Avian Assemblage, Monitoring and Bioassessment of Margalla Hills National Park, Islamabad Capital Territory, Pakistan

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ABSTRACT

We aimed to establish avian assemblage, bioassessment scale and to provide indices for future monitoring of birds in hiking trails, undisturbed forest and urban areas of Margalla Hills National Park, Islamabad, Pakistan. The park harbors a good assemblage of birds. As many as 12,295 individuals of 83 species (12 orders, 38 families) were recorded from the National Park. The hiking trails (74 species, 5219 individuals) were found to be more diverse followed by undisturbed forest (60 species, 3377 individuals) while urban areas (41 species, 3699 individuals) were least diverse. The bird abundance (number of individuals and encounter rate) was significantly different among the studied habitats. The encounter rate is provided as an index of monitoring and bioassesmnet of the National Park. The bioassessment of the National Park, based on the studied biometrics using avifauna as an indicator of biotic integrity, revealed excellent biotic integrity.

INTRODUCTION

Protected areas, such as national parks, usually contain high richness and abundance of forest birds compared to their surrounding areas (Lee *et al*., 2007). There is often a perceived conflict between human recreation in protected areas and wildlife conservation. Apparently, non-consumptive movements like hiking and bird watching at recreational trails may disturb wildlife negatively at individual, population and community levels (Larson *et al*., 2016). Hiking and exploration on hiking trails are known to disturb species of many passerine birds (Thompson, 2015) and raptor birds (Stalmaster and Kaiser, 1998). Usually places with high recreational use are altered by unofficial trail networks and tracks shaped by visitors in addition to managed trail system (Leung *et al*., 2002).

Many studies have highlighted the negative impacts

of disturbance such as activation of stress hormones, increased movement and displacement on wildlife due to recreational activities (Frid and Dill, 2002; Tablado and Jenni, 2017). At a population level, disturbance due to recreational activities is known to reduce biodiversity (Kangas *et al*., 2010). Some birds are sensitive to edge effect created by recreational tracks. Enhanced predation rates and higher rates of brood parasitism are risks associated with nesting near the edge (Herkert, 1994). Yet, some avian species prefer forest edges and nest near roads and trails (Wolf *et al*., 2013).

Islamabad Capital Territory is the federal capital of Pakistan, and is located between Punjab and Khyber Pakhtunkhwa province. The city spreads over an area of 1,166 km². The Margalla Hills National Park (MHNP) (33.4352° N, 72.5613°E) covers an area of 17, 386 ha., and is situated at about 685-1604 m elevation in Islamabad Capital Territory. The National Park features a sub-humid subtropical climate with moderately long summer followed by wet monsoon and mild, wet and short winter (Masroor, 2011). The annual average temperature is 21.5°C, and means annual rainfall is 941 mm (Accessible from https://en.climatedata.org/location/32). The main landscape topography includes hills range, Shakarpariyan forest and a wetland (Rawal Lake) with sub-tropical scrub forest featuring *Acacia modesta*, *Olea cuspidata* and *Dodonaea viscosa* in most part with some chir pine (*Pinus*

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roxburghii) zone in the north. Barker *et al.* (1999) reported 23 bird species from the vicinity of Islamabad Capital Territory (ICT), Pakistan. Malik *et al.* (2014) reported 104 species of birds (16 orders, 42 families, 73 genera) from Shakarparian, ICT.

A few small, local ornithological surveys have been carried out within ICT, avian assemblage and components of species diversity are still poorly documented and the bioassesmnet of National Park has not been done. In the first large-scale, structured bird surveys, we established avian assemblage, bioassessment scale and provided indices for future monitoring of birds in different habitats of Margalla Hills National Park, ICT. We investigated the relationship between habitat disturbance and avian biodiversity in the Margalla Hills National Park, ICT. The MHNP was well suited for this work because it is protected by the Islamabad Wildlife Ordinance 1979. The National Park is often used for recreational activity, and consists of habitats with various levels of disturbance and habitat deterioration: undisturbed forests, hiking trails, and urban areas.

MATERIALS AND METHODS

We conducted the present study in the central zone of Margalla Hills National Park (MHNP), Islamabad Capital Territory (ICT), Pakistan. We gathered data in three habitats of the national park: Hiking Trails No. 4, 5 and 6 (15 transects in total, 5 transects per trail, 500 m apart), Undisturbed Forest (15 census stations) and Urban Areas (Saidpur, Talhar and Gokinas Village, 15 census stations) (Fig. 1). These habitats differed in the level of disturbance: Undisturbed forest (undisturbed), hiking trails (mildly disturbed), urban areas (severely disturbed). The trails are regularly visited by visitors for nature based outdoor recreational activities, sports, fitness and bird watching. The selected undisturbed forest area comprised of thick vegetation of the representative forest types of the park while urban areas had human settlements, hotels, restaurants and other urban features such as roads.

Bird surveys were conducted from March 2018 to February 2019 (Spring-Summer: March-August and Autumn-Winter: September-February). We, 2-4 surveyors lead by the first author, carried out a total of 90 surveys and spent approximately 450 field hours. The observations were made two hours after sunrise, and two hours prior to sunset. We used line transect method along the hiking trails (length= 300m; width= 50 m) and point count method (census station with a radius of 100 m) in urban areas and undisturbed forest of the National Park. The observers walked along the transect of pre-determined length to record bird species and count their number of individuals

in the line transect method while the observer stood in the centre of the census station to make observations (adapted from Bibby *et al.*, 1998). We divided the total number of field minutes at each habitat by fifteen to estimate encounter rate: number of individuals encountered per 15 minutes of the survey. Bird species were identified using binoculars (Bresser 10×50). The photographs were captured using modern DSLR cameras (Nikon D7100mm with Nikon lens 150-600 mm; Canon 80D with Canon lens 55-250mm).
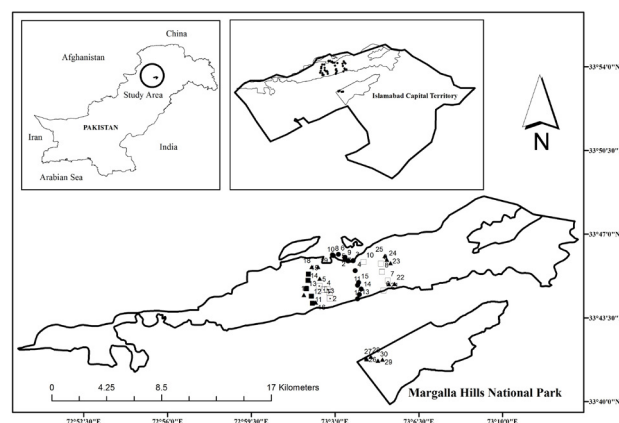
Fig. 1. Map of study area Margalla Hills National Park.

Statistical analysis

We used Kruskal-Wallis and Wlicoxon signed rank test to compare avian diversity (number of individuals and encounter rate) ($\alpha = 0.05$). The data on following biometrics and score were used to develop an index of biotic integrity (IBI): whether the species was habitat generalist (score 10) or specialist (20); least concern (10) or not-evaluated (20); was invasive (10) or not (20); uncommon (encounter rate < 0.50, score 20) or common (encounter rate > 0.50, 10); global population trend stable or increasing (10) or stable or decreasing (20).

The scores for all species at each habitat were summed to produce a total score which was then assigned a condition category. The maximum possible IBI score for any given habitat was 8300. The IBI > 5800 (<70% of the max. possible IBI) represented excellent biological integrity, 4000-5800 (50%-70%) indicated good biotic integrity while < 4000 (<50%) poor biotic integrity.

RESULTS

Birds assemblage

We recorded a total of 12,295 individuals of 83 bird species (12 orders, 41 families) from the National Park. The hiking trails (74 species, 5219 individuals) were found

to be more diverse followed by undisturbed forest (60 species, 3377 individuals) while urban areas (41 species, 3699 individuals) were the least diverse (Tables I, II).

The bird abundance (number of individuals) was significantly different (H= 15.23, df= 2, P< 0.001) among urban areas, hiking trails and undisturbed forest. The number of individuals recorded from urban areas- hiking trails (Z= -3.28, P= 0.01) and hiking trails- undisturbed forest (Z= -2.96, P< 0.001) were significantly different while non-significant for urban areas- undisturbed forest (Z= -1.03 P= 0.302).

Table I. Number of bird species (S), number of individuals (N), Shannon-Wiener diversity index (H'), evenness Index (E) and index of biotic integrity (IBI) recorded from different habitats (UA, Urban areas; HT, Hiking Trails; UF, Undisturbed Forest) of Margalla Hills National Park (MHNP), Islamabad Capital Territory.

	UA	HT	UF	MHNP
Total number of bird species (S)	41	74	60	83
Total number of individuals (N)	3699	5219	3377	12295
Diversity Index (H')	3.08	3.57	3.56	
Evenness Index (E)	0.82	0.82	1.35	
Index of Biotic Integrity (IBI)	6150	6180	6200	6160

IBI > 5800= excellent biological integrity, 4000-5800= good biotic integrity, < 4000 poor biotic integrity.

Indices of monitoring and bioassessment

The encounter rate (Table II) is provided as an index of monitoring of the birds of Margalla Hills National Park, ICT. The most frequently encountered bird species of the National Park were Himalayan bulbul (*Pycnonotus leucogenys*, Fig. 5A), Indian white-eye (*Zosterops palpebrosus*, Fig. 5I) and jungle babbler (*Turdoides striata*) while grey-headed canary-flycatcher (*Culicicapa ceylonensis*) (Fig. 5C), pied kingfisher (*Ceryle rudis*, Fig. 2E) and white-breasted kingfisher (*Halcyon smyrnensis*, Fig. 2D) were the least frequently encountered.

The most frequently encountered bird species in urban areas were common myna (*Acridotheres tristis*, Fig. 5G), house sparrow (*Passer domesticus*) and house crow (*Corvus splendens*) while the least frequently encountered were Eurasian sparrowhawk (*Accipter nisus*, Fig. 2B), white-breasted kingfisher and blue-throated barbet (*Psilopogon asiaticus*, Fig. 3F). We recorded Himalayan bulbul, rusty-cheeked skimitar-babbler (*Erythrogenys erythrogenys*), and oriental white-eye as the most frequent while grey-headed canary-flycatcher, great grey shrike (*Lanius excubitor*,) and spotted owlet (*Athene brama*,

Fig. 5D) as the least frequent species along the hiking trails. The most frequently encountered bird species in undisturbed forest were oriental white-eye, jungle babbler and Himalayan bulbul while the least frequently encountered were pied kingfisher, grey-bellied cuckoo (*Cacomantis passerines*) and white-capped water-redstart (*Phoenicuruc leucocephalus*).
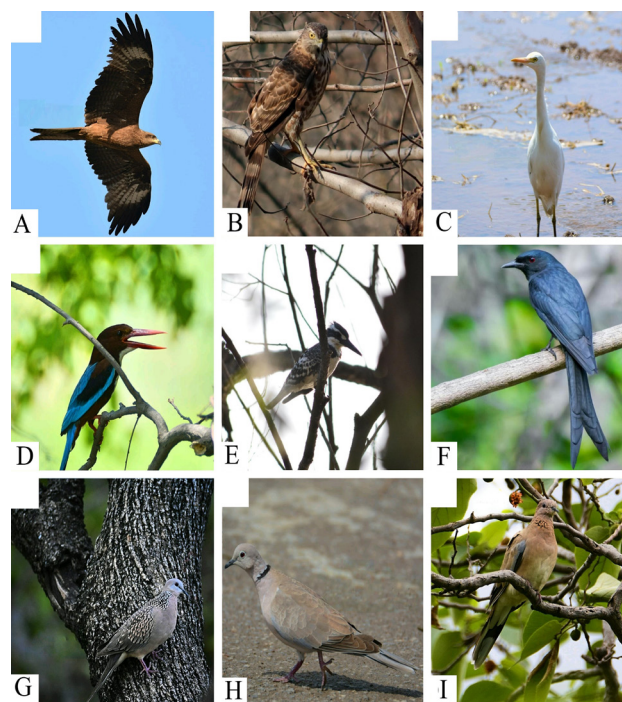
Fig. 2. Black kite (*Milvus migrans*) (A), Eurasian sparrowhawk (*Accipter nisus*) (B), cattle egret (*Bubulcus ibis*) (C), white-breasted kingfisher (*Halcyon smyrnensis*) (D), pied kingfisher (*Ceryle rudis*) (E), black drongo (*Dicrurus macrocercus*) (F), spotted dove (*Spilopelia chinensis*) (G), Eurasian collared dove (*Streptopelia decaocto*) (H), laughing dove (*Spilopelia senegalensis*) (I). Photo credit A, C, D, F, G, H, I Muhammad Shahzaib and B, E Umer Waqas.

The encounter rate was significantly different (H= 10.14, df= 2, P= 0.006) among urban areas, hiking trails and undisturbed forest. The encounter rate recorded from urban areas- hiking trails was significantly different (Z= -2.14, P= 0.03) while non-significant for urban areas- undisturbed forest (Z= -1.37 P= 0.16) and hiking trails- undisturbed forest (Z= -0.09, P= 0.92). The bioassessment of the national park based on the studied biometrics using avifauna as an indicator of biotic integrity revealed excellent biotic integrity (Table I).

Fig. 3. Rufous treepie (*Dendrocitta vagabunda*) (A), yellow-billed blue-magpie (*Urocissa flavirostris*) (B), barn swallow (*Hirundo rustica*) (C), common babbler (*Argya caudata*) (D), red-billed leiothrix (*Leiothrix lutea*) (E), blue-throated barbet (*Psilopogon asiaticus*) (F), blue-tailed bee-eater (*Merops philippinus*) (G), purple sunbird (*Cinnyris asiaticus*) ♀ (H), purple sunbird (*Cinnyris asiaticus*) ♂ (I). Photo credit C, D, F, G, H, I Muhammad Shahzaib and A, B, E Umer Waqas.

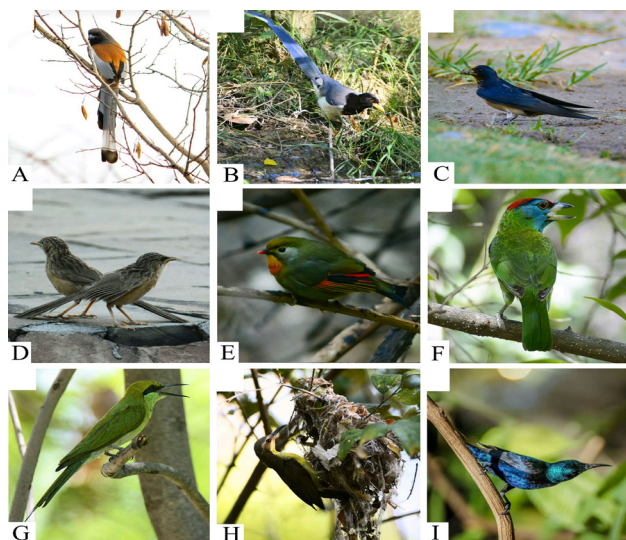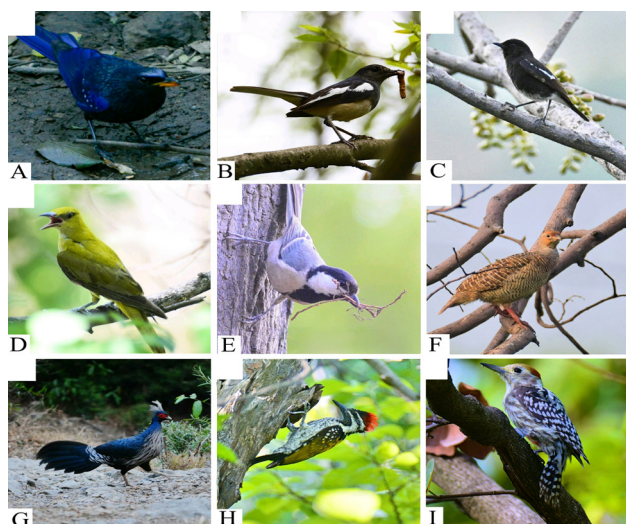Fig. 4. Blue whistling thrush (*Myophonus caeruleus*) (A), Oriental magpie-robin (*Copsychus saularis*) (B), pied bush chat (*Saxicola caprata*) (C), Eurasian golden oriole (*Oriolus oriolus*) (D), cinereous tit (*Parus cinereus*) (E), grey francolin (*Francolinus pondicerianus*) (F), kalij pheasant (*Lophura leucomelanos)* (G), black-rumped flameback (*Dinopium benghalense*) (H), yellow-crowned woodpecker (*Leiopicus mahrattensis*) (I). Photo credit B, C, D, F, I Muhammad Shahzaib and A, G, H Umer Waqas.
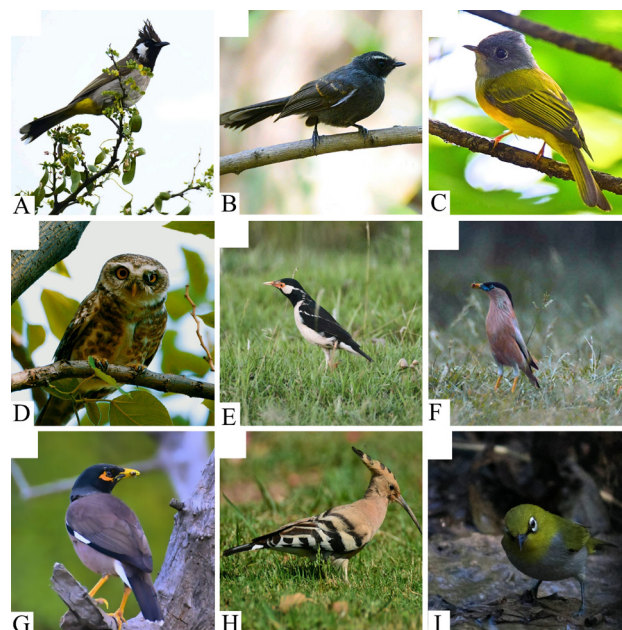
Fig. 5. Himalayan bulbul (*Pycnonotus leucogenys*), (A), white-throated fantail (*Rhipidura albicollis*) (B), grey-headed canary-flycatcher (*Culicicapa ceylonensis*) (C), spotted owlet (*Athene brama*) (D), Asian pied starling (*Gracupica contra*) (E), brahminy starling (*Sturnia pagodarum*) (F), common myna (*Acridotheres tristis*) (G), Eurasian hoopoe (*Upupa epops*) (H), Oriental white-eye (*Zosterops palpebrosus*) (I). Photo credit A, B, C, D, F, G Muhammad Shahzaib and H, I Umer Waqas.

DISCUSSION

The National Park harbors good assemblage of birds including forest birds, passerine birds, and birds of prey. Their richness and abundance varied among the studied habitats. Habitat generalists such as Himalayan bulbul, Jungle babbler, common myna and house sparrow were common in hiking trails and urban areas while habitat specialist black bulbul (*Hypsipetes leucocephalus*), Eurasian sparrow hawk and speckled piculet (*Picumnus innominatus*) were encountered in the forest. Since we did not include wetlands such as Rawal Lake in our study, we recorded a fewer water bird species. We recorded Himalayan bulbul as the most common while grey-headed canary flycather was the least common in the national park. We are presenting abundance data, the encounter rate and provided bioassesmnet scale, for the first time.

Malik *et al*. (2014) reported 104 bird species, of which 29 were water birds, from Shakarpariyan and its surroundings, Islamabad Capital Territory (ICT). The most abundant species was pied cuckoo (*Clametor jacobinus*) followed by common koel (*Endynamys scolopacea*)

Table II. Number of individuals and encounter rate (in italics, sightings/ 15 min.) of bird species recorded from different habitats (UA= Urban areas, HT= Hiking Trails, UF= Undisturbed Forest) of Margalla Hills National Park (MHNP), Islamabad Capital Territory.

S. N	Species	Summer			Winter			Study period			MHNP
		UA	HT	UF	UA	HT	UF	UA	HT	UF	
1	*Accipiter badius*	5	3	0	2	2	0	7	5	0	12
	Shikra	*0.05*	*0.03*	*0*	*0.03*	*0.02*	*0*	*0.04*	*0.02*	*0*	*0.02*
2	*Accipiter nisus*	0	13	18	4	10	14	4	23	32	59
	Eurasian sparrowhawk	*0*	*0.11*	*0.23*	*0.06*	*0.09*	*0.18*	*0.02*	*0.1*	*0.2*	*0.1*
3	*Acridotheres tristis*	350	25	56	289	37	48	639	62	104	805
	Common myna	*3.5*	*0.21*	*0.7*	*4.01*	*0.33*	*0.6*	*3.72*	*0.27*	*0.65*	*1.43*
4	*Amandava amandava*	0	9	0	0	10	0	0	19	0	19
	Red avadat	*0*	*0.08*	*0*	*0*	*0.09*	*0*	*0*	*0.08*	*0*	*0.03*
5	*Apus apus*	34	0	0	25	0	0	59	0	0	59
	Common swift	*0.34*	*0*	*0*	*0.35*	*0*	*0*	*0.34*	*0*	*0*	*0.1*
6	*Argya caudata*	22	0	28	14	0	20	36	0	48	84
	Common babbler (Fig. 3D)	*0.22*	*0*	*0.35*	*0.19*	*0*	*0.25*	*0.21*	*0*	*0.3*	*0.15*
7	*Athene brama*	12	0	0	8	4	0	20	4	0	24
	Spotted owlet	*0.12*	*0*	*0*	*0.11*	*0.04*	*0*	*0.12*	*0.02*	*0*	*0.04*
8	*Bubulcus ibis*	21	0	0	13	0	0	34	0	0	34
	Cattle egret (Fig. 2C)	*0.21*	*0*	*0*	*0.18*	*0*	*0*	*0.2*	*0*	*0*	*0.06*
9	*Cacomantis passerines*	0	8	0	0	12	2	0	20	2	22
	Grey-bellied cuckoo	*0*	*0.07*	*0*	*0*	*0.11*	*0.03*	*0*	*0.09*	*0.01*	*0.04*
10	*Carpodacus rodochroa*	0	0	0	10	23	16	10	23	16	49
	Pink-browed rosefinch	*0*	*0*	*0*	*0.14*	*0.21*	*0.2*	*0.06*	*0.1*	*0.1*	*0.09*
11	*Ceryle rudis*	0	3	2	0	2	0	0	5	2	7
	Pied kingfisher	*0*	*0.03*	*0.03*	*0*	*0.02*	*0*	*0*	*0.02*	*0.01*	*0.01*
12	*Cinnyris asiaticus*	91	97	29	0	0	0	91	97	29	217
	Purple sunbird (Fig. 3H, 3I)	*0.91*	*0.81*	*0.36*	*0*	*0*	*0*	*0.53*	*0.42*	*0.18*	*0.38*
13	*Columba palumbus*	12	0	0	8	0	0	0	33	0	33
	Common woodpigeon	*0.12*	*0*	*0*	*0.11*	*0*	*0*	*0*	*0.14*	*0*	*0.06*
14	*Copsychus saularis*	79	99	0	67	84	0	146	183	0	329
	Oriental mapie robin (Fig. 4B)	*0.79*	*0.83*	*0*	*0.93*	*0.75*	*0*	*0.85*	*0.79*	*0*	*0.58*
15	*Coracias benghalensis*	0	27	12	0	24	16	0	51	28	79
	Indian roller	*0*	*0.23*	*0.15*	*0*	*0.21*	*0.2*	*0*	*0.22*	*0.18*	*0.14*
16	*Corvus splendens*	146	0	0	129	25	4	275	25	4	304
	House crow	*1.46*	*0*	*0*	*1.79*	*0.22*	*0.05*	*1.6*	*0.11*	*0.03*	*0.54*
17	*Culicicapa ceylonensis*	0	3	0	0	0	0	0	3	0	3
	Grey-headed canary-flycatcher	*0*	*0.03*	*0*	*0*	*0*	*0*	*0*	*0.01*	*0*	*0.01*
18	*Cyornis rubeculoides*	0	23	16	0	0	0	0	23	16	39
	Blue-throated blue flycatcher	*0*	*0.19*	*0.2*	*0*	*0*	*0*	*0*	*0.1*	*0.1*	*0.07*
19	*Dendrocitta vagabunda*	21	35	0	18	30	0	39	65	0	104
	Rufous treepie (Fig. 3A)	*0.21*	*0.29*	*0*	*0.25*	*0.27*	*0*	*0.23*	*0.28*	*0*	*0.18*
20	*Dendrocopos macei*	7	11	4	12	14	6	19	25	10	54
	Fulvous-breasted woodpecker	*0.07*	*0.09*	*0.05*	*0.17*	*0.13*	*0.08*	*0.11*	*0.11*	*0.06*	*0.1*

S. N	Species	Summer			Winter			Study period			MHNP
		UA	HT	UF	UA	HT	UF	UA	HT	UF	
21	*Dicrurus macrocercus* Black drongo (Fig. 2F)	24 *0.24*	29 *0.24*	17 *0.21*	18 *0.25*	32 *0.29*	10 *0.13*	42 *0.24*	61 *0.26*	27 *0.17*	130 *0.23*
22	*Dinopium benghalense* Black-rumped flameback (Fig. 4H)	0 *0*	14 *0.12*	13 *0.16*	0 *0*	10 *0.09*	15 *0.19*	0 *0*	24 *0.1*	28 *0.18*	52 *0.09*
23	*Emberiza cia* Rock bunting	0 *0*	0 *0*	0 *0*	0 *0*	42 *0.38*	26 *0.33*	0 *0*	42 *0.18*	26 *0.16*	68 *0.12*
24	*Emberiza lathami* Crested bunting	0 *0*	22 *0.18*	19 *0.24*	0 *0*	0 *0*	0 *0*	0 *0*	22 *0.09*	19 *0.12*	41 *0.07*
25	*Emberiza leucocephalos* Pine bunting	0 *0*	26 *0.22*	22 *0.28*	0 *0*	30 *0.27*	16 *0.2*	0 *0*	56 *0.24*	38 *0.24*	94 *0.17*
26	*Erythrogenys erythrogenys* Rusty-cheeked scimiter-babbler	0 *0*	193 *1.61*	90 *1.13*	0 *0*	180 *1.61*	98 *1.23*	0 *0*	373 *1.61*	188 *1.18*	561 *0.99*
27	*Eudynamys scolopaceus* Asian koel	33 *0.33*	20 *0.17*	26 *0.33*	18 *0.25*	12 *0.11*	13 *0.16*	51 *0.3*	32 *0.14*	39 *0.24*	122 *0.22*
28	*Ficedula parva* Red-breasted flycatcher	0 *0*	16 *0.13*	0 *0*	0 *0*	12 *0.11*	0 *0*	0 *0*	28 *0.12*	0 *0*	28 *0.05*
29	*Francolinus francolinus* Black francolin	0 *0*	18 *0.15*	29 *0.36*	0 *0*	8 *0.07*	34 *0.43*	0 *0*	26 *0.11*	63 *0.39*	89 *0.16*
30	*Francolinus pondicerianus* Grey francolin (Fig. 4F)	0 *0*	12 *0.1*	46 *0.58*	0 *0*	16 *0.14*	22 *0.28*	0 *0*	28 *0.12*	68 *0.43*	96 *0.17*
31	*Galerida cristata* Crested lark	0 *0*	39 *0.33*	69 *0.86*	0 *0*	0 *0*	0 *0*	0 *0*	39 *0.17*	69 *0.43*	108 *0.19*
32	*Garrulus lanceolatus* Black-headed jay	0 *0*	20 *0.17*	15 *0.19*	0 *0*	23 *0.21*	12 *0.15*	0 *0*	43 *0.19*	27 *0.17*	70 *0.12*
33	*Gracupica contra* Asian pied starling (Fig. 5E)	18 *0.18*	0 *0*	0 *0*	15 *0.21*	0 *0*	0 *0*	33 *0.19*	0 *0*	0 *0*	33 *0.06*
34	*Halcyon smyrnensis* White-throated kingfisher	1 *0.01*	3 *0.03*	0 *0*	2 *0.03*	2 *0.02*	0 *0*	3 *0.02*	7 *0.03*	0 *0*	10 *0.02*
35	*Hierococcyx varius* Common hawk-cuckoo	0 *0*	11 *0.09*	0 *0*	0 *0*	17 *0.15*	22 *0.28*	0 *0*	28 *0.12*	22 *0.14*	50 *0.09*
36	*Hirundo rustica* Barn swallow (Fig. 3C)	39 *0.39*	15 *0.13*	0 *0*	0 *0*	0 *0*	0 *0*	39 *0.23*	15 *0.06*	0 *0*	54 *0.1*
37	*Hypsipetes leucocephalus* Black bulbul	0 *0*	58 *0.48*	19 *0.24*	0 *0*	42 *0.38*	22 *0.28*	0 *0*	100 *0.43*	41 *0.26*	141 *0.25*
38	*Lanius excubitor* Great grey shrike	19 *0.19*	0 *0*	0 *0*	8 *0.11*	3 *0.03*	0 *0*	27 *0.16*	3 *0.01*	0 *0*	30 *0.05*
39	*Lanius schach* Long-tailed shrike	0 *0*	5 *0.04*	0 *0*	2 *0.03*	4 *0.04*	0 *0*	0 *0*	7 *0.03*	4 *0.03*	11 *0.02*
40	*Leiopicus mahrattensis* Yellow-crowned woodpecker (Fig. 4I)	0 *0*	13 *0.11*	2 *0.03*	0 *0*	6 *0.05*	4 *0.05*	0 *0*	19 *0.08*	6 *0.04*	25 *0.04*

S. N	Species	Summer			Winter			Study period			MHNP
		UA	HT	UF	UA	HT	UF	UA	HT	UF	
41	*Leiothrix lutea* Red-billed leiothrix (Fig 3E)	0	0	0	0	35	43	0	35	43	78
		0	*0*	*0*	*0*	*0.31*	*0.54*	*0*	*0.15*	*0.27*	*0.14*
42	*Lophura leucomelanos* Kalij pheasant (Fig. 4G)	0	86	14	0	75	18	0	161	32	193
		0	*0.72*	*0.18*	*0*	*0.67*	*0.23*	*0*	*0.69*	*0.2*	*0.34*
43	*Merops philippinus* Blue-tailed bee-eater (Fig. 3G)	11	13	0	0	0	0	11	13	0	24
		0.11	*0.11*	*0*	*0*	*0*	*0*	*0.06*	*0.06*	*0*	*0.04*
44	*Milvus migrans* Black kite (Fig. 2A)	74	0	0	62	0	0	136	0	0	136
		0.74	*0*	*0*	*0.86*	*0*	*0*	*0.79*	*0*	*0*	*0.24*
45	*Monticola cinclorhyncha* Blue-capped rock-thrush	0	13	13	0	5	7	0	18	20	38
		0	*0.11*	*0.16*	*0*	*0.04*	*0.09*	*0*	*0.08*	*0.13*	*0.07*
46	*Motacilla alba* White wagtail	0	19	0	0	14	0	20	0	0	20
		0	*0.16*	*0*	*0*	*0.13*	*0*	*0.12*	*0*	*0*	*0.04*
47	*Myophonus caeruleus* Blue whistling thrush (Fig. 4A)	0	12	9	0	8	11	0	20	20	40
		0	*0.1*	*0.11*	*0*	*0.07*	*0.14*	*0*	*0.09*	*0.13*	*0.07*
48	*Niltava sundara* Rufous-bellied niltava	0	18	12	0	20	9	0	38	21	59
		0	*0.15*	*0.15*	*0*	*0.18*	*0.11*	*0*	*0.16*	*0.13*	*0.1*
49	*Oenanthe fusca* Brown rock chat	67	0	0	52	0	0	119	0	0	119
		0.67	*0*	*0*	*0.72*	*0*	*0*	*0.69*	*0*	*0*	*0.21*
50	*Oriolus oriolus* Eurasian golden oriole (Fig. 4D)	0	44	94	0	0	0	0	44	94	138
		0	*0.37*	*1.18*	*0*	*0*	*0*	*0*	*0.19*	*0.59*	*0.24*
51	*Orthotomus sutorius* Common tailorbird	49	105	35	52	110	32	101	215	67	383
		0.49	*0.88*	*0.44*	*0.72*	*0.98*	*0.4*	*0.59*	*0.93*	*0.42*	*0.68*
52	*Parus cinereus* Cinereous tit (Fig. 4E)	82	28	35	0	0	0	82	28	35	145
		0.82	*0.23*	*0.44*	*0*	*0*	*0*	*0.48*	*0.12*	*0.22*	*0.26*
53	*Passer domesticus* House sparrow	212	0	0	186	0	0	398	0	0	398
		2.12	*0*	*0*	*2.58*	*0*	*0*	*2.31*	*0*	*0*	*0.71*
54	*Pericrocotus flammeus* Orange minivet	0	20	10	0	0	10	0	30	10	40
		0	*0.17*	*0.13*	*0*	*0*	*0.13*	*0*	*0.13*	*0.06*	*0.07*
55	*Phoenicurus coeruleocephala* Blue-capped redstart	0	0	0	0	20	17	0	20	17	37
		0	*0*	*0*	*0*	*0.18*	*0.21*	*0*	*0.09*	*0.11*	*0.07*
56	*Phoenicurus leucocephalus* White-capped redstart	0	0	0	0	8	3	0	8	3	11
		0	*0*	*0*	*0*	*0.07*	*0.04*	*0*	*0.03*	*0.02*	*0.02*
57	*Phylloscopus collybita* Common chifchaff	0	62	33	10	45	26	10	107	59	176
		0	*0.52*	*0.41*	*0.14*	*0.4*	*0.33*	*0.06*	*0.46*	*0.37*	*0.31*
58	*Phylloscopus xanthoschisto* Grey-hooded warbler	17	65	88	12	46	71	29	111	159	299
		0.17	*0.54*	*1.1*	*0.17*	*0.41*	*0.89*	*0.17*	*0.48*	*0.99*	*0.53*
59	*Picumnus innominatus* Speckled piculet	0	0	0	0	17	24	0	17	24	41
		0	*0*	*0*	*0*	*0.15*	*0.3*	*0*	*0.07*	*0.15*	*0.07*
60	*Picus squamatus* Scaly-bellied woodpecker	0	6	0	0	2	5	0	8	5	13
		0	*0.05*	*0*	*0*	*0.02*	*0.06*	*0*	*0.03*	*0.03*	*0.02*

S. N	Species	Summer			Winter			Study period			MHNP
		UA	HT	UF	UA	HT	UF	UA	HT	UF	
61	*Ploceus philippinus* Baya weaver	10	0	0	8	5	0	18	5	0	23
		0.1	*0*	*0*	*0.11*	*0.04*	*0*	*0.1*	*0.02*	*0*	*0.04*
62	*Prinia gracilis* Graceful prinia	0	52	23	0	34	27	0	86	50	136
		0	*0.43*	*0.29*	*0*	*0.3*	*0.34*	*0*	*0.37*	*0.31*	*0.24*
63	*Prinia hodgsonii* Grey-breasted prinia	0	53	71	0	34	58	0	87	129	216
		0	*0.44*	*0.89*	*0*	*0.3*	*0.73*	*0*	*0.38*	*0.81*	*0.38*
64	*Prunella atrogularis* Black-throated accentor	0	0	0	0	26	14	0	26	14	40
		0	*0*	*0*	*0*	*0.23*	*0.18*	*0*	*0.11*	*0.09*	*0.07*
65	*Psilopogon asiaticus* Blue-throated barbet	0	146	93	5	68	74	5	214	167	386
		0	*1.22*	*1.16*	*0.07*	*0.61*	*0.93*	*0.03*	*0.92*	*1.04*	*0.68*
66	*Psittacula himalayana* Slaty-headed parakeet	0	5	10	0	2	22	0	7	32	39
		0	*0.04*	*0.13*	*0*	*0.02*	*0.28*	*0*	*0.03*	*0.2*	*0.07*
67	*Psittacula krameria* Rose-ringed parakeet	12	14	31	6	22	29	18	36	60	114
		0.12	*0.12*	*0.39*	*0.08*	*0.2*	*0.36*	*0.1*	*0.16*	*0.38*	*0.2*
68	*Pycnonotus cafer* Red-vented bulbul	53	36	48	50	30	42	103	66	90	259
		0.53	*0.3*	*0.6*	*0.69*	*0.27*	*0.53*	*0.6*	*0.28*	*0.56*	*0.46*
69	*Pycnonotus leucogenys* Himalayan bulbul	116	365	92	120	342	101	236	707	193	1136
		1.16	*3.04*	*1.15*	*1.67*	*3.05*	*1.26*	*1.37*	*3.05*	*1.21*	*2.01*
70	*Rhipidura albicollis* White-throated fantail (Fig. 5B)	0	32	0	0	26	0	0	58	0	58
		0	*0.27*	*0*	*0*	*0.23*	*0*	*0*	*0.25*	*0*	*0.1*
71	*Saxicola caprata* Pied bush chat (Fig. 4C)	0	31	17	0	25	22	0	56	39	95
		0	*0.26*	*0.21*	*0*	*0.22*	*0.28*	*0*	*0.24*	*0.24*	*0.17*
72	*Saxicola ferreus* Grey bush chat	0	0	0	15	52	36	15	52	36	103
		0	*0*	*0*	*0.21*	*0.46*	*0.45*	*0.09*	*0.22*	*0.23*	*0.18*
73	*Saxicoloides fulicatus* Indian robin	0	19	9	0	15	12	0	34	21	55
		0	*0.16*	*0.11*	*0*	*0.13*	*0.15*	*0*	*0.15*	*0.13*	*0.1*
74	*Spilopelia chinensis* Spotted dove (Fig. 2G)	75	177	30	60	140	43	135	317	73	525
		0.75	*1.48*	*0.38*	*0.83*	*1.25*	*0.54*	*0.78*	*1.37*	*0.46*	*0.93*
75	*Spilopelia senegalensis* Laughing dove (Fig. 2I)	37	24	32	40	20	18	77	44	50	171
		0.37	*0.2*	*0.4*	*0.56*	*0.18*	*0.23*	*0.45*	*0.19*	*0.31*	*0.3*
76	*Streptopelia decaocto* Eurasian collared dove (Fig. 2H)	62	0	45	65	12	40	127	12	85	224
		0.62	*0*	*0.56*	*0.9*	*0.11*	*0.5*	*0.74*	*0.05*	*0.53*	*0.4*
77	*Sturnia pagodarum* Brahminy starling (Fig. 5F)	21	0	0	0	0	0	21	0	0	21
		0.21	*0*	*0*	*0*	*0*	*0*	*0.12*	*0*	*0*	*0.04*
78	*Terpsiphone paradise* Indian paradise flycatcher	0	122	26	0	45	17	0	167	43	210
		0	*1.02*	*0.33*	*0*	*0.4*	*0.21*	*0*	*0.72*	*0.27*	*0.37*
79	*Trochalopteron variegatum* Variegated laughingthrush	0	0	0	0	38	32	0	38	32	70
		0	*0*	*0*	*0*	*0.34*	*0.4*	*0*	*0.16*	*0.2*	*0.12*
80	*Turdoides striata* Jungle babbler	134	167	143	110	174	127	244	341	270	855
		1.34	*1.39*	*1.79*	*1.53*	*1.55*	*1.59*	*1.42*	*1.47*	*1.69*	*1.52*

S. N	Species	Summer			Winter			Study period			MHNP
		UA	HT	UF	UA	HT	UF	UA	HT	UF	
81	*Upupa epops*	20	0	0	18	5	0	38	5	0	43
	Eurasian hoopoe (Fig. 5H)	*0.2*	*0*	*0*	*0.25*	*0.04*	*0*	*0.22*	*0.02*	*0*	*0.08*
82	*Urocissa flavirostris*	0	15	8	0	0	0	0	15	8	23
	Yellow-billed blue magpie (Fig. 3B)	*0*	*0.13*	*0.1*	*0*	*0*	*0*	*0*	*0.06*	*0.05*	*0.04*
83	*Zosterops palpebrosus*	100	206	244	82	148	176	182	354	420	956
	Indian white-eye	*1*	*1.72*	*3.05*	*1.14*	*1.32*	*2.2*	*1.06*	*1.53*	*2.63*	*1.7*

while the least common was common Teal (*Anas crecca*). We recorded 39 bird species which were not reported previously by Malik *et al*. (2014). We attribute this to our study duration and extent of the study area, for we did not gather data from the wetlands.

We found that the urban areas had the lowest species richness but higher abundance of passerine species such as common myna. Similar findings were reported previously from other parts of Pakistan. Altaf *et al*. (2018) reported higher bird species diversity at natural habitat (forest habitat= 109 species with common myna (n=34) as most common species; rural forest habitat= 95 species, common myna (n=437); wetland habitat= 51 species, Intermediate Egret (n=1577) as compared to disturbed habitat (agri-rural habitat= 74 species with house crow (n=310) as the most common species; agriculture habitat= 60 species, black kite (n=106); urban vegetative habitat= 44 species, house crow (n=405) and urban non-vegetative habitat= 20 species, black kite (n=410), in the tropical thorn forest area along River Chenab Punjab, Pakistan.

Our findings suggest that bird species richness (89% of the total species of the National Park) along the hiking trails was highest. However, Bötsch *et al*. (2018) reported 16.8 bird species per km² along recreational trails, areas with high level of recreation, while 17.5 species per km² away from the trails at Allschwilerwald and Sihlwald forest, Switzerland. This difference might be due to availability of non-woody and woody vegetation along the trails in MHNP which provides refuge to passerine and forest bird allows higher detection.

High bird diversity is known from undisturbed forest areas. Aben *et al*. (2018) detected 115 bird species from deciduous forest in the Andean foothills, Bolivia. The highest species number was recorded from deciduous forest (n= 73), followed by semi-deciduous forest (69) while the disturbed forest had the lowest species number (58) due to recent anthropogenic disturbance in the area. Morante-Filho *et al*. (2015) reported 184 (103 forest specialist, 81 generalist) bird species (5931 individuals) from forest habitat in Southern Bahia State, North Eastern Brazil. The number of species (n= 62) was higher in areas encompassing 65-50% forest cover as compared to areas with 25-50% forest area (n= 28). Sargent *et al*. (2017) documented 34 bird species from Pennsylvania Wild Region, USA. Of the recorded species, 13 had higher densities in conifer forest, 11 in northern hardwood and 11 species in oak forest indicating importance of a forest type for pattern of diversity and distribution of different forest species. Jones and Nealson (2005) reported higher species richness from undisturbed old secondary forest as compared to other habitat types. The mean number of bird species in undisturbed sites of rain forest (n= 18.33) and eucalyptus habitat (n=17.60) was significantly higher than both semi-disturbed (15.87 and 12.33 in rainforest and eucalyptus habitat, respectively) and disturbed forest (14.60 and 14.07 in rainforest and eucalyptus habitat, respectively) in Queensland, Australia. The primary cause of disturbance was bird watching activity. Our findings also suggest that undisturbed forest areas have high bird diversity when compared with urban habitat, but highest bird diversity areas may also include hiking trails, low level of disturbance caused by hiking and bird watching, in sub-tropical scrub forest (protected) habitat.

Our findings provide up to date comprehensive data on avian inventory and abundance in MHNP, ICT. Collectively, the study added to the available knowledge of avian biodiversity of the ICT and reported the first observations of 39 species in the region. We believe that species biodiversity may have been underestimated because of methodological limitations including study time and resources. The park exhibited excellent biotic integrity. We expect our data could be replicated and used by the future researchers to carry out detailed studies on avian population monitoring and ecological health for the entire national park based on scales (encounter rate and bioassement) we provided.

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Supplementary material

There is supplementary material associated with this article. Access the material online at: https://dx.doi.org/10.17582/journal.pjz/20211213061202

Statement of conflict of interest

The authors have declared no conflict of interest.

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