American Journal of
Biomedical Science & Research

www.biomedgrid.com
ISSN: 2642-1747

Research Article



# Ornithofauna Diversity of Tehsil Pakpattan, Punjab, Pakistan

**Muhammad Amir Sial***

*Department of Wildlife and Ecology, University of Veterinary and Animal Sciences, Lahore*

***Corresponding author:** Muhammad Amir Sial, Department of Wildlife and Ecology, University of Veterinary and Animal Sciences, Outfall road, Lahore, Punjab, Pakistan.

***To Cite This Article:*** *Muhammad Amir Sial*. University of Veterinary and Animal Sciences, Outfall road, Lahore, Punjab, Pakistan. Am J Biomed Sci & Res. 2023 20(6) AJBSR.MS.ID.002771,* DOI: 10.34297/AJBSR.2023.20.002771

**Received:** December 12, 2023; **Published:** December 15, 2023

## Abstract

Tehsil Pakpattan is situated in the Doab region of Punjab Pakistan along the river Sutlej. The Current study was intended to evaluate the avian biodiversity of Tehsil Pakpattan. The study included the evaluation of species diversity, IUCN Red List status, migratory description, and feeding habits of the bird populations of Tehsil Pakpattan. Regular surveys were conducted at 10 different localities of Tehsil Pakpattan including Islam Colony, Kanipur, Farid Kot, 14 S/P, Chak Khagga, Musewal, 8 S/P, Noorpur, Green Town, and Bonga Niaz Khan from January 2022 to April 2023. The Shannon Wiener Diversity index value (R'=3.41) evidenced the eminent diversity of bird populations in the study area. A total of 1884 individuals representing 41 species, 30 families, and 12 orders were recorded. The Highest diversity was of Order Passeriformes. The most abundant birds in the observed population were the Cattle egret (n=160), House crow (n=150), Asian green bee-eater (n=100), Rock pigeon (n=100), Bown rock chat (n=98) and House sparrow (n=90). Among all species, 34 were the resident, 2 were summer breeders, and one was a winter visitor. 37(75.60%) of the bird species belonged to the Least Concern (LC), 2(4.87%) Nearly Threatened (NT), and 2(4.84%) Vulnerable (VU) categories of the IUCN Red List.

**Keywords:** Aves, Ornithofauna, Pakpattan, Birds of pakistan, Bird diversity

## Introduction

Birds belong to the Class Aves making it the only group of Phylum Chordata to have feathered vertebrates. Class Aves has more than 10,000 bird species conferring it as the most diverse group of vertebrates [1]. Pakistan has a fantastically diverse avifauna comprising of more than 790 bird species [2,3]. Class Aves is the most diverse and best studied among all other vertebrate groups. Undoubtedly, birds are eye- catching and permeating creatures of nature [4]. High agility makes their presence global approximately in all habitats [5]. Birds are highly diverse, widely recognized, and valuable living creatures that serve as valuable indicators for tracking global biodiversity patterns. They are easily observable and provide useful insights into biodiversity. A flourishing bird population indicates environmentally friendly and sustainable growth and better environmental health. Birds have eminent ecological, biological, and financial contributions including pollination, seed dispersal, nutrient cycling, pest control, and scavenging [6,7].

Unfortunately, over the past few decades, the human population has been increasing at an exponential rate, as per the projected numbers the world population will reach a gigantic number of 9.7 billion in 2050 and 11.2 billion by the end of the 21st century [8]. Substantial growth in the human population, unplanned expansion of urban settings, and lack of knowledge about wildlife are posing various bewildering threats to the precious bird species including illegal hunting and shooting, habitat destruction, environmental pollution, and illegitimate trade. Due to these astonishing menaces, bird diversity is declining expeditiously [9,10].

The area of Tehsil Pakpattan is situated along the bank of river Sutlej in the Bari Doab Region of Punjab. The climate of Tehsil Pakpattan is dry, damp, and sizzling in summers and winters are dry, cool, and short in duration. Around the year, the temperature varied from 42°F to 105°F and barely less than 38°F or above 112°F (GOP, n.d.). Furthermore, it is noteworthy that there is no study conducted

so far in the area of Tehsil Pakpattan regarding the estimation and assessment of bird diversity. However, studies regarding the impact of deforestation and avian population dynamics have been carried out in adjoining areas like District Okara [3,11]. Hence, the present study is conceived for the evaluation of IUCN status, migratory behavior, and feeding habits of the avifauna of Tehsil Pakpattan.

## Materials and Methods

### Study Area

**Table 1:** Description of survey sites of study area.

| Sr. | Survey Site | Coordinates | | Type of Survey Site | Elevation (ft) |
|---|---|---|---|---|---|
| | | E | N | | |
| 1 | Islam Colony | 30.35 | 73.39516 | Urban | 589 |
| 2 | Kani Pur | 30.40291 | 73.51485 | Agri-Rural | 652 |
| 3 | Farid Kot | 30.37803 | 73.54669 | Rural | 665 |
| 4 | Bunga Niaz Khan | 30.18992 | 73.45135 | Rural | 612 |
| 5 | Arif Abad | 30.33394 | 73.34321 | Rural | 561 |
| 6 | Malik Bahawil | 30.2863 | 73.43802 | Agri-Rural Forest | 605 |
| 7 | Chak 25 SP | 30.43691 | 73.40486 | Agri-Rural Forest | 592 |
| 8 | Noor Pur | 30.49354 | 73.24533 | Agri-Rural Forest | 552 |
| 9 | Green Town | 30.36158 | 73.37733 | Urban | 570 |
| 10 | Bonga Hayat | 30.49569 | 73.52083 | Agri-Rural | 633 |

The study was conducted in the 10 urban, agri-rural Forests, agri-rural, and rural localities of Tehsil Pakpattan, Punjab Pakistan (Table 1). Pakpattan is one of the two tehsils of district Pakpattan. Tehsil is a term for the sub-administrative. Branch in the Provincial governing setup of Pakistan. Tehsil headquarters of Pakpattan are located in the city of Pakpattan. It has a population of 0.9 million majority of living in rural vicinities.

### Surveying and Data Collection

For data collection, regular surveys were conducted from January 2022 to April 2023 on a weekly basis. Birds were observed using binoculars (10×50mm) and the direct vision method (naked eye) while some of the birds were identified using the sound capture feature of the Bird NET mobile application developed by Cornell Lab of Ornithology, Cornell University, USA. The identification was confirmed by Books and field guides of ornithology including "Birds of Pakistan" and "Ornithology in laboratory and field" [12-14]. The bird count for population density estimation was carried out using the transect count method devised by *Emlen, et al.,* [15].

### Statistical Analysis

For the statistical analysis of data, Shannon Wiener's Diversity Index (H'), Species evenness index, Simpson's diversity index ($I_{simpson}$), Simpson's dominance index (Isimpson), and Margalef's index (IMargalef) were applied using Microsoft Excel (MS Excel) version 2019 Table 2. Graphical representations, tables, and graphs were generated using MS Excel version 2019.

**Table 2:** Various Diversity indices used in the study their formulae and outcome values.

| Sr | Index | Formula | Value |
|---|---|---|---|
| 1 | Shannon Wiener Diversity Index | $H' = -\sum_{i=1}^{s} p_i In\, p_i$ | 3.418538 |
| 2 | Species Evenness Index | $E = H' / \ln S$ | 0.453318 |
| 3 | Margalef's Index | $I_{M\,\arg alef} = (S-1)/InN$ | 5.304229 |
| 4 | Simpson's Dominance Index | $D_{simpson} = \frac{\sum n(n-1)}{N(N-1)}$ | 0.039809 |
| 5 | Simpson's Diversity Index | $I_{simpson} = 1 - D_{simpson}$ | 0.960191 |

## Results

### Composition of Avian Diversity

Preponderantly, 1884 individual birds belonging to 41 species, 30 families, and 12 orders were sighted in the study area. Results revealed that Order Passeriformes is the most diverse among all orders. Out of 41 species, 19 species were belonging to order Passeriformes, 4 to Coraciiformes, 4 to Charadriiformes, 3 Columbiformes, 2 Cuculiformes, 2 Bucerotiformes, 2 Galliformes, one each from Pelecaniformes, Piciformes, Ciconiiformes, Strigiformes, and Accipitriformes Figure 1. The percentage of individual bird count that the order Passeriformes is richest in diversity amongst other orders in the study area (Figures 1,2).

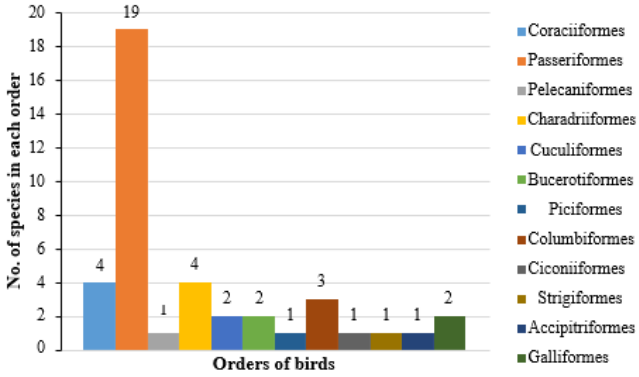


**Figure 1:** Species diversity among various orders exhibiting bird species in each order.

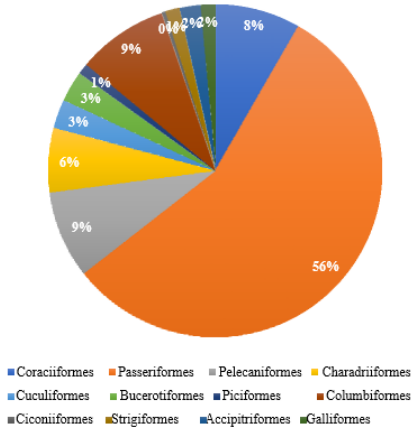


**Figure 2:** Percentage of individual birds among different orders.

### Diversity Indices

The outcomes for various diversity indices were recorded as Shannon Wiener's Diversity Index (R') 3.4185, Species Evenness index 0.4533, Simpson's Diversity Index ($I_{simpson}$) 0.9601, Simpson's dominance index (Dsimpson) 0.0398 and Margalef's index 5.30422906 (Tables 2,3).

**Table 3:** Detailed description of assvifauna observed in Tehsil Pakpattan.

| Sr. | Common Name | Scientific Name | Order | Family | Description | IUCN STATUS | Feeding Habits | N |
|---|---|---|---|---|---|---|---|---|
| 1 | Asian Green bee-eater | Merops orientalis *Latham, et al.,* (1801) | Coraciiformes | Meropidae | Resident | Least Concern | Insectivores | 100 |
| 2 | Zitting Cisticola | Sylvia juncidis *Rafinesque, et al.,* (1810) | Passeriformes | Cisticolidae | Summer breeder | Least Concern | Insectivores | 20 |
| 3 | Common myna | Acridotheres tristis *Linnaeus, et al.,* (1766) | Passeriformes | Sturnidae | Resident | Least Concern | Omnivores | 70 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4 | House crow | Corvus splendens *Vieillot, et al.,* (1817) | Passeriformes | Corvidae | Resident | Least Concern | Scavenger | 150 |
| 5 | Indian roller | Coracias benghalensis *Linnaeus, et al.,* (1758) | Coraciiformes | Coraciidae | Resident | Least Concern | Carnivores | 10 |
| 6 | Cattle egret | Bubulcus ibis *Linnaeus, et al.,* (1758) | Pelecaniformes | Ardeidae | Resident | Least Concern | Insectivores | 160 |
| 7 | Red-vented bulbul | Pycnonotus cafer *Linnaeus, et al.,* (1766) | Passeriformes | Pycnonotidae | Resident | Least Concern | Omnivores | 70 |
| 8 | Rufous treepie | Dendrocitta vagabunda *Latham, et al.,* (1790) | Passeriformes | Corvidae | Resident | Least Concern | Omnivores | 25 |
| 9 | Black drongo | Dicrurus macrocerus *Vieillot, et al.,* (1817) | Passeriformes | Dicruridae | Resident | Least Concern | Insectivores | 27 |
| 10 | Barn swallow | Hirundo rustica *Linnaeus, et al.,* (1758) | Passeriformes | Hirundinidae | Summer breeder | Least Concern | Insectivores | 50 |
| 11 | White-throated kingfisher | Halcyon smyrnesis *Linnaeus, et al.,* (1758) | Coraciiformes | Alcedinidae | Resident | Least Concern | Piscivores | 16 |
| 12 | Red-wattled lapwing | Vanellus indicus *Boddaert, et al.,* (1783) | Charadriiformes | Charadriidae | Resident | Least Concern | Insectivores | 75 |
| 13 | Greater Coucal | Centropus sinensis *Stephens, et al.,* (1815) | Cuculiformes | Cuculidae | Resident | Least Concern | Insectivores | 23 |
| 14 | House sparrow | Passer domesticus *Linnaeus, et al.,* (1758) | Passeriformes | Passeridae | Resident | Least Concern | Omnivores | 90 |
| 15 | Eurasian Hoopoe | Upupa epops *Linnaeus, et al.,* (1758) | Bucerotiformes | Upupidae | Resident | Least Concern | Insectivores | 36 |
| 16 | Coppersmith barbet | Megalaima haemacephala PL *S Müller, et al.,* (1776) | Piciformes | Megalaimidae | Summer breeder | Least Concern | Frugivores | 20 |
| 17 | Asian Koel | Eudynamys scolopaceus *Linnaeus, et al.,* (1758) | Cuculiformes | Cuculidae | Resident | Least Concern | Omnivores | 30 |
| 18 | Common Tailorbird | Orthotomus sutorius *Pennant, et al.,* (1769) | Passeriformes | Cisticolidae | Resident | Least Concern | Insectivores | 45 |
| 19 | Black-rumped Flameback | Dinopium benghalense *Linnaeus, et al.,* (1758) | Piciformes | Picidae | Resident | Least Concern | Insectivores | 21 |
| 20 | Jungle babbler | Turdoides striata *Dumont, et al.,* (1823) | Passeriformes | Leiothrichidae | Resident | Least Concern | Insectivores | 64 |
| 21 | Brown Rock Chat | Oenanthe fusca *Blyth, et al.,* (1851) | Passeriformes | Muscicapidae | Resident | Least Concern | Insectivores | 98 |
| 22 | Oriental Magpie-Robin | Copsychus saularis *Linnaeus, et al.,* (1758) | Passeriformes | Muscicapidae | Resident | Least Concern | Carnivores | 56 |
| 23 | Baya Weaver | Ploceus philippinus *Linnaeus, et al.,* (1766) | Passeriformes | Ploceidae | Resident | Least Concern | Omnivores | 42 |
| 24 | Rock Pigeon | Columba livia JF *Gmelin, et al.,* (1789) | Columbiformes | Columbidae | Resident | Least Concern | Omnivores | 100 |
| 25 | Painted Stork | Mycteria leucocephala *Pennant, et al.,* (1769) | Ciconiiformes | Ciconiidae | Resident | Near Threatened | Piscivores | 7 |
| 26 | Spotted Owlet | Athene brama *Temminck, et al.,* (1821) | Strigiformes | Strigidae | Summer breeder | Least Concern | Carnivores | 26 |
| 27 | White Wagtail | Motacilla alba *Linnaeus, et al.,* (1758) | Passeriformes | Motacillidae | Summer breeder | Least Concern | Insectivores | 60 |
| 28 | Black-winged Stilt | Himantopus himantopus *Linnaeus, et al.,* (1758) | Charadriiformes | Recurvirostridae | Resident | Least Concern | Omnivores | 20 |
| 29 | Black Kite | Milvus migrans *Boddaert, et al.,* (1783) | Accipitriformes | Accipitridae | Resident | Least Concern | Scavenger | 38 |
| 30 | Purple Sunbird | Cinnyris asiaticus *Latham, et al.,* (1790) | Passeriformes | Nectariniidae | Summer breeder | Least Concern | Nectarivores | 12 |
| 31 | Common Starling | Sturnus vulgaris *Linnaeus, et al.,* (1758) | Passeriformes | Sturnidae | Winter visitor | Least Concern | Omnivores | 19 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 32 | Indian Robin | Copsychus fulicatus *Linnaeus, et al.,* (1766) | Passeriformes | Muscicapidae | Resident | Least Concern | Carnivores | 65 |
| 33 | Laughing Dove | Spilopelia senegalensis *Linnaeus, et al.,* (1766) | Columbiformes | Columbidae | Resident | Least Concern | Granivores | 60 |
| 34 | Grey Francolin | Ortygornis pondicerianus JF *Gmelin, et al.,* (1789) | Galliformes | Phasianidae | Resident | Least Concern | Insectivores | 10 |
| 35 | Wire-tailed Swallow | Hirundo smithii Leach, KD *Koenig, et al.,* (1818) | Passeriformes | Hirundinidae | Summer breeder | Least Concern | Insectivores | 80 |
| 36 | Indian Golden Oriole | Oriolus kundo *Sykes, et al.,* (1832) | Passeriformes | Oriolidae | Summer breeder | Least Concern | Frugivores | 15 |
| 37 | Red throated bee-eater | Merops bulocki *Vieillot, et al.,* (1817) | Coraciiformes | Meropidae | Resident | Least Concern | Insectivores | 30 |
| 38 | Yellow-eyed pigeon | Columba eversmanni (*Bonaparte, et al.,* 1856) | Columbiformes | Columbidae | Resident | Vulnerable | Granivores | 5 |
| 39 | Black-tailed Godwit | Limosa limosa (*Linnaeus, et al.,* 1758) | Charadriiformes | Scolopacidae | Resident | Near Threatened | Carnivores | 12 |
| 40 | River tern | Sterna aurantia (*JE Gray, et al.,* 1831) | Charadriiformes | Laridae | Resident | Vulnerable | Carnivores | 10 |
| 41 | Common Quail | Coturnix coturnix (*Linnaeus, et al.,* 1758) | Galliformes | Phasianidae | Summer breeder | Least Concern | Insectivores | 17 |

**IUCN Red List Status of Avifauna**

The results disclosed that 2 species (*Sterna aurantia; Columba eversmanni*) were Vulnerable (VU) and 2 (*Limosa limosa; Mycteria leucocephala*) Near Threatened (NT) and the rest of the species (N=34) belonged to Least Concern (LC) category of IUCN Red List (Figures 3-8).

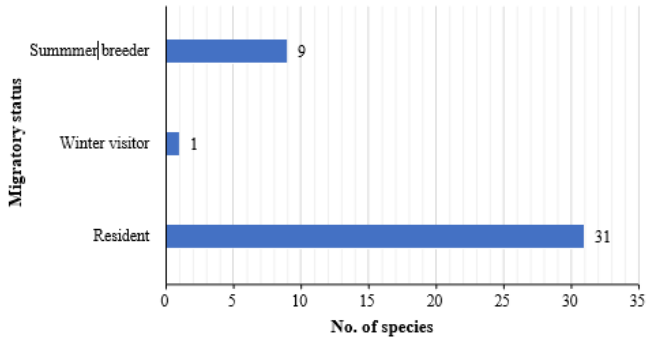


**Figure 3:** Migratory status of the ornithon-fauna indicating the abundance of summer breeder, winter visiting, and resident species.

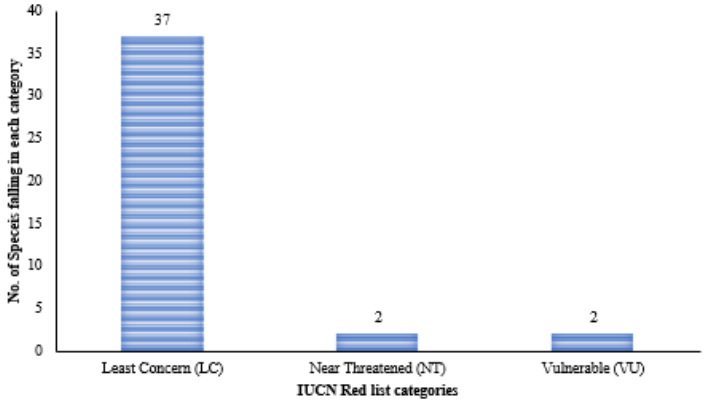


**Figure 4:** Distribution of the avifauna as per their IUCN Red List status.

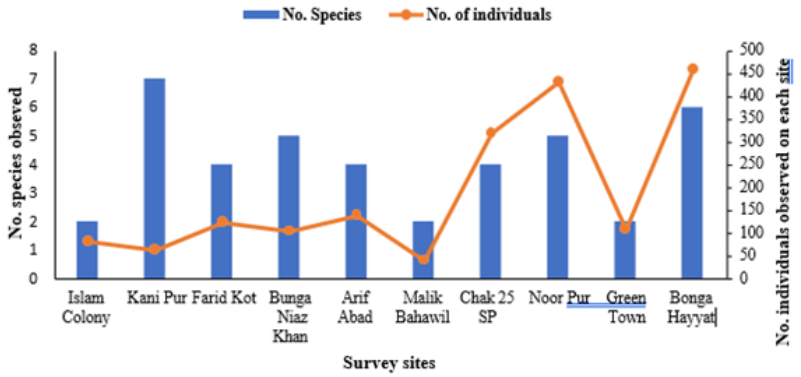


**Figure 5:** Relative number of species and individuals observed at each survey site.

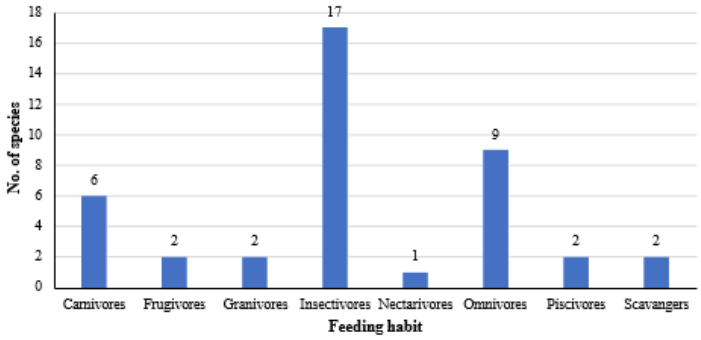


**Figure 6:** Feeding habits of different bird species.

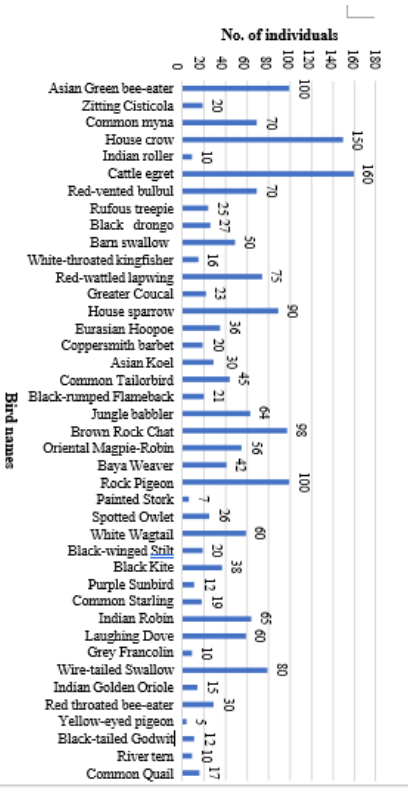


**Figure 7:** Birds belonging to each respective species.

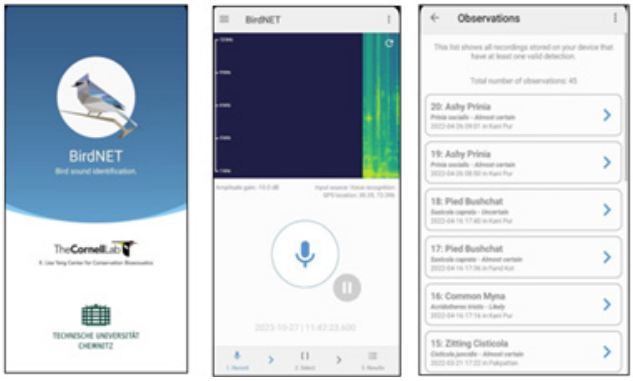


**Figure 8:** Interface of BirdNET mobile application for sound capture identification of birds.

**Migratory Status**

The Majority of the recorded bird population was comprised of resident species. Results showed that 75.60% (N=31) of the bird species was resident, 21.95% (n=9) were summer breeder, and 2.43 % of species (N=1) were winter visitor.

**Feeding Habits**

The Plurality of the bird species was Insectivores (n=17) while other species were Omnivores (n=9), Carnivores (n=6), Frugivores (n=2), Granivores (n=2), Piscivores (n=2), Scavengers (n=2), and Nectarivores (n=1).

## Discussion

Pakistan has a marvelous avifaunal diversity. Birds are regarded as valuable environmental indicators and help us to recognize the preeminent zones for conservation. Protection efforts are aided by metrics like the current species distribution, their historical distribution evidence, and the degree of threat to the species [16]. Birds are crucial for the continuance of ecological cycles, especially in the trophic hierarchies of food chains [17]. The current study was designed to get an insight into the species diversity, IUCN Red List status, feeding types, and migratory behavior of the ornithofaunal populations of Tehsil Pakpattan, Punjab, Pakistan. There has not been any survey conducted for the appraisal of bird diversity in this region so far. A total of 1884 birds were observed belonging to 41 species, 30 families, and 12 orders of Class Aves. A significant proportion (55.15%) of the bird population belonged to Order Passeriformes making it the most diverse group among all other groups and substantiating the previous findings from the adjacent areas of the study zone as well as from other areas of the country [3,18,19]. For the quantitative analysis of diversity various diversity indices were applied including Shannon Wiener Diversity Index (R'=3.41853), Species Evenness index, Simpson's dominance index ($I_{simpson}$=0.039808), Simpson's dominance index (Dsimpson=0.03980), and Margalef's index (IMargaled=5.30422) outcomes of these were strongly suggesting a rich avifaunal population in Tehsil Pakpattan. The majority of survey sites are situated in Agri-farming and countryside settings which is why predominantly bird species are insectivores and omnivores relying on grains and other herbaceous and carnivore feed sources. Nutritive habits of bird species suggested that the bird population is predominantly feeding on small insects and other arthropods viz. Insectivores. The observed population is dominantly comprised of resident avifauna as 75.60% (N=31) of the bird species were resident followed by 21.95% (N=9) summer breeders and 2.43% (N=1) winter visitors. As the study site comprised the region with low industrial and urbanization activities the results regarding the status of threat level indicated that the majority of bird population (90.24%, N=37) belongs to the least concerned (LC) category while 2 (4.87%) species were falling in the Near Threatened (NT) and 2 (4.87%) were in the Vulnerable (VU) categories of Red List of International Union of Conservation of Nature (IUCN). The findings of our study also ascertained that the conservation status of the avifauna of Tehsil Pakpattan is at a satisfactory level and there are no signs of environmental pressure driving population decline. Meanwhile, the highest number of individual birds and species were observed at (N=460) birds and (N=7) at Bonga Hayat and Kanipur respectively. The site where the lowest number of birds were observed was Bhaiwal (N=2) while the lowest number of species sighted was N=2 at Islam Colony, Malik Bhaiwal, and Green Town. The lowest species diversity and bird observance in these areas strongly suggested that the anthropogenic activities in urban areas are callously affecting the avifauna due to land use, environmental pollution, and habitat loss [20-22]. Moreover, the availability of plenty of dietary resources, habitat suitability, lower degree of urbanization, and natural habitat exploitation in the other parts of the study area procures a secure and flourishing habitat for the bird populations and results in a rich ornithofaunal glimpse in the study area [17].

## Conclusion

The study concluded that the area of tehsil Pakpattan has a rich avifaunal diversity. A large number of (n=41) species is an unambiguous sign of a healthy and least exploited habitat. While the urban vicinities in the study area embodied the least proportion of bird population indicating a trend of non-ecofriendly anthropogenic activities in the urban setting causing the dwindling of avifauna in the region. Overall, the study suggested the study area is a healthy, less exploited, and stable habitat for the flourishment of bird pop-

ulations. Furthermore, efforts should be made to the awareness of messes through well-organized strategies through effective channels like social media, mass media, and publicity campaigns for the dispersal of information in rural areas regarding the protection and conservation of avifauna to mitigate the loss of avian diversity in defiance of upcoming environmental challenges in future.

## Acknowledgement

The authors are delighted to acknowledge the Chairman, Department of Wildlife and Ecology, University of Veterinary and Animal Sciences (UVAS), Lahore, Pakistan for their continuous support during this study.

## Conflict of Interest

None.

## References

1. BirdLife International (2023) Country profile: Pakistan. http://datazone.birdlife.org/country/pakistan assessed on 15 July 2023.
2. Bibi F and Ali Z (2013) Measurement of diversity indices of avian communities at Taunsa barrage wildlife sanctuary, Pakistan. J Anim Plan Sci 23(2): 469-474.
3. Shah SHA, Ahmad MA, Sarwar MS, Ashraf M, Siddique S, et al. (2023) Population Dynamics of Avian Diversity in the District Okara, Pakistan American J Zool 6(1): 9-19.
4. Whelan CJ, Wenny DG, Marquis RJ (2008) Ecosystem services provided by birds. Ann NY Acad Sci 1134: 25-60.
5. Wenny DG, Devault TL, Jhonson MD, Kelly Dav, Sekercioglu CH, et al. (2011) The Need to Quantify Ecosystem Services Provided by Birds. The Auk 128(1): 1-14.
6. Ullah I, Sun XY, Wu, QM, Xu Z (2021) Patterns of Bird Relative Abundance, Diversity Indices and Conservation Status in Sheikh Badin National Park, DI Khan, Pakistan. Appl Ecol Environ Res 19(6): 4903-4921.
7. Annand A, Singh AK, Abhishek, Kumar A (2022) Avifaunal Diversity and Status Assessment in Kaimur Wildlife Sanctuary, Bihar, India. Indian J Natur Sci 13: 74.
8. Sadam A, Khan RU, Mahmood S Gul J (2021) Spatial Distribution and Diversity of Bird Communities in District Mardan, Khyber Pakhtunkhwa, Pakistan. Pakisatan J Zool 54(2): 503-1000.
9. Altaf M (2016) Assessment of avian and mammalian diversity at selected sites along river Chenab. PhD Thesis. University of Veterinary and Animal Sciences, Lahore, Pakistan.
10. Aslam S, Siddiqui S, Ullaj U, Manzoor U, Lateef T, et al. (2022) Vertebrate wildlife of Pakistan: A Review. Canadian J Pur and Appl Sci 16(2): 5483-5495.
11. Shah SHA, Bilal A, Ahmad MM, Bukhari SS (2022) Deforestation Is Causing a Great Loss in Avian Diversity in Pakistan. American J Zool 5(3): 24-29.
12. Roberts TJ (1991) The Birds of Pakistan. Oxford University Press, Karachi pp.100-200.
13. Roberts TJ (1992) The Birds of Pakistan. Oxford University Press, Karachi pp.100-200.
14. Pettingill OS and Breckenridge WJ (1995) Ornithology in laboratory and field. Academic Press, Inc Orlando USA 100-200.
15. Emlen JT (1971) Population densities of birds derived from transect counts. The Auk 88(2): 323-342.
16. Altaf M, Javid A, Khan AM, Khan MSH, Umair M, et al. (2018) Anthropogenic impact on the distribution of the birds in the tropical thorn forest, Punjab, Pakistan J Asia-Pacific Biod 11 (2018): 229-236.
17. Haider MZ, Amed S, Sial N, Afzal G, Riaz A, et al. (2022) Avian Diversity and Abundance of Taunsa Barrage Ramsar Site in Punjab, Pak J Zool System Evol Res 2022: 1-14.
18. Abbas S, Hussain E, Abbas H, Hussain S, Tabassum R, et al. (2019) Species Diversity, Feeding Habits and Conservation Status of Birds in Qurumbar National Park, Gilgit-Baltistan, Pakistan. International J Zool Invest 5(2): 108-117.
19. Khan MH, Alam M, Fozia, Atta-Ur-Rehman, Ihtesham Y, et al. (2020) Seasonal Variations in Diversity and Distribution of Avian Fauna in Trimmu Barrage at District Jhang Punjab, Pakistan. Inter J Emer Tech 11(5): 647-651.
20. Sidra S, Ali Z and Chaudhry MN (2013) Avian diversity at new campus of Punjab University in relation to land use change. Pak J Zool 45(4): 1069-1082.
21. Zaman A, Rafique A, Jabeen F, Sultana T (2023) Diversity, Abundance and Seasonal Assessment of Wild Birds in Urban Habitat of District Chiniot, Pakistan. Pakistan J Zool 55(2): 501-1002.
22. Board PIT (nd) Climate District Pakpattan, Government of Punjab. https://pakpattan.punjab.gov.pk/climate assessed on 15 July 2023.