



Assessment of avian biodiversity in relation to fruit tree species in Peshawar University premises, KP Pakistan.

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The diversity of avifauna is assessed in relation and to the fruit trees in the premises of University of Peshawar. The main objective of the study is to assess the species richness and population density of frugivores and fruit trees in our study area. The study is being done using random walk method with focal observation for avian biodiversity identification and enumeration. The site was visited every weekend for two months continuously from March-May 2022. The data was collected twice a day i.e. during dawn and dusk. Initially 02 study sites were studied i.e. (Botanical Garden and Research Garden) and (Malakander Horticulture Research Farm) with an area of 15 acres and 38 acres respectively. Highest number of fruit trees species were encountered in Site A (Botanical Garden and Research Garden) which were fifteen in number followed by Site B (Malakander Horticulture Farm) which consist of 10 species in number. Therein, Apricot trees were highest in number with 1014 plants followed by Peach 901 plants, Pear 690 plants, Plum 206 plants, Persimmon 130 plants, Loquat 128 plants and Guava 40 plants respectively. The specie richness of avian birds being observed in Site A were 28 with highest number of *Striated prinia* (56) followed by 36 species in Site B with highest number of *Red Vented Bulbul* (54). While specie abundance in Site A was 456 and Site B was 332 respectively. According to the results of Simpson diversity index both the Sites comprises of 93% heterogenic species and 7% homogenic species. Whereas Shannon diversity index for Site A was (H=2.94) and for Site B (H= 3.10). Conservation of avian biodiversity within Peshawar city can be flourished by managing the urban green space and promoting native flora with special emphasis on fruit trees.

Keywords: Avian Biodiversity, fruit trees, frugivores, Species richness, Species abundance.

INTRODUCTION

Birds are considered ecological indicators and are sensitive to environmental changes. They provide diverse group of ecosystem services such as provisioning, regulating and supporting the ecosystem. Birds are present in various habitat types and are the functional units that play vital role in structure and function of ecosystem, they have pest control services through consumption of insects (Philpott SM et al. 2009). Frugivores are species of birds and mammals that thrives mostly on raw fruits or succulent fruit-like produce of plants such as roots, shoots, nuts and seeds etc. Frugivores (fruit-eating animals) depend on pulp of fleshy fruits, which is the soft, edible, nutritive tissues surrounding the seeds, as primary food resource (Howe, H.F. 1986). Among them approximately 20% mammals are primarily dependent on fruit or fruit like materials in the wild. Status and distribution of Frugivores are highly interlinked with the distribution and abundance of fruit bearing plant and vice versa. The frugivory interaction is

symbiotic for the animal, since it obtains food, and for the plant, since it may have its seeds dispersed, thus increasing the chance of germination and seedling survival (Howe and Smallwood 1982; Schupp et al. 2010) and helping the plants to colonize wider areas (Espeland and Emam 2011). Seed dispersal determines the spatial arrangement and physical environment of seeds and thus is an important step in the reproductive cycle of most plants (Harper, J.L. 1977, Howe, H.F., and J. Smallwood. 1982, Schupp, E.W., and Fuentes M. 1995., Wilson, M.F. 1992). Bird species diversity, in particular is expected to be influenced by tree species diversity since birds rely a great deal on tree as resources in one way or the other e.g., nesting, roosting and feeding). Areas of higher habitat diversity tend to support most bird species. (Wiens and Rotenberry 1981). The number of tropical plants that produce fruit for fauna is generally high and animals are considered to be the main seed dispersers in forests (Howe & Smallwood 1982). According to Srivastava, the perennial woody

nature of fruit trees, their physiological stages of growth and the differential root distribution pattern make these plants more efficient on the use of nutrients than annual crops.

MATERIALS AND METHODS

Description of the Study area:

The study area is situated in the North western Pakistan (Peshawar: 34.020359° latitude and 71.486515° longitude. study area was divided into two strata in order to get a clear picture. Site A (Botanical Garden and

Research Garden PFI) 34.0181° latitude and 71.4876° longitude having area of 15 acres, and Site B (Malakander Horticulture Research Farm) spreading over an area of 38 acres respectively. Various fruit plants and bird species were identified and recorded in study area through Random walk preferably during dawn and dusk, direct observation were made and recorded. Recording were also made through rapid encounter rate for a specific time of the day systematically. GPS coordinates of each observation were made in the area for future analysis.



Figure 1-2. Showing Map of Site, A and B of Study Area:

Data Collection:

The study is mostly based on direct observation method. The whole area was surveyed on foot. Avian biodiversity

is identified by physical features such as color, beak structure and body structure with the help of field guide and reference book. The observations were taken at sunrise and sunset. The following field guides used for species identification is:

- i. A field guide to birds of Pakistan by Z. B. Mirza.
- ii. The Birds of Pakistan by TJ Roberts.

Assessment of Correlation between frugivores and fruit trees species:

The recorded data is used to calculate the correlation of frugivores and fruit trees using Shannon diversity index and Simpson diversity index and the software used for computation is Paleontological Statistic (PAST) software.

RESULTS

Site A Botanical Garden and Research Garden

Site A is spread over an area of 15 acres consisting of fifteen fruit tree species with highest number of *Morus alba* followed by *Punica granatum*. The area of study is basically a research area of Pakistan Forest Institute Peshawar which is an urban area. Residential area of government official lies adjoining to the study area. The area being a research garden means all the fruit plant species present were planted.

Table 1: Fruit Tree Composition and number of Tree species at site A

S. No	Fruit Species	Number
a.	<i>verrhoa carambola</i>	02
b.	<i>Ziziphus mauritiana</i>	04
c.	<i>Phoenix dactylifera</i>	03
d.	<i>Ziziphus jujube</i>	02
e.	<i>Flacourtia indica</i>	01
f.	<i>Punica granatum</i>	04
g.	<i>Pyrus communis</i>	03
h.	<i>Prunus persica</i>	02
i.	<i>Prunus bokharensis</i>	01
j.	<i>Eriobotrya japonica</i>	01
k.	<i>Diospyros embryopteris</i>	03
l.	<i>Prunus Fasciculata</i>	02
m.	<i>Syzygium cumini</i>	03
n.	<i>Cordia dichotoma</i>	01
o.	<i>Morus alba</i>	05
	Total	37

Site B Horticulture Research Farm

Site B (Malakander Horticulture Research Farm) spreading over an area of 38 acres is basically a research farm of Agriculture University Peshawar. It lies in sub urban area. This area consists of ten fruit tree species with highest number of Apricot plants which were 1014 followed by Peach plants which were 901 in number.

Table 2: Fruit Tree Composition and number of tree species at Site B

S.No	Fruit Species	Number of Individuals (n)
1)	<i>Prunus persica</i>	901
2)	<i>Prunus angustifolia</i>	206
3)	<i>Prunus armeniaca</i>	1014
4)	<i>Diospyros embryopteris</i>	130
5)	<i>Pyrus communis</i>	690
6)	<i>Eriobotrya japonica</i>	128
7)	<i>Psidium guajava</i>	40
8)	<i>Citrus sinensis</i>	15
9)	<i>Citrus limetta</i>	20
10)	<i>Citrus aurantium</i>	20
	Total	3164

Graphical Representation of Birds Observed in Site A and Site B and their Relative Abundance

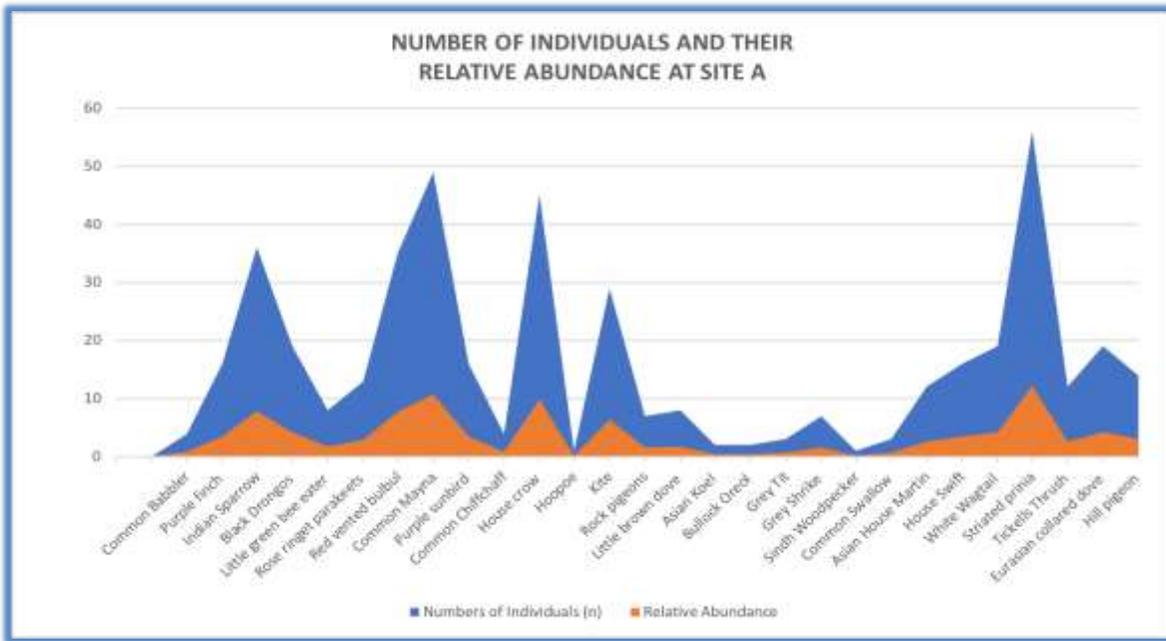


Figure 3. Number of bird species and their Relative Abundance at Site A

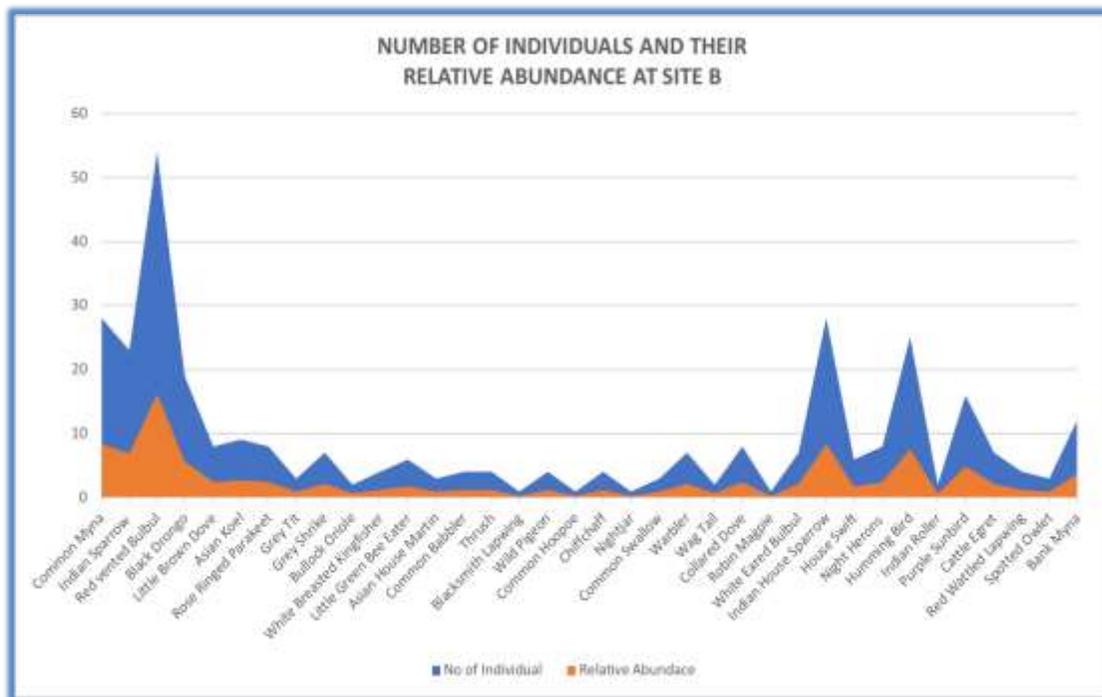


Figure 4. Number of bird species and their Relative Abundance at Site

N = total number of individuals of all species

Diversity Calculation:

Simpson Diversity Index:

$$\text{Simpson index } D = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

Where:

n = number of individuals of each species

Table 3: Assessing avian biodiversity Of Site A through Simpson Diversity Index

S.NO	Bird Species	Numbers of Individuals (n)	(n-1)	n(n-1)
1.	Common Babbler	4	3	12
2.	Purple finch	16	15	240
3.	Indian Sparrow	36	35	1260
4.	Black Drongos	19	18	342
5.	Little green bee eater	8	7	56
6.	Rose ringet parakeet	13	12	156
7.	Red vented bulbul	35	34	1190
8.	Common Mayna	49	48	2352
9.	Purple sunbird	16	15	240
10.	Common Chiffchaff	4	3	12
11.	House crow	45	44	1980
12.	Hoopoe	1	0	0
13.	Kite	29	28	812
14.	Rock pigeons	7	6	42
15.	Little brown dove	8	7	56
16.	Asian Koel	2	1	2
17.	Bullock Oreol	2	1	2
18.	Grey Tit	3	2	6
19.	Grey Shrike	7	6	42
20.	Sindh Woodpecker	1	0	0
21.	Common Swallow	3	2	6
22.	Asian House Martin	12	11	132
23.	House Swift	16	15	240
24.	White Wagtail	19	18	342
25.	Striated prinia	56	55	3080
26.	Tickells Thrush	12	11	132
27.	Eurasian collared dove	19	18	342
28.	Hill pigeon	14	13	182
	Total:	456		13258

$N = 456,$
 $N-1 = 456-1 = 455$
 $N(N-1) = 456(455)$
 $= 207,480$

Simpson Diversity Index for Site A

$$D = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

207,480

=0.93 (93% different species)=0.07 (7% same species)

$$= 1 - \frac{13258}{332}$$

Table 4. Assessing avian biodiversity of Site B through Simpson Diversity Index

S.NO	Bird Species	Number of Individual (n)	(n-1)	n(n-1)
1.	Common Myna	28	27	756
2.	Indian Sparrow	23	22	506
3.	Red vented Bulbul	54	53	2862
4.	Black Drongo	19	18	342
5.	Little Brown Dove	8	7	56
6.	Asian Koel	9	8	72
7.	Rose Ringed Parakeet	8	7	56
8.	Grey Tit	3	2	6
9.	Grey Shrike	7	6	42
10.	Bullock Oriole	2	1	2
11.	White Breasted Kingfisher	4	3	12
12.	Little Green Bee Eater	6	5	30
13.	Asian House Martin	3	2	6
14.	Common Babbler	4	3	12
15.	Thrush	4	3	12
16.	Blacksmith Lapwing	1	0	0
17.	Wild Pigeon	4	3	12
18.	Common Hoopoe	1	0	0
19.	Chiffchaff	4	3	12
20.	Nightjar	1	0	0
21.	Common Swallow	3	2	6
22.	Warbler	7	6	42
23.	Wag Tail	2	1	2
24.	Collared Dove	8	7	56
25.	Robin Magpie	1	0	0
26.	White Eared Bulbul	7	6	42
27.	Indian House Sparrow	28	27	756
28.	House Swift	6	5	30
29.	Night Herons	8	7	56
30.	Humming Bird	25	24	600
31.	Indian Roller	2	1	2
32.	Purple Sunbird	16	15	240
33.	Cattle Egret	7	6	42
34.	Red Wattled Lapwing	4	3	12
35.	Spotted Owlet	3	2	6
36.	Bank Myna	12	11	132
37.	Total:	332		6820

N = 332,

N-1 = 332-1 = 331

N(N-1) = 332(331)

= 109,892

N(N-1)

= 1- $\frac{6820}{332}$

109892

=0.93 (93% different species)

=0.07 (7% same species)

Simpson Diversity Index for Site B

$$D = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

Table 5: Simpson Diversity Index Rank Table

Rank	Index value	Diversity
4	S > 0.65	High diversity
3	S=0.55----0.65	Medium Diversity
2	S= 0.45----0.55	Low Diversity
1	S< 0.45	Near specialization

$$H = -\sum_{i=1}^s p_i \log(p_i)$$

where:

H = Shannon Index

P_i = Proportion of each ⁱth species

S = Number of species in a community

i = Constant

Log = Natural Logarithm

Shannon diversity index:

Table 6. Calculating Birds diversity at Site A through Shannon Diversity Index

NO	Bird Species	Family	No of individual	pi (proportion)	Log (pi)	-pi*log (pi)
1	Common Babbler	<i>Leiothrichidae.</i>	4	0.00877193	-4.73619843	0.0415456
2	Purple finch	<i>Fringillidae</i>	16	0.03508772	-3.34990407	0.1175405
3	Indian Sparrow	<i>Passeridae</i>	36	0.07894737	-2.53897385	0.20044531
4	Black Drongos	<i>Dicruridae</i>	19	0.04166667	-3.17805375	0.13241892
5	Little green bee eater	<i>Meropidae</i>	8	0.01754386	-4.04305125	0.07093073
6	Rose ringet parakeets	<i>Psittacidae</i>	13	0.02850877	-3.55754352	0.10142119
7	Red vented bulbul	<i>Passerines</i>	35	0.07675439	-2.5671447	0.19703963
8	Common Mayna	<i>Sturnidae</i>	49	0.10745614	-2.23067251	0.23969946
9	Purple sunbird	<i>Nectariniidae</i>	16	0.03508772	-3.34990407	0.1175405
10	Common Chiffchaff	<i>Phylloscopidae</i>	4	0.00877193	-4.73619843	0.0415456
11	House crow	<i>Corvidae</i>	45	0.09868421	-2.31583033	0.22853589
12	Hoopoe	<i>Upupidae</i>	1	0.00219298	-6.12249393	0.01342651
13	Kite	<i>Accipitridae</i>	29	0.06359649	-2.755197	0.17522086
14	Rock pigeons	<i>Columbidae</i>	7	0.01535088	-4.17658248	0.06411422
15	Little brown dove	<i>Columbidae</i>	8	0.01754386	-4.04305125	0.07093073
16	Asian Koel	<i>Cuculidae</i>	2	0.00438596	-5.42934675	0.0238129
17	Bullock Oreol	<i>Icteridae</i>	2	0.00438596	-5.42934675	0.0238129
18	Grey Tit	<i>Paridae</i>	3	0.00657895	-5.02388012	0.03305186
19	Grey Shrike	<i>Laniidae</i>	7	0.01535088	-4.17658248	0.06411422
20	Sindh Woodpecker	<i>Picidae</i>	1	0.00219298	-6.12249393	0.01342651
21	Common Swallow	<i>Hirundinidae</i>	3	0.00657895	-5.02388012	0.03305186
22	Asian House Martin	<i>Hirundinidae</i>	12	0.02631579	-3.63758614	0.09572595
23	House Swift	<i>Apodidae</i>	16	0.03508772	-3.34990407	0.1175405
24	White Wagtail	<i>Motacillidae</i>	19	0.04166667	-3.17805375	0.13241892
25	Striated prinia	<i>Cisticolidae</i>	56	0.12280702	-2.0971411	0.25754365
26	Tickells Thrush	<i>Turdidae</i>	12	0.02631579	-3.63758614	0.09572595
27	Eurasian collared dove	<i>Columbidae</i>	19	0.04166667	-3.17805375	0.13241892
28	Hill pigeon	<i>Columbidae</i>	14	0.03070175	-3.48343562	0.10694757
Total			456			2.94194729

$$H = 2.94194729$$

Table 7: Calculating Bird's diversity at Site B through Shannon Diversity Index

NO	Bird Specie	Family	No of Individual	Pi (proportion)	Log (pi)	-pi*log(pi)
1	Common Myna	<i>Sturnidae</i>	28	0.08433735	-2.47293045	0.2085604
2	Indian Sparrow	<i>Passeridae</i>	23	0.06927711	-2.66964073	0.18494499
3	Red vented Bulbul	<i>Passerines</i>	54	0.1626506	-1.81615094	0.29539804
4	Black Drongo	<i>Dicruridae</i>	19	0.05722892	-2.86069591	0.16371454
5	Little Brown Dove	<i>Columbidae</i>	8	0.02409639	-3.72569324	0.08977576
6	Asian Koel	<i>Cuculidae</i>	9	0.02710843	-3.60791053	0.09780479
7	Rose Ringed Parakeet	<i>Psittacidae</i>	8	0.02409639	-3.72569324	0.08977576
8	Grey Tit	<i>Paridae</i>	3	0.00903614	-4.70652319	0.0425288
9	Grey Shrike	<i>Laniidae</i>	7	0.02108434	-3.85922469	0.08136921
10	Bullock Oriole	<i>Oriolidae</i>	2	0.0060241	-5.11198719	0.03079512
11	White Breasted Kingfisher	<i>Halcyon smyrnensis</i>	4	0.01204819	-4.41884084	0.05323903
12	Little Green Bee Eater	<i>Meropidae</i>	6	0.01807229	-4.01337545	0.07253089
13	Asian House Martin	<i>Delichon dasypus</i>	3	0.00903614	-4.70652319	0.0425288
14	Common Babbler	<i>Leiothrichidae</i>	4	0.01204819	-4.41884084	0.05323903
15	Thrush	<i>Turdidae</i>	4	0.01204819	-4.41884084	0.05323903
16	Blacksmith Lapwing	<i>Charadriiformes</i>	1	0.00301205	-5.80513437	0.01748535
17	Wild Pigeon	<i>Columbiformes</i>	4	0.01204819	-4.41884084	0.05323903
18	Common Hoopoe	<i>Upupidae</i>	1	0.00301205	-5.80513437	0.01748535
19	Chiffchaff	<i>Phylloscopidae</i>	4	0.01204819	-4.41884084	0.05323903
20	Nightjar	<i>Caprimulgidae</i>	1	0.00301205	-5.80513437	0.01748535
21	Common Swallow	<i>Hirundinidae</i>	3	0.00903614	-4.70652319	0.0425288
22	Warbler	<i>Parulidae</i>	7	0.02108434	-3.85922469	0.08136921
23	Wag Tail	<i>Motacillidae</i>	2	0.0060241	-5.11198719	0.03079512
24	Collared Dove	<i>Columbidae</i>	8	0.02409639	-3.72569324	0.08977576
25	Robin Magpie	<i>Muscicapidae</i>	1	0.00301205	-5.80513437	0.01748535
26	White Eared Bulbul	<i>Pycnonotus</i>	7	0.02108434	-3.85922469	0.08136921
27	Indian House Sparrow	<i>Passeridae</i>	28	0.08433735	-2.47293045	0.2085604
28	House Swift	<i>Apodidae</i>	6	0.01807229	-4.01337545	0.07253089
29	Night Herons	<i>Ardeidae</i>	8	0.02409639	-3.72569324	0.08977576
30	Humming Bird	<i>Trochilidae</i>	25	0.0753012	-2.58625921	0.19474842
31	Indian Roller	<i>Coraciidae</i>	2	0.0060241	-5.11198719	0.03079512
32	Purple Sunbird	<i>Nectariniidae</i>	16	0.04819277	-3.03254627	0.1461468
33	Cattle Egret	<i>Ardeidae</i>	7	0.02108434	-3.85922469	0.08136921
34	Red Wattled Lapwing	<i>Charadriidae</i>	4	0.01204819	-4.41884084	0.05323903
35	Spotted Owlet	<i>Strigidae</i>	3	0.00903614	-4.70652319	0.0425288
36	Bank Myna	<i>Sturnidae</i>	12	0.03614458	-3.32022827	0.12000826
37	Total		332			3.10140447

$$H = 3.10140447$$

Table 8 Shannon Diversity Index Rank Table

Index Value	Diversity
<1.5	Low diversity
<2.5 --->1.5	Medium Diversity
>2.5	High Diversity

CONCLUSION

The specie richness of avian birds being observed in Site A were 28 with highest number of *Striated prinia* (56) followed by 36 species in Site B with highest number of *Red Vented Bulbul*(54) . While specie abundance in Site A was 456 and Site B was 332 respectively. Highest Relative abundance in Site A was of *Straited prinia* which was 11% while in Site B *Red vented Bulbul* had the highest Relative abundance which was 16%. According to the results of Simpson diversity index both the Sites comprise of 93% heterogenic species and 7% homogenic species. Whereas Shannon diversity index for Site A was (H= 2.94) and for Site B (H= 3.10).

The results justify that Site A (Botanical Garden and Research Garden 15 Acres) serves as a home to diverse and greater number of Species as compared to Site B (Malakander Horticulture research farm 38 Acres) with respect to its areas. Site A comprise of both Fruit bearing as well as non-fruit bearing species. Secondly both short heighted and long heighted trees are present in the said site which provide habitat to greater range of species. Apart from that anthropogenic pressure over this area is very low as compared to Site B which lowers the disturbances to the avian biodiversity of that area. And hence favor's a diverse range of species.

Whereas Site B comprise of only fruit bearing plants which favors mostly frugivores, making it a home to only short heighted plants. Secondly the area experiences a higher anthropogenic pressure being near to Staff colonies. On the other hand, a higher use of insecticides as compared to Site A in order to protect fruits from spoiling, causing bird species to avoid contact with the plants. Causing a lower influx of avian biodiversity with respect to its area. But apart from all these cons this site had lower number of predators which enables the specie to flourish and enrich its population over the area.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Umair Safdar, Ahmad Zamir, Arz Muhammad Umrani designed and performed the experiments, wrote the manuscript and analysed the data. Muhammad Sajawal and Imtiaz Ahmad helped in data collection. Hasil Khan, Muhammad Hamza, Muhammad Rayyan, Roheel Shah and Afra Siab reviewed the manuscript.. All authors read and approved the final version.

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