | Omnivorous |
| **Order: Bucerotiformes** | | |
| Family: Upupidae | | |
| *Upupa epops* (Eurasian hoopoe) | SV | Omnivorous |
| **Order: Caprimulgiformes** | | |
| Family: Apodidae | | |
| *Apus affinis* (Little swift) | SV | Insectivorous |
| **Order: Charadriiformes** | | |
| Family: Charadriidae | | |
| *Vanellus indicus* (Red-wattled lapwing) | VAG | Granivorous |
| Family: Scolopacidae | | |
| *Tringa nebularia* (Common greenshank) | PM | Carnivore |
| **Order: Columbiformes** | | |
| Family: Columbidae | | |
| *Streptopelia decaocto* (Collar dove) | PM | Granivorous |
| *Spelopelia senegalensis* (Laughing dove) | SV | Granivorous |
| *Columba livia* (Rock pigeon) | R | Granivorous |
| *Streptopelia turtur* (Turtle dove) | VAG | Granivorous |
| *Zenaida macroura* (Mourning dove) | SV | Granivorous |
| **Order: Coraciiformes** | | |
| Family: Coraciidae | | |
| *Coracias benghalensis* (Indian roller) | R | Insectivorous |
| Family: Meropidae | | |
| *Merops orientalis* (Green bee-eater) | SV | Insectivorous |
| *Merops apiaster* (European bee-eater) | SV | Insectivorous |
| Family: Alcedinidae | | |
| *Ceryl rudis* (Pied kingfisher) | R | Carnivorous |
| *Alcedo atthis* (Common kingfisher) | R | Carnivorous |
| **Order: Cuculiformes** | | |
| Family: Cuculidae | | |
| *Eudynamys scolopaceus* (Asian koel) | SV | Omnivorous |
| *Cuculus canorus* (Common cuckoo) | SV | Insectivorous |
| *Cacomantis passerines* (Grey bellied cuckoo) | | |
| **Order: Strigiformes** | | |
| Family: Strigidae | | |
| *Athene noctua* (Little owl) | R | Carnivore |
| **Order: Falconiformes** | | |
| Family: Falconidae | | |
| *Falco tinnunculus* (Common Kestrel) | SV | Carnivorous |
| *Falco pelegrinoides* (Barbary falcon) | SV | Carnivorous |
| *Falco jugger* (Laggar falcon) | SV | Carnivorous |
| **Order: Galliformes** | | |
| Family: Phasianidae | | |
| *Coturnix couturnix* (Common quail) | R | Omnivorous |
| *Alectoris chukar* (Chakor) | R | Omnivorous |
| **Order: Gruiformes** | | |
| Family: Rallidae | | |
| *Amaurornis phoenicurus* (Waterhen) | WV | Insectivorous |
| Family: Gruidae | | |
| *Grus virgo* (Demoiselle crane) | WV | Omnivorous |
| **Order: Passeriformes** | | |
| Family: Acrocephalidae | | |
| *Acrocephalus orinus* (Large-billed reed warbler) | SV | Insectivorous |
| *Acrocephalus dumetorum* (Blyth's reed warbler) | SV | Insectivorous |
| *Iduna rama* (Sykes's warbler) | SV | Insectivorous |
| *Iduna caligata* (Booted warbler) | SV | Insectivorous |
| Family: Locustellidae | | |
| *Locustella naevia* (Common grass-hopper warbler) | SV | Insectivorous |
| Family: Corvidae | | |
| *Corvus splendens* (House crow) | R | Omnivorous |

*Table continued on next page.....*

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| Order/ Family/ Scientific name (Common name) | Status | Feeding |
|---|---|---|
| Family: Pycnonotidae | | |
| *Pycnonotus cafer* (Red vented bulbul) | R | Frugivorous |
| Family: Dicruridae | | |
| *Dendrocitta vagabunda* (Rufous treepie) | VAG | Frugivorous |
| *Dicrurus macrocercus* (Black drango) | SV | Insectivorous |
| Family: Sturnidae | | |
| *Acridotheres tristis* (Common myna) | R | Omnivorous |
| *Acridotheres fuscus* (Jungle myna) | R | Omnivorous |
| *Acridotheres ginginianus* (Bank myna) | R | Omnivorous |
| *Sturnia malabarica* (Chestnut-tailed starling) | R | Omnivorous |
| Family: Passeridae | | |
| *Passer domesticus* (House sparrow) | R | Omnivorous |
| *Passer montanus* (Eurasian tree sparrow) | SV | Omnivorous |
| Family: Laniidae | | |
| *Lanius schach* (Long tail shrike) | R | Insectivorous |
| Family: Leiothrichidae | | |
| *Argya huttoni* (Afghan babbler) | R | Insectivorous |
| Family: Motacillidae | | |
| *Motacilla alba* (White wagtail) | WV | Insectivorous |
| *Motacilla maderaspatensis* (White browed wagtail) | WV | Insectivorous |
| Motacilla *cinerea* (Grey wagtail) | WV | Insectivorous |
| *Motacilla flava* (Western yellow wagtail) | WV | Insectivorous |
| *Anthus trivialis* (Tree pipit) | WV | Insectivorous |
| Family: Muscicapidae | | |
| *Saxicola maurus* (Siberian stonechat) | SV | Insectivorous |
| *Phoenicurus ochruros* (Black redstart) | R | Insectivorous |
| *Luscinia svecica* (Bluethroat) | R | Insectivorous |
| *Ficedula albicilla* (Red-throated flycatcher) | R | Insectivorous |
| *Phoenicurus leucocephalus* (White-capped water redstart) | R | Insectivorous |
| Family: Hirundinidae | | |
| *Hirundo rustica* (Barn swallow) | SM | Insectivorous |
| *Ripari riparia* (Bank swallow) | SM | Insectivorous |
| Family: Alaudidae | | |
| *Alauda gulgula* (Oriental skylark) | R | Insectivorous |
| Family: Tichodromidae | | |
| *Tichodroma muraria* (Wallcreeper) | R | Insectivorous |
| Family: Fringillidae | | |
| *Haemorhous purpureus* (Purple finch) | R | Insectivorous |
| *Carduelis carduelis* (European goldfinch) | R | Insectivorous |
| Family: Oriolidae | | |
| *Oriolus oriolus (Eurasian golden oriole)* | R | Insectivorous |
| Family: Turdidae | | |
| *Turdus maximus* (Tibetan blackbird) | R | Insectivorous |
| Family: Campephagidae | | |
| *Pericrocotus ethologus* (Long-tailed minivet) | R | Insectivorous |
| Family: Paridae | | |
| *Periparus ater* (Cole tit) | | Insectivorous |
| Family: Phylloscopidae | | |
| *Phylloscopus collybita* (Common chiffchaff) | R | Insectivorous |
| *Phylloscopus trochiloides* (Greenish warbler) | R | Insectivorous |
| *Phylloscopus occipitalis* (Western crowned warbler) | R | Insectivorous |
| Family: Emberizidae | | |
| *Emberiza cia* (Rock bunting) | SV | Insectivorous |
| Family: Ploceidae | | |
| *Ploceus philippinus* (Baya weaver) | VAG | Insectivorous |
| **Order: Pelecaniformes** | | |
| Family: Ardeidae | | |
| *Egretta garzetta* (Little egret) | WV | Carnivorous |
| *Ardeola grayii* (Pond heron) | WV | Carnivorous |
| **Order: Psittaciformes** | | |
| Family: Psittaculidae | | |
| *Psittacula krameri* (Rose-ringed parakeet) | VAG | Frugivorous |
| *Psittacula himalayana* (Slaty-headed parakeet) | VAG | Frugivorous |

PM, passage migrant; R, resident; SM, summer migrant; SV, summer visitor; WV, winter visitors; VAG, vagrant.

Of the 83 bird species 30 were residential, followed by 21 summer visitors and 16 winter visitors while both passage migrants and vagrants were 7 and seasonal migrants 2 (Table IV and Fig. 5).

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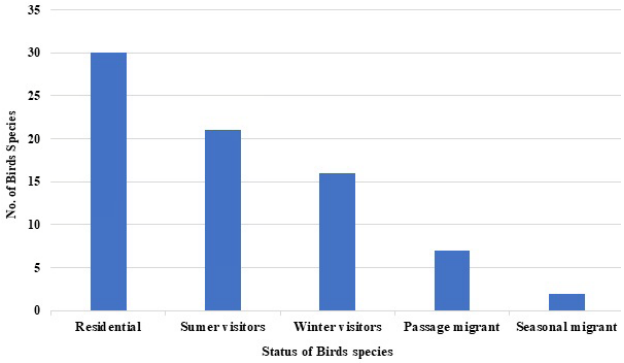


Fig. 5. Seasonal observation of birds species in Bajaur.

**Table II. Habitat wise maximum number of birds species and their average population in Bajaur Valley in 2021.**

| S. | Common name | HI | HII | HIII | Total | AP |
|---|---|---|---|---|---|---|
| 1 | Black Kite | - | 10 | 7 | 17 | 58.5 ±1.5 |
| 2 | Shikra | 10 | 15 | 3 | 28 | 9.33±4.9 |
| 3 | Sparrowhawk | 4 | 18 | 11 | 33 | 11±5.7 |
| 4 | Golden eagle | 1 | 1 | - | 2 | 1±00 |
| 5 | Eastern imperial eagle | 2 | - | - | 2 | 2±00 |
| 6 | Indian spotted eagle | - | 2 | - | 2 | 2±00 |
| 7 | Long-legged buzzard | 1 | 1 | 1 | 3 | 1±00 |
| 8 | Mallard | - | 51 | - | 51 | 51±00 |
| 9 | Eurasian teal | - | 18 | - | 18 | 18±00 |
| 10 | Northern pintail | - | 14 | - | 14 | 14±00 |
| 11 | White-eyed pochard | - | 6 | - | 6 | 6±00 |
| 12 | Eurasian wigeon | - | 6 | - | 6 | 6±00 |
| 13 | Eurasian hoopoe | - | 52 | 30 | 82 | 41±11 |
| 14 | Little swift | - | - | 532 | 532 | 532±00 |
| 15 | Red-wattled lapwing | - | 14 | - | 14 | 14±00 |
| 16 | Common greenshank | - | 12 | - | 12 | 12±00 |
| 17 | Collar dove | 4 | 6 | - | 10 | 5±1 |
| 18 | Laughing dove | 2 | 218 | 186 | 406 | 135.33 ±95 |
| 19 | Rock pigeon | - | 100 | 100 | 200 | 100±00 |
| 20 | Turtle dove | 53 | 100 | 44 | 197 | 65.66±24 |
| 21 | Mourning dove | 3 | 34 | 22 | 59 | 19.66±12 |
| 22 | Indian roller | - | 477 | - | 477 | 477±00 |
| 23 | Green bee-eater | - | 30 | -- | 30 | 30±00 |
| 24 | European bee-eater | - | 58 | 40 | 98 | 49±9 |
| 25 | Pied kingfisher | - | 92 | - | 92 | 92±00 |
| 26 | Common kingfisher | - | 103 | - | 103 | 103±00 |
| 27 | Asian koel | - | 80 | 14 | 94 | 47±33 |
| 28 | Common cuckoo | - | 4 | - | 4 | 4±00 |
| 29 | Grey bellied cuckoo | - | 2 | 2 | 4 | 2±00 |
| 30 | Little owl | - | 500 | 100 | 600 | 300±20 |
| 31 | Common Kestrel | 8 | 5 | 1 | 14 | 4.66±2.8 |
| 32 | Barbary falcon | 1 | 6 | 2 | 9 | 3±21 |
| 33 | Laggar falcon | - | 31 | 8 | 39 | 19±11 |
| 34 | Common quail | 38 | 140 | 8 | 186 | 62±56 |
| 35 | Chakor | 2020 | 19 | - | 2039 | 1019.5 ±10* |
| 36 | Water hen | - | 50 | 4 | 54 | 27±23 |
| 37 | Demoiselle crane | - | 100 | 5 | 105 | 52.5±47 |
| 38 | Large-billed reed warbler | 198 | 400 | 100 | 698 | 232.66±12 |
| 39 | Blyth's reed warbler | 156 | 300 | 100 | 556 | 185.33±84 |
| 40 | Sykes's warbler | 108 | 320 | 80 | 508 | 169±10 |
| 41 | Booted warbler | 195 | 220 | 80 | 495 | 165±60 |
| 42 | Grasshopper warbler | 19 | 80 | 20 | 119 | 39.66±28 |
| 43 | House Crow | - | 600 | 1012 | 1612 | 806±20* |
| 44 | Red vented bulbul | 133 | 2880 | 2000 | 5013 | 1671 ±11*** |
| 45 | Rufous treepie | - | 70 | 23 | 93 | 46.5±23 |
| 46 | Black drongo | 4 | 300 | 26 | 330 | 110±13 |
| 47 | Common myna | 400 | 2433 | 6030 | 8863 | 2954.33 ±23*** |
| 48 | Jungle myna | 60 | 109 | 200 | 369 | 123±58 |
| 49 | Bank myna | - | 1500 | 205 | 1705 | 852.5 ±64* |
| 50 | Chestnut-tailed starling | - | 3 | | 3 | 3±00 |
| 51 | House sparrow | 2394 | 23200 | 20799 | 46393 | 15464.33 ±92*** |
| 52 | Eurasian tree sparrow | - | 8 | - | 8 | 8±00 |
| 53 | Long tailed shrike | 478 | 2740 | 160 | 3378 | 1126 ±11** |
| 54 | Afghan babbler | 543 | 2000 | 1000 | 3543 | 1181 ±60** |
| 55 | White wagtail | - | 90 | 7 | 97 | 48.5±41 |
| 56 | White browed wagtail | - | 30 | 3 | 33 | 16.5±13 |
| 57 | Grey wagtail | - | 70 | 13 | 83 | 41.5±28 |
| 58 | Western yellow wagtail | - | 10 | 8 | 18 | 9±1 |
| 59 | Tree pipit | 15 | 25 | - | 40 | 20±5 |
| 60 | Siberian stonechat | 50 | 150 | 20 | 220 | 73.33± |
| 61 | Black redstart | 40 | 6 | - | 46 | 23±17 |
| 62 | Bluethroat | 4 | 6 | - | 10 | 5±1 |
| 63 | Red-throated flycatcher | - | 6 | - | 6 | 6±00 |
| 64 | White-capped water redstart | - | 12 | - | 12 | 12±00 |

*Table contibued on next page.....*

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| S. | Common name | HI | HII | HIII | Total | AP |
|---|---|---|---|---|---|---|
| 65 | Bank swallow | - | 1046 | 1100 | 2146 | 1073 ±27* |
| 66 | Barn swallow | - | 47 | 400 | 447 | 223.5±17 |
| 67 | Oriental skylark | 80 | 600 | - | 680 | 340±26 |
| 68 | Wallcreeper | 2 | 8 | - | 10 | 5±3 |
| 69 | Purple finch | - | 500 | 44 | 544 | 272±22 |
| 70 | European goldfinch | - | 52 | - | 52 | 52±00 |
| 71 | Eurasian golden oriole | | 11 | 3 | 14 | 7±4 |
| 72 | Tibetan blackbird | 14 | - | - | 14 | 7±3 |
| 73 | Long-tailed minivet | - | 4 | - | 4 | 4±00 |
| 74 | Cole tit | 60 | 200 | 40 | 300 | 100±71 |
| 75 | Common chiffchaff | - | 1128 | - | 1128 | 1128 ±00* |
| 76 | Greenish warbler | 108 | 220 | 80 | 408 | 136±60 |
| 77 | Western crowned warbler | - | 154 | - | 154 | 154±00 |
| 78 | Rock bunting | 90 | 119 | 10 | 219 | 73±46 |
| 79 | Baya weaver | - | 1 | - | 1 | 1±00 |
| 80 | Little egret | - | 117 | - | 117 | 117±00 |
| 81 | Pond heron | - | 54 | - | 54 | 54±00 |
| 82 | Rose-ringed parakeet | - | 25 | 15 | 40 | 20±5 |
| 83 | Slaty-headed parakeet | - | 12 | 8 | 20 | 10±2 |
| | Sum | 5142 | 44350 | 36753 | 86245 | |
| | Mean | 165.87 ±36 | 540.85 ±25 | 706.78 ±32 | 1039.09 ±51 | |

HI, mountainous belt; HII, agricultural lands; HIII, residential areas, Mean±Std, mean standard deviation; AP, average population; *, 1-2k; **, 3-4k; ***, 4k and onward.

**Table III. Orderly number of families, genra and species in each order.**

| Orders | No. of families | % | No. of Genra | % | No. of Species | % |
|---|---|---|---|---|---|---|
| Accipitriformes | 1 | 2.5 | 5 | 8.19 | 7 | 8.43 |
| Anseriformes | 1 | 2.5 | 3 | 4.91 | 5 | 6.02 |
| Bucerotiformes | 1 | 2.5 | 1 | 1.63 | 1 | 1.20 |
| Caprimulgiformes | 1 | 2.5 | 1 | 1.63 | 1 | 1.20 |
| Charadriiformes | 2 | 5 | 2 | 3.27 | 2 | 2.40 |
| Columbiformes | 1 | 2.5 | 4 | 6.55 | 5 | 6.02 |
| Coraciiformes | 3 | 7.5 | 4 | 6.55 | 5 | 6.02 |
| Cuculiformes | 1 | 2.5 | 3 | 4.91 | 3 | 3.61 |
| Strigiformes | 1 | 2.5 | 1 | 1.63 | 1 | 1.20 |
| Falconiformes | 1 | 2.5 | 1 | 1.63 | 3 | 3.61 |
| Galliformes | 1 | 2.5 | 2 | 3.27 | 2 | 2.40 |
| Gruiformes | 2 | 5 | 2 | 3.27 | 2 | 2.40 |
| Passeriformes | 22 | 55 | 30 | 49.18 | 42 | 50.60 |
| Pelecaniformes | 1 | 2.5 | 2 | 3.27 | 2 | 2.40 |
| Psittaciformes | 1 | 2.5 | 2 | 3.27 | 2 | 2.40 |
| Total | 40 | 100 | 63 | 103.27 | 83 | 100 |

**Table IV. Factors affecting avian bioecology and diversity.**

| Facts | Mountains | Agricultural | Residential |
|---|---|---|---|
| Habitat destruction | √ | √ | √ |
| Cutting of vegetations | √ | √ | √ |
| Insecticides spray | - | √ | √ |
| Drying of water reservoirs | √ | √ | - |
| Illegal hunting | √ | √ | - |
| Merciless killing | √ | √ | √ |
| Rapid urbanization | - | √ | √ |
| Road constructions | √ | √ | √ |
| Deforestation | √ | - | - |
| Predation | √ | √ | √ |
| Disease | √ | √ | √ |
| Harsh environmental | √ | √ | - |
| Over grazing | √ | - | - |
| Wood collection | √ | √ | - |
| Plantations | √ | - | - |
| Human interruptions | √ | √ | √ |
| Pollution | - | √ | √ |
| Factories | √ | √ | √ |

√, Yes; -, No.

*Factors affecting avian bioecology and diversity*

A rich abundance of bird species was recorded in the habitat having more vegetation, low elevation, distance to human settlements and near to the water sources. However, it decreased with a lack of shelter and distance from water sources. The factors effecting the avifauna included cutting of seasonal crops and overgrazing, scarcity, the toxicity of their diets and drinking water due to lack of rains and dried of natural water reservoirs, illegal and merciless killing, rapid urbanization and road constrictions, deforestation, habitat destruction, predation, disease and harsh environmental conditions (Table IV).

## DISCUSSION

The current research was carried out about birds' current list, population status, feeding behaviors, migratory status, main declining factors, diversity and distribution in the reflective habitat of district Bajaur Khyber-Pakhtunkhwa Pakistan in the year (January-December) 2021. In all habitats of the study area birds, bioecology and rich diversity were explored. Habitats providing a better source of food, drinking water and protective breeding sites contain rich avian diversity

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(Girma *et al*., 2017). A total of 83 bird species belonging to 15 orders and 40 families were recorded. A large number of bird species belonged to orders Passeriformes (50.60%) and Accipitriformes (8.43%). Shah (2021) reported 98 bird species from Punjab belonging to 11 orders and 38 families. He found the richest bird species in the order Passeriformes and the family Muscicapidae. Sadam *et al*. (2021a) reported 35 bird species from district Mardan in two major habitats (i.e., cropland and urban areas). Khalid *et al*. (2017) reported 78 bird species belonging to 34 families and 11 orders from Rawalakot, Azad Jammu and Kashmir. Passerines were the dominant order. Altaf *et al*. (2013) recorded 64 bird species from Head Khanki, water works on Chenab River in District, Gujranwala, Punjab, Pakistan. Ali and Akhter (2005) reported 103, 115, 126 and 110 bird species each from Ucchali, Nammal, Chashma, and Rangpur Lakes respectively. Awan *et al*. (2000) recorded 59 bird species in Muzaffarabad, Azad Kashmir, Pakistan, of which 11 were summer visitors, 24 resident birds and 14 winter visitors. Hussain *et al*. (2018) reported 670 bird species in Pakistan.

Rich diversity of bird species was recorded from agricultural areas 44,350 (540.85±25) although the highest average population of birds was recorded in residential areas 36,753 (706.78±32). Shah (2021) reported that forest and agricultural areas had a rich diversity of bird species. He also reported that habitats near water sources and agricultural lands supported insects and grains also that attracted many bird species. Similarly, Kiros *et al*. (2018) explained that all those habitats which provide shelter, nesting sites and feeding resources could have a rich diversity of bird species. Mostly the resident bird species were in the highest density in all habitats, followed by summer visitors and winter visitors. Adhikari *et al*. (2019) reported rich diversity of resident bird species from Chitwan National Park, Nepal.

In all the habitats bird species were recorded but comparatively agricultural lands and urban areas had rich a diversity of bird species as compared to the mountains. The most diverse birds were insectivores and omnivores as many insects existed in agricultural lands and other food sources in rural areas, respectively. Similarly, based on seasonal status most abundant species were residential and summer visitors. Sadam *et al*. (2021a) reported insectivore Passeriformes were abundant present in agricultural areas because of more insects and omnivorous birds in the urban area.

Awan *et al*. (2012) reported more resident birds and winter visitors in Muzaffarabad, Azad Jammun and Kashmir, Pakistan. Similarly, Mehmood *et al*. (2018) reported 57 bird species of which 51 were residents, one passage migrant and five summer visitors.

The abundant species were noted in agricultural lands which had about 51% of bird species followed by residents (39.97%) and mountains (9.023%). The most diverse birds were insectivore (49.39%), followed by omnivore (20.48%), carnivores (18.07%), granivore (7.22%) and frugivore (4.81%). Similarly, Luo *et al*. (2019) recorded most species 41% in a habitat near a water body, and 14% of species in grassland at Dianchi Lake, south-west China. Sadam *et al*. (2021b) also reported more species in agricultural areas near urban areas. He also reported bird species were more diverse and abundant in dense forests of Mardan Khyber-Pakhtunkhwa. Begum *et al*. (2016) reported 133 bird species near the coastal and allied area of Balochistan.

It was investigated that the bird species and their habitats were in great danger due to many ecological factors viz., habitat destruction, scarcity of food and water, illegal killing and hunting for meat and trophy, capturing for trade and domestication purposes, human interruption and pollution. The same factors were also reported by Ghalib *et al*. (2008) for the water birds along the Karachi coast; according to him the overall number of water birds had fallen during recent years due to the degradation of wetlands, lack of management, disturbance, and environmental pollution including the effect of pesticides. Similarly, Ghalib *et al*. (2009) also reported the major threats to the shorebirds were habitat degradation, land reclamation, hunting, disturbance, and droughts. Khan *et al*. (2021) reported that mountainous birds were greatly affected due to illegal killing, hunting, capturing, nest destruction, cutting of vegetation and overgrazing.

In the study area agricultural areas and residential areas were sprayed with insecticide which greatly affected insects and grains as a food source for many bird species. Comparatively, the mountainous territory had a low abundance and diversity of bird species due to great disturbance in the form of road constriction, human interruption, cutting of vegetation and drying of natural water reservoirs. Younas *et al*. (2017) recorded that the construction of motorways and factories in hilly and mountainous areas declined the various flora as a source of habitat, feeding, and foraging activities for avian fauna. Similarly, Muzaffar (2003) reported that floral vegetation provided all the basic resources to various residential birds.

In the study area, agricultural lands, plant farming, and grasslands are present which provide nesting sites in trees as well on land. Except for marine and fully developed urban areas all the basic habitats were present which provide an aesthetic environment for avian fauna. Altaf *et al*. (2013) are of the view that bird species mostly depend on attractive habitats which fulfill all their basic life requirements. In the same way, Sadam *et al*. (2021a) also

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reported the habitat and possible requirements of common birds of district Mardan. Sulieman *et al*. (2016) reported that urbanization and the cutting of forests reduced the attraction and habitats of birds. Khan and Gabol (2021) reported that egg collection and predation greatly impacted mountainous birds.

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