

**DIVERSITY, STATUS AND HABITAT USAGE OF AVIFAUNA AT MAGURA
SADAR UPAZILA, BANGLADESH**

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Abstract: A study on diversity, status, and habitat preference of avifauna was conducted from November 2017 to October 2018 in Magura Sadar upazila, Magura. Data was collected through direct field observations using line-transect method. Field surveys were made for three days per month in both rural and urban sites. A total of 140 species of birds belonged to 18 orders and 48 families were reported. Among the total species, 55% (77 species) were non-passerines and 45% (63 species) passerines with the highest individuals were counted under order Passeriformes. Resident bird species were dominant (106 species, 75.71%) over migratory (34 species, 24.28%) species. Species richness was the highest in the rural areas (124 species, 88.57%) and occurrence was the highest in winter season (97 species, 69.29%). The maximum species were recorded from trees (87 species, 62.14%) as preferred habitat. In this study, in total 4,060 individuals of birds were counted and among them, 51.55% (n=2093) were observed in the rural areas and 48.45% (n=1967) were in the urban areas. The highest number of birds was found in December (10.34%, n=432) and seasonal abundance was the highest in winter (40.15%, n=1630). Abundance was the highest for Common Myna (5.76%, n=234) among all recorded species. Diversity indices showed that the bird species were the most diverse in the rural areas in the winter season and in July. Habitat diversity indices were the highest for trees and birds used different types of habitats at different times for roosting, breeding and feeding. Regarding the observation status, 29.28% species was very common, 4.28% common, 31.42% fairly common, and 35% were few. This baseline data indicate that this study site is significant from the ecological and conservation point of views. Therefore, further research is necessary to understand how this avian diversity is maintained in this ecological setting.

Key words: Diversity, Bird, Magura, Habitat, Bangladesh

INTRODUCTION

Bangladesh is located at the junction of the Indo-Himalayas and Indo-China

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sub-regions where the species of two biogeographic realms overlap (IUCN Bangladesh 2015). This geographic location makes the country as a transitional zone for both flora and fauna among Southeast Asia (Stanford 1991). The natural forests of the country are classified on the basis of three major.

Vegetation types: evergreen to semi-evergreen hill forests, deciduous Sal forests, and mangrove forests (Husain 2003, Mukul 2008). Depending upon such conditions, Bangladesh harbors a total of 690 bird species, of which 380 are residents, 209 winter visitors, 11 summer visitors, and rest 90 vagrants (Khan 2008, Khan 2018). The total number of bird species in the country is nearly the same as all of Europe (Khan 2008).

Avifauna is a very familiar group of wildlife that contribute to providing ecological services in both natural and modified ecosystems. They play a vital role in ecological functioning and process i.e. act as a bio-indicator in evaluating environmental pollution and healthy ecosystem (Sekercioglu 2006, Slabbekoorn *et al.* 2008, Mistry *et al.* 2008), agents of nutrient recycling and plant gene flow through seed dispersal and pollination (Sekercioglu 2006, Sekercioglu *et al.* 2004). Scavenger birds, such as the Pied Crow (*Corvus albus*) helps to minimize the levels of disposable wastes (Gatesire *et al.* 2014) and regulate the population of harmful insects and other pests (Sekercioglu 2006, Sekercioglu *et al.* 2004). Additionally, insectivorous birds and raptors regulate disease vectors such as mosquitoes and rodents (Gatesire *et al.* 2014). These ecosystem services are important for many communities for current and future generations.

Habitat loss, indiscriminate killing, rapid industrialization, use of herbicides, pesticides, insecticides fertilizer, hunting, poisoning, and trapping have been posing serious threats for avifauna in Bangladesh (Sarker and Sarker 1988, IUCN Bangladesh 2015, Khan 2018). These threats are also accelerating their population decline in the country. For instance, huge number of migratory bird populations are trapped and killed in *haor*, *baor*, *beel* and *char* areas of Bangladesh. Therefore, baseline studies are essential to monitor threats as well as assess the spatial and temporal frame of bird diversity (Nazmul *et al.* 2018). We also think monitoring of avifaunal diversity in Bangladesh is imperative for assessing landscape diversity as well as the overall avifaunal community.

However, some researches on avian diversity were conducted in some districts of Bangladesh (Jaman *et al.* 2011; Amin and Hasan 2019, Karmakar *et al.* 2011). Magura Sadar upazila is very green with many homestead trees and open cultivated lands. Landscape constitutes diverse types of habitats such as homestead areas, cultivated lands, and fallow lands. Literature surveys indicate that the study on birds in Sadar upazila under Magura district has not yet been

done. Therefore, to construct baseline data a survey on birds is important. The present study aimed to investigate species diversity, status, abundance, and habitat usage of birds at Sadar upazila, Magura. This research subsequently will help to make a conservation plan for the protection of avifauna in the study area.

MATERIAL AND METHODS

Study Area: This study was done in Sadar upazila (406.5 Km²) under Magura district (23°29'15.00" N 89°25'14.88" E) for 12 months starting from November 2017 to October 2018. The study period was divided into three time period such as summer (March-June), rainy (July-October), and winter (November-February). The study area is enriched with diverse natural habitats that include grasslands, wetlands, agricultural lands, homestead forests, canals, and rivers. Six sites, both in urban and rural settings for data collection was considered. Among the six study sites, 3 were in the rural areas and 3 in urban areas (Fig. 1). Equal number (9 field trips in each area) of field trips in both the rural and the urban areas were done. All habitats were classified into six categories viz., Flying, Grasslands (1≥ meter), Grounds (all type of land), Trees, Urban settlements (poles, buildings, towers, etc.) and Water body (both permanent and temporary). The survey covered the rural as well as the urban habitats such as trees (orchard, homestead garden, roadside tree), water body (pond, *beel*, canals, river sides, small and shallow water bodies), semi-urban settings (human habitations, small market, shack), grasslands (peripheral areas of agricultural land, bushes, thickets), grounds (fallow land, yard). Residential and commercial areas with congested large markets in urban settings were surveyed.

Data collection protocol: Data collection was done through direct field observations using transect line methods (Gaston 1975) and at least 3 days were spent per month. The survey was conducted in the early morning (06:00 to 10:00 am) and in the afternoon (03:00 to 06:30 pm) to correlate with birds' peak activity (Fisher and Hicks 2006) and night for nocturnal birds. At least 9 hours of effort (4 hours in morning + 3.30 hours in afternoon + 1.30 hours at night) per day totaling 324 hours was ensured. We surveyed equal number of transect lines both in the urban and the rural sites. The size of the transect line was 1000×100 square meters. Each transect line was observed repeatedly for at least two times. Some avifaunas which were normally hidden in the bushes, jungles, and branches of trees, were recorded by receiving their song and calls. Sometimes the calls were recorded by Huawei GT3 Phone which was later identified by the experts in the laboratory.

Torchlight was used to observe nocturnal birds in the branches of trees. When any bird was seen during the survey, photographed them with a Nikon D7100 DSLR Camera with a 70-300 mm VR lens for accurate identification. Additionally, we talked to the local inhabitants and showed them photographs available in the field guide for identifying nocturnal as well as rare birds. We followed some popular Bangladeshi field guides on birds to identify them (Halder 2010, Khan 2015, IUCN Bangladesh 2015, Khan 2018).

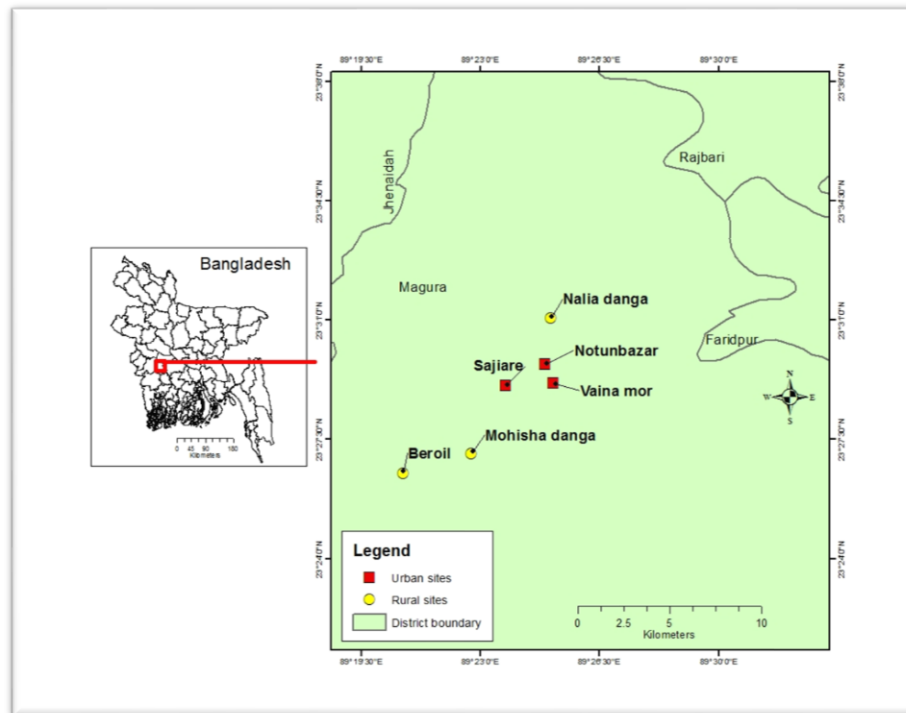


Fig. 1. Avifaunal survey sites in Magura Sadar upazila.

Data analysis: The relative abundance of particular bird species was calculated following the formula-

$$\text{Relative abundance} = \frac{\text{Number of individuals of a species}}{\text{Total number of individuals of all}} \times 100$$

Khan (2015) was followed to estimate the observation status as very common (VC) 80-100%, common (C) 50-79%, fairly common (FC) 20-49% and few (F) 10-19% which was calculated based on total sighting per survey attempt. The

calculation was done according to Shannon-Wiener index (1949), Simpson's index (1949) of diversity and Evenness (quantifies how numerically equal the community is) in the study area using the following formulas-

Shannon-Wiener Index, $H = -\sum(P_i) |\ln P_i|$

Evenness, $E = H/\ln(S)$ (natural log)

Simpson's index of diversity, $D_s = 1 - \sum n_i(n_i-1)/N(N-1)$

(where, n_i = number of individuals of a species; N = the total number of individuals; $P_i = (n_i/N)$ number of individuals of a species/ total number of individuals of all species).

RESULTS AND DISCUSSION

Species composition: A total of 140 species of birds belonging to 18 orders, 48 families, and 96 genera were recorded from the study area. The recorded species constituted 20.29% of total bird species recorded by Khan in Bangladesh (2018). Among them, 77 (55%) were non-passerines and 63(45%) passerines; 106 (75.71%) residents and 34 (24.28%) were migratory (Table 1). We found 3 summer visitors (*Clamator jacobinus*, *Cuculus micropterus* and *Merops philippinus*) and one passage migrant (*Cuculus canorus*) (Table 1). Passeriformes had the highest number of bird species (63) followed by Charadriformes (14), Coraciformes (9), and Cuculiformes (9) (Table 1). The highest number of species was found under a single family Cuculidae (9). The avian diversity suggests that the study area support diverse range of habitats making suitable for both resident and migratory species of birds. Bangladesh Bureau of Statistics primarily enlisted 18 species of birds in 2011 in Magura Sadar but yet to report in the scientific literature.

Species richness and abundance: We observed 124 species of birds in the rural sites and 113 species in the urban sites (Fig 2A). The highest number of species (87, 62.14%) were observed in trees and the lowest (11, 7.86%) in flying conditions (Fig 2B). We found the highest number of species in the winter season (97, 69.29%) (Fig 2C). We also recorded the highest number of species in June (72 species) and the lowest in April (50 species) (Fig. 2D). Some studies showed that 41 species were recorded in Comilla (Jaman *et al.* 2011), 105 in Naogaon (Amin and Hasan 2019) and 57 in Joypurhat (Karmakar *et al.* 2011). These data suggest that the habitat in Sadar upazila under Magura district may be more favorable for avifauna than the previously studied sites. A total of 4,060 individuals of birds were counted during our study. Among them, 2093(51.55%) individuals were observed in the rural sites and 1967(48.45%) in the urban sites

(Fig. 3A). Species richness and individual counts were almost the same in the rural and the urban sites. This result indicated that habitat quality was not different between the two sites. Among the habitats, tree was the most

Table 1. List of Avifauna in Magura Sadar Upazila, Magura from November 2017- October 2018

(Note: N- Number of individual; RA- Relative abundance; OS- Observation Status; VC- Very Common; C-Common, FC- Fairly common, Few- F; LC- Least Concern, EN- Endangered; GL- Grassland, T- Tree, US- Urban settlement, G- Ground, WB- Water body; U- Urban, R- Rural; Rs- Resident, WV- Winter Visitor, SV- Summer Visitor; W-Winter, Su- Summer and Ri- Rainy Season, Y- Year round)

Scientific Name	English Name	N	RA	OS	IUCN BD Status	Micro Habitat	Site	Status	Season
<i>Accipiter badius</i>	Shikra	1	0.025	F	LC	T	R	Rs	Ri
<i>Clanga hastata</i>	Indian Spotted Eagle	7	0.172	F	EN	T	U	R	W
<i>Milvus migrans</i>	Black Kite	44	1.084	VC	LC	Flying, T, US	U, R	Rs	Y
<i>Elanus caeruleus</i>	Black-winged Kite	9	0.221	FC	LC	T	U, R	Rs	Su, Ri
<i>Haliastur indus</i>	Brahminy Kite	2	0.049	F	LC	T	R	R	Su
<i>Nisaetus cirrhatus</i>	Changeable Hawk Eagle	1	0.024	F	LC	US	R	R	Su
<i>Dendrocygna javanica</i>	Lesser Whistling Duck	7	0.172	F	LC	WB	U, R	Rs	W
<i>Upupa epops</i>	Common Hoopoe	2	0.049	F	LC	G	R	R	Su
<i>Apus nipalensis</i>	House Swift	128	3.152	VC	LC	Flying	U, R	Rs	W
<i>Cypsiurus balasiensis</i>	Asian Palm Swift	64	1.576	VC	LC	Flying	U, R	Rs	Y
<i>Charadrius alexandrinus</i>	Kentish Plover	9	0.221	F	LC	WB	R	WV	W
<i>Charadrius dubius</i>	Little Ringed Plover	24	0.591	F	LC	G	R	R	W
<i>Charadrius mongolus</i>	Lesser Sandplover	28	0.689	FC	LC	WB	U, R	WV	W
<i>Pluvialis fulva</i>	Pacific Golden Plover	63	1.551	C	LC	WB	U, R	WV	Ri, W
<i>Pluvialis squatarola</i>	Grey Plover	26	0.640	FC	LC	WB	U	WV	Ri
<i>Tringa glareola</i>	Wood Sandpiper	6	0.147	FC	LC	WB	U, R	WV	W, Su
<i>Vanellus cinereus</i>	Grey-headed Lapwing	61	1.502	C	LC	WB	U, R	WV	Ri, W
<i>Vanellus indicus</i>	Red-wattled Lapwing	5	0.123	FC	LC	WB, GL	U, R	Rs	Su
<i>Metopidius indicus</i>	Bronze-winged Jacana	8	0.197	C	LC	WB	U, R	Rs	W
<i>Actitis hypoleucos</i>	Common Sandpiper	17	0.418	F	LC	WB	U	WV	W
<i>Calidris minuta</i>	Little Stint	51	1.256	FC	LC	WB	U, R	WV	W
<i>Calidris temminckii</i>	Temminck's Stint	9	0.221	F	LC	WB	U, R	WV	W
<i>Gallinago gallinago</i>	Common Snipe	11	0.270	F	LC	WB	R	WV	W
<i>Gallinago stenura</i>	Pin-tailed Snipe	12	0.295	F	LC	WB	R	WV	W
<i>Anastomus oscitans</i>	Asian Openbill	47	1.157	FC	LC	T	U, R	Rs	Su
<i>Columba livia</i>	Blue Rock Pigeon	72	1.773	VC	LC	US, T, G,	U, R	Rs	Y

Scientific Name	English Name	N	RA	OS	IUCN BD Status	Micro Habitat	Site	Status	Season
						Flying			
<i>Spilopelia chinensis</i>	Eastern Spotted Dove	72	1.773	VC	LC	US, T, G, Flying	U, R	Rs	W
<i>Streptopelia decaocto</i>	Eurasian Collared Dove	5	0.123	F	LC	G	U, R	Rs	W
<i>Streptopelia tranquebarica</i>	Red Turtle Dove	11	0.270	FC	LC	G, T	U, R	Rs	Su, Ri
<i>Treron phoenicopterus</i>	Yellow Footed Green Pigeon	13	0.320	F	LC	T	U, R	Rs	W
<i>Alcedo atthis</i>	Common Kingfisher	62	1.527	VC	LC	T	U, R	Rs	Y
<i>Alcedo meninting</i>	Blue-eared Kingfisher	5	0.123	F	LC	T	U	R	W
<i>Ceryle rudis</i>	Pied Kingfisher	25	0.615	VC	LC	Flying, T	U, R	Rs	Y
<i>Halcyon smymensis</i>	White-breasted Kingfisher	39	0.960	VC	LC	T	U, R	Rs	Y
<i>Pelargopsis capensis</i>	Stork-billed Kingfisher	6	0.147	FC	LC	T	U, R	Rs	Su, Ri
<i>Coracias benghalensis</i>	Indian Roller	10	0.246	FC	LC	GL	U, R	Rs	Su, Ri
<i>Merops leschenaulti</i>	Chestnut-headed Bee-eater	3	0.073	F	LC	T	U	R	W
<i>Merops orientalis</i>	Asian Green Bee-eater	28	0.689	FC	LC	T	U, R	Rs	W
<i>Merops philippinus</i>	Blue-tailed Bee-eater	6	0.147	F	LC	US	U	SV	Ri
<i>Cacomantis merulinus</i>	Plaintive Cuckoo	10	0.246	FC	LC	T	U, R	Rs	Su
<i>Cacomantis passerinus</i>	Grey-bellied Cuckoo	11	0.270	FC	LC	T	U, R	Rs	Su
<i>Centropus bengalensis</i>	Lesser Coucal	3	0.073	FC	LC	T	U, R	Rs	Su, Ri
<i>Centropus sinensis</i>	Greater Coucal	7	0.172	FC	LC	G, T	U, R	Rs	Y
<i>Cuculus canorus</i>	Common Cuckoo	1	0.024	F	LC	T	R	PV	Su
<i>Cuculus micropterus</i>	Indian Cuckoo	7	0.172	FC	LC	T	U, R	SV	Su, Ri
<i>Eudynamis scolopaceus</i>	Western Koel	23	0.566	VC	LC	T	U, R	Rs	Y
<i>Hierococcyx varius</i>	Common Hawk-Cuckoo	15	0.369	VC	LC	T	U, R	Rs	W
<i>Clamator jacobinus</i>	Jacobin Cuckoo	5	0.123	FC	LC	T	U, R	SV	Su, Ri
<i>Falco chicquera</i>	Red-headed Falcon	1	0.024	F	LC	US	R	WV	Ri
<i>Falco tinnunculus</i>	Common Kestrel	1	0.024	F	LC	US	U	WV	W
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	26	0.640	VC	LC	WB, T	U, R	Rs	Y
<i>Aegithina tiphia</i>	Common Iora	58	1.428	VC	LC	T	U, R	Rs	Y
<i>Mirafra assamica</i>	Rufous-winged Lark	8	0.197	F	LC	GL, T	U, R	Rs	Su
<i>Artamus fuscus</i>	Ashy Wood Swallow	19	0.467	FC	LC	US, T	U, R	Rs	Su, Ri
<i>Coracina melanoptera</i>	Black-headed Cuckooshrike	10	0.246	FC	LC	T	U, R	Rs	Su

Scientific Name	English Name	N	RA	OS	IUCN BD Status	Micro Habitat	Site	Status	Season
<i>Pericrocotus cinnamomeus</i>	Small Minivet	3	0.073	F	LC	T	R	R	W
<i>Tephrodornis pondicerianus</i>	Common Woodshrike	8	0.197	FC	LC	T	U, R	Rs	Su
<i>Cisticola juncidis</i>	Zitting Cisticola	46	1.133	VC	LC	GL	U, R	Rs	Y
<i>Prinia gracilis</i>	Graceful Prinia	25	0.615	VC	LC	GL, T	U, R	Rs	Y
<i>Prinia inornata</i>	Plain Prinia	26	0.640	VC	LC	GL, T	U, R	Rs	Y
<i>Corvus leuallantii</i>	Jungle Crow	114	2.807	VC	LC	G, US, T	U, R	Rs	Y
<i>Corvus splendens</i>	House Crow	120	2.955	VC	LC	G, US, T	U, R	Rs	Y
<i>Dendrocitta vagabunda</i>	Rufous Treepie	50	1.231	VC	LC	T	U, R	Rs	Y
<i>Dicaeum erythrorhynchos</i>	Pale-billed Flowerpecker	2	0.049	F	LC	T	U	R	W
<i>Dicrurus aeneus</i>	Bronzed Drongo	2	0.049	F	LC	US, T	U, R	Rs	Su, Ri
<i>Dicrurus leucophaeus</i>	Ashy Drongo	4	0.098	F	LC	T	R	WV	W
<i>Dicrurus macrocercus</i>	Black Drongo	83	2.044	VC	LC	G, US, T	U, R	Rs	Y
<i>Dicrurus remifer</i>	Lesser Racket-tailed Drongo	2	0.049	F	LC	G	R	WV	Su
<i>Lonchura malabarica</i>	White-throated Munia	6	0.147	FC	LC	T, G, GL	U, R	Rs	W, Su
<i>Lonchura punctulata</i>	Scaly-breasted Munia	70	1.724	VC	LC	GL, G, T, US	U, R	Rs	Y
<i>Lonchura malacca</i>	Tricoloured Munia	76	1.871	FC	LC	G	U, R	Rs	Su, Ri
<i>Lonchura striata</i>	White-rumped Munia	55	1.354	VC	LC	GL	U, R	Rs	W
<i>Hirundo rustica</i>	Barn Swallow	43	1.059	FC	LC	T	U, R	WV	W
<i>Lanius cristatus</i>	Brown Shrike	7	0.172	FC	LC	T	U	WV	W
<i>Lanius schach</i>	Long-tailed Shrike	29	0.714	VC	LC	GL, T, US	U, R	Rs	W
<i>Lanius tephronotus</i>	Grey-backed Shrike	3	0.073	F	LC	T	R	R	W
<i>Hypothymis azurea</i>	Black-naped Monarch	2	0.049	F	LC	T	U	R	Ri
<i>Terpsiphone paradisi</i>	Paradise flycatcher	13	0.3202	FC	LC	T	U, R	Rs	Su, Ri
<i>Anthus rufulus</i>	Paddy field Pipit	26	0.640	VC	LC	GL, T	U, R	Rs	Y
<i>Motacilla alba</i>	White Wagtail	22	0.541	FC	LC	WB	U, R	WV	W
<i>Motacilla cinerea</i>	Grey Wagtail	22	0.541	FC	LC	WB	U, R	WV	W
<i>Motacilla citreola</i>	Citrine Wagtail	1	0.024	F	LC	WB	R	WV	W
<i>Motacilla flava</i>	Yellow Wagtail	1	0.024	F	LC	WB	U	WV	W
<i>Motacilla madaraspatensis</i>	White-browed Wagtail	4	0.098	F	LC	WB	U	R	W
<i>Copsychus saularis</i>	Oriental Magpie-robin	53	1.305	VC	LC	T, G, GL	U, R	Rs	Y
<i>Cyornis rubeculoides</i>	Blue-throated Blue Flycatcher	6	0.147	FC	LC	T	U, R	WV	W
<i>Ficedula albicilla</i>	Taiga Flycatcher	2	0.049	F	LC	T	U	WV	W
<i>Luscinia svecica</i>	Bluethroat	15	0.369	C	LC	GL	R	WV	W, Su
<i>Saxicola leucurus</i>	White-tailed Stonechat	15	0.369	FC	LC	GL	U, R	Rs	W

Scientific Name	English Name	N	RA	OS	IUCN BD Status	Micro Habitat	Site	Status	Season
<i>Saxicola torquatus</i>	Common Stonechat	4	0.098	F	LC	GL	U	WV	w
<i>Nectarinia asiatica</i>	Purple Sunbird	10	0.246	FC	LC	T	U, R	Rs	W
<i>Nectarinia zeylonica</i>	Purple-rumped Sunbird	3	0.073	F	LC	T	R	R	W
<i>Oriolus chinensis</i>	Black-naped Oriole	1	0.024	F	LC	T	U	WV	W
<i>Oriolus oriolus</i>	Eurasian Golden Oriole	8	0.197	FC	LC	T	R	R	Su, Ri
<i>Oriolus xanthornus</i>	Black-hooded Oriole	28	0.689	VC	LC	T	U, R	Rs	Y
<i>Passer domesticus</i>	House Sparrow	171	4.211	VC	LC	G, T, WB	U, R	Rs	Y
<i>Ploceus benghalensis</i>	Black-breasted Weaver	6	0.147	F	LC	G	R	R	Su
<i>Ploceus philippinus</i>	Baya Weaver	38	0.935	FC	LC	T	U, R	Rs	Su
<i>Pycnonotus cafer</i>	Red-vented Bulbul	149	3.669	VC	LC	T, G, GL	U, R	Rs	Y
<i>Acridotheres fuscus</i>	Jungle Myna	146	3.596	VC	LC	G, T	U, R	R	Y
<i>Acridotheres ginginianus</i>	Bank Myna	23	0.566	FC	LC	WB, T	U, R	Rs	Su, Ri
<i>Acridotheres tristis</i>	Common Myna	234	5.763	VC	LC	G, T	U, R	Rs	Y
<i>Sturnus contra</i>	Asian Pied Starling	122	3.004	VC	LC	G, T	U, R	Rs	W
<i>Sturnus malabaricus</i>	Chestnut-tailed Starling	85	2.093	VC	LC	T	U, R	Rs	W
<i>Acrocephalus agricola</i>	Paddy field Warbler	1	0.024	F	LC	T	R	R	W
<i>Acrocephalus dumetorum</i>	Blyth's Reed-warbler	1	0.024	F	LC	GL	R	WV	W
<i>Megalurus palustris</i>	Striated Grassbird	33	0.812	FC	LC	GL, T	U, R	Rs	Ri
<i>Orthotomus satorius</i>	Common Tailorbird	76	1.871	VC	LC	T	U, R	Rs	Y
<i>Malacocincla abbotti</i>	Abbott's Babbler	4	0.098	FC	LC	T	U, R	Rs	Ri
<i>Turdoides earlei</i>	Striated Babbler	2	0.049	F	LC	GL	R	R	Su
<i>Turdoides striata</i>	Jungle Babbler	62	1.527	VC	LC	G, T	U	R	Y
<i>Zoothera citrina</i>	Orange-headed Thrush	7	0.172	FC	LC	G	U, R	Rs	Su
<i>Zoothera dauma</i>	Eurasian Scaly Thrush	6	0.147	F	LC	G	R	WV	w
<i>Zosterops palpebrosus</i>	Oriental White-eye	20	0.492	FC	LC	T	U, R	Rs	W
<i>Ardea alba</i>	Great Egret	8	0.197	FC	LC	WB, G	U, R	Rs	Ri, W
<i>Ardea intermedia</i>	Intermediate Egret	17	0.418	C	LC	WB, G	U, R	Rs	W
<i>Ardeola grayii</i>	Indian Pond Heron	95	2.339	VC	LC	WB, T, GL	U, R	Rs	W
<i>Bubulcus ibis</i>	Cattle Egret	79	1.945	VC	LC	GL, WB, G	U, R	Rs	W
<i>Egretta garzetta</i>	Little Egret	115	2.832	VC	LC	WB, G	U, R	Rs	Y
<i>Ixobrychus cinnamomeus</i>	Cinnamon Bittern	7	0.172	FC	LC	WB, GL	U, R	Rs	Su
<i>Ixobrychus sinensis</i>	Yellow Bittern	4	0.098	FC	LC	WB, GL	U, R	Rs	Su

Scientific Name	English Name	N	RA	OS	IUCN BD Status	Micro Habitat	Site	Status	Season
<i>Nycticorax nycticorax</i>	Black-crowned Night Heron	2	0.049	F	LC	GL	R	R	Ri
<i>Psilopogon asiaticus</i>	Blue-throated Barbet	11	0.270	FC	LC	T	U, R	Rs	Su, Ri
<i>Psilopogon haemacephala</i>	Coppersmith Barbet	61	1.502	VC	LC	T	U, R	Rs	Y
<i>Psilopogon lineatus</i>	Lineated Barbet	29	0.714	VC	LC	T	U, R	Rs	Y
<i>Dendrocopos macei</i>	Fulvous-breasted Woodpecker	38	0.935	VC	LC	T	U, R	Rs	Y
<i>Dinopium benghalense</i>	Black-rumped Flameback	32	0.788	VC	LC	T	U, R	Rs	Y
<i>Jynx torquilla</i>	Eurasian Wryneck	3	0.073	F	LC	GL	U, R	WV	W
<i>Micropternus brachyurus</i>	Rufous Woodpecker	2	0.049	F	LC	T	R	R	Su
<i>Tachybaptus ruficollis</i>	Little Grebe	2	0.049	F	LC	WB	U	R	W
<i>Psittacula cyanocephala</i>	Plum-headed Parakeet	2	0.049	F	LC	T	R	R	Su
<i>Psittacula eupatria</i>	Alexandrine Parakeet	9	0.221	FC	LC	T	R	R	W, Su
<i>Psittacula krameri</i>	Rose-ringed Parakeet	52	1.280	VC	LC	T	U, R	Rs	Y
<i>Athene brama</i>	Spotted Owlet	2	0.049	F	LC	T	U	R	Ri
<i>Ketupa zeylonensis</i>	Brown Fish Owl	1	0.024	F	LC	T	R	R	Su
<i>Ninox scutulata</i>	Brown Boobook	1	0.024	F	LC	T	R	R	Ri
<i>Otus lettia</i>	Collared Scops Owl	5	0.123	FC	LC	T	U, R	Rs	Su
<i>Tyto alba</i>	Common Barn Owl	2	0.049	F	LC	US	U	R	W
<i>Microcarbo niger</i>	Little Cormorant	64	1.576	VC	LC	WB, GL, Flying	U, R	Rs	W
<i>Phalacrocorax carbo</i>	Great Cormorant	17	0.418	FC	LC	Flying, WB	U, R	WV	Ri, W

used habitat (n=2061, 50.76%) by the birds followed by water body 656 (16.16%) (Fig. 3B).

Seasonal variation showed that the highest number of individuals were recorded in winter 630 (40.15%) and in December 432 (10.64%) followed by November 423 (10.41%) and January 388 (9.56%) and the lowest number was observed in July 212 (5.22%) (Fig. 3C, Fig. 3D). We found many migratory birds during winter that contributed to the highest number of individuals in this season. We observed Common Myna as the most abundant species in the study area with 234 individuals (5.76%) (Table 1). We observed this species around the year both in the rural and the urban sites may be because of their scavenging behavior and high adaptive power in the modified habitats as previously reported (Lowe et al. 2011).

Diversity indices: We compared diversity indices in terms of sites, habitat, season, and month. We found the highest species diversity in the rural areas ($H = 4.225$, $D_s = 0.979$), in winter season ($H = 4.124$, $D_s = 0.980$) and in trees ($H =$

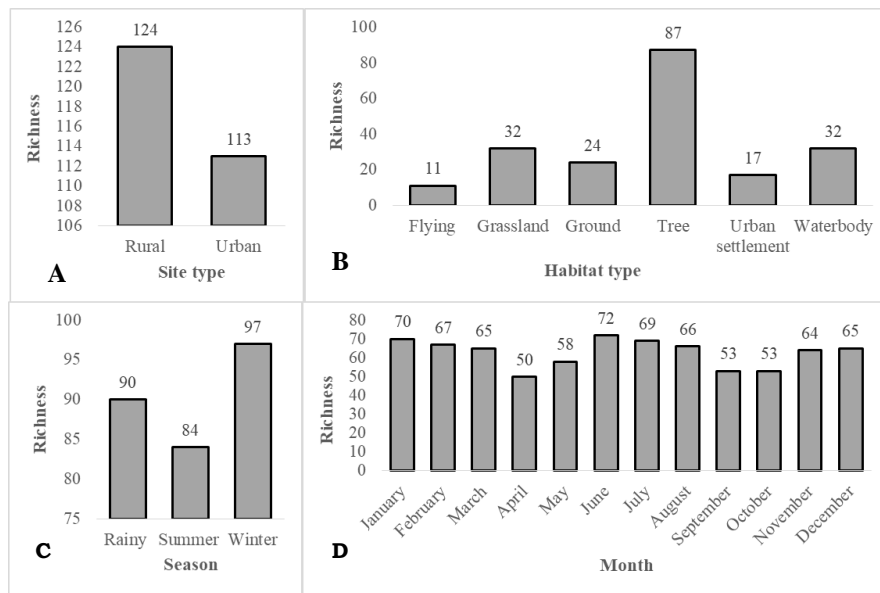


Fig. 2. Diversity of avifauna in different sites (A) habitats (B) seasons (C) and months (D).

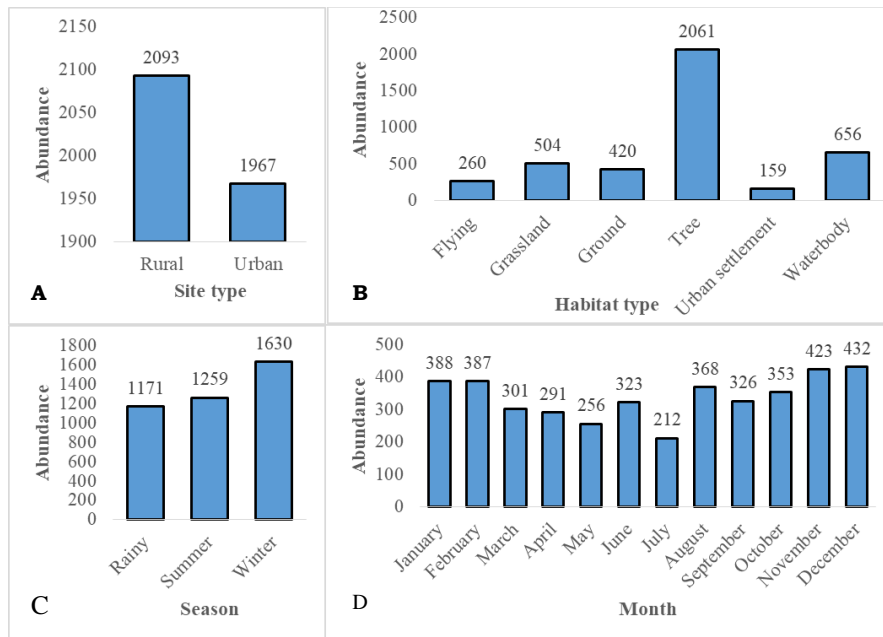


Fig. 3. Abundance of avifauna in different sites (A) habitats (B) seasons (C) and months (D).

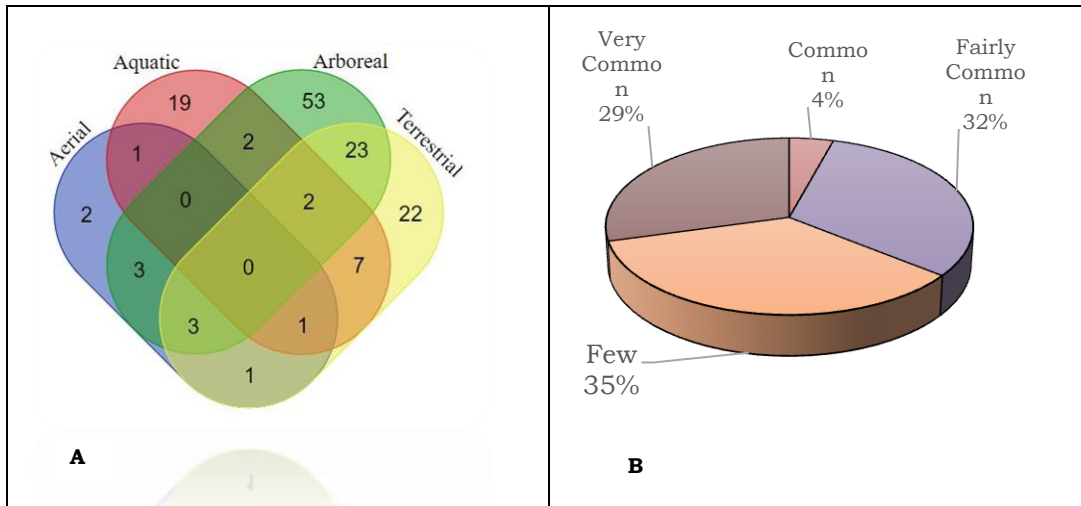


Fig. 4. (A) Habitat usage and (B) Relative abundance of birds.

3.783, $D_s = 0.967$) (Table 2). Tree supported the usage of more species probably due to the availability of native planted trees in the homestead forests that can provide shelter, food, roosting and nesting facilities for birds. We found the highest species diversity in July, because this is the post-breeding period of different groups of residents and migratory birds in the country (Khan 2018). Moreover, insect food items were available during the cultivation of crops, particularly in July that may attract insectivore birds to prey on them. We found the highest species evenness in the urban areas ($E = 0.878$), in the grounds ($E = 0.852$), in summer ($E = 0.908$), particularly in October ($E = 0.945$) (Table 2). We observed migratory birds visiting during winter in different water bodies of the study area while roosting and feeding. Among the 30 winter visitors, 24 were found in the rural sites and 20 in the urban sites (Table 2). Previous studies suggested that higher diversity of birds in winter probably due to the influx of migratory birds (Maheswaran and Rahmani 2001, Albores and Siguenza 2011) which correspond with our present study.

Habitat usage, relative abundance and threatened status: We recorded 22 terrestrial species, 53 arboreal, 19 aquatic, and 2 aerial from the study area. The other species repeatedly changed their habitat and the number of overlapping habitats has been shown in figure 4A. Little Cormorant was observed using

aerial, aquatic, and terrestrial habitats; Black Kite, Blue Rock Pigeon, Eastern Spotted

Table 2. Diversity indices in terms of sites, habitats, months and seasons

Site wise Diversity	Site type	Shannon-Weiner Index (H)	Evenness (E)	Simpson's Index (D_s)
	Rural	4.225	0.876	0.979
	Urban	4.150	0.878	0.978
Habitat Diversity	Habitat type	Shannon-Weiner Index (H)	Evenness (E)	Simpson's Index (D_s)
	Flying	1.546	0.645	0.688
	Grassland	2.902	0.837	0.930
	Ground	2.707	0.852	0.918
	Tree	3.783	0.847	0.967
	Urban settlement	2.170	0.766	0.843
	Waterbody	2.945	0.850	0.933
Monthly Diversity	Month	Shannon-Weiner Index (H)	Evenness (E)	Simpson's Index (D_s)
	January	3.802	0.895	0.968
	February	3.772	0.897	0.971
	March	3.727	0.893	0.966
	April	3.467	0.886	0.962
	May	3.767	0.928	0.971
	June	3.862	0.903	0.973
	July	3.882	0.917	0.976
	August	3.752	0.896	0.969
	September	3.560	0.897	0.967
	October	3.752	0.945	0.971
	November	3.649	0.877	0.972
	December	3.812	0.913	0.975
Seasonal Diversity	Season	Shannon-Weiner Index (H)	Evenness (E)	Simpson's Index (D_s)
	Rainy	4.023	0.894	0.976
	Summer	4.021	0.908	0.978
	Winter	4.124	0.902	0.980

Dove used aerial, arboreal, and terrestrial habitats. Bank Myna, White-breasted Waterhen preferred aquatic and arboreal habitats (Fig 4A). According to the

IUCN Bangladesh (2015), different groups of birds use different types of habitats such as aquatic birds forage and feed in the floodplains, riversides, and ponds whereas terrestrial birds forage on the grounds and trees as well as in the air. Some birds switch their habitats frequently in order to get a more suitable habitat for feeding, breeding, and roosting purposes. Relative abundance is the highest for Common Myna, *Acridotheres tristis* (5.763). The observation status of the species showed that 41 (29%) species were very common, 6 (4%) common, 44 (32%) fairly common, and 49 (35%) few (Fig 4B). According to the IUCN Bangladesh (2015), all recorded birds in this study are categorized as the least concern except Indian Spotted Eagle, *Clanga hastate* which is an endangered species in Bangladesh (Table 1).

CONCLUSION

Our study showed that the urban and the rural sites of Magura Sadar upazila shared almost similar habitats where the least developmental activities and slow urbanization occurs. Probably these habitats are suitable for more species diversity of birds as it has fewer disturbances and predators. Proper management system, conservation awareness among local people, and protection of habitats might help increase avian diversity in the study area. Therefore, we suggest a comprehensive study on birds to understand which factors influencing rich avifauna in this area.

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