



## Diversity, composition and conservation status of avian fauna in the forest and the wetland sites of Hastinapur wildlife sanctuary, India

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ARTICLE INFO	ABSTRACT
<p>Received : 28 January 2023                      Revised : 13 April 2023                      Accepted : 29 April 2023</p> <p>Available online: 10 May 2023</p> <p><b>Key Words:</b>                      Avian fauna                      Conservation                      Diversity                      Evenness                      Hastinapur wildlife sanctuary                      Species Composition</p>	<p><b>Almost, in all flora and fauna, the species richness is affected by environmental changes; hence it is important to survey regularly to understand the current composition and diversity of different wildlife species in an ecosystem. The present study surveyed to assess the species distribution, conservation status, abundance and diversity of birds using the point count method, at two different habitats, a wetland (Bhikund Jheel; BJ) and a forest (Arjun Van; AV) in Hastinapur wildlife sanctuary, India. We surveyed early in the morning (before and after sunrise) and evening (before sunset) for 20 min at every point from January 2019 to April 2019. A total of 96 bird species were recorded, which belong to the 40 families and 15 orders. Out of 96 species, we recorded 67 resident bird species and 29 migratory bird species. The number of bird species specific to the type of habitat was higher in Bhikund Jheel than those in Arjun Van. The species richness and abundance were higher in the wetland (81; 5605) than in the forest habitat (45; 1716); however, evenness (J') and diversity [Shannon-Weiner (H') and Simpson diversity (D)] indices were higher in the forest habitat (J': 0.827, H': 3.420, D: 0.960) than in the wetland habitat (J': 0.669, H': 2.940, D: 0.827). Overall, we found that in the wetland habitats had more species richness than in the forests.</b></p>

### Introduction

The three sides of water and the range of mountains on another side around the Indian subcontinent make it different from any other subcontinent. Variations in geographical and climatic conditions are responsible for different types of ecosystems which lead the establishment of distinguished flora and fauna as mega biodiversity in the subcontinent. Birds are worldwide distributed because they have varied anatomical and ecological adaptations (O'Connor *et al.*, 2011). Indian avian diversity is very varied and contains approximately 13% (1200-1300) species of birds out of the 9600 according to the new classification (Ali *et al.*, 1987; Grimmett *et al.*, 1999; Javed and Kaul, 2000). Out of total of 75 families of birds, 48 families are found in the Indian subcontinent. Avian diversity acts as an

important ecological indicator to assess the quality of habitats since their habitat is roughly divided into forests, scrubs and wetlands and also the mixed type of habitat for many species to sustain their requirement (Blair, 1999). Avifauna is not similar in the each side of Himalayas as the survey showed that 4/5 parts of the bird species of the Indian subcontinent were found in the eastern Himalayan region which was twice as than the western Himalayas (Price *et al.*, 2003) and this region is the most diverse in the world (Stattersfield *et al.*, 1998). In Asia, Indian Himalayas are particularly important as a large number of threatened avian species are found in this part of the Oriental region (Acharya and Vijayan, 2010). Being a natural predator of insects and rodents, bird diversity helps

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mankind by acting as a bio-pest controlling agent, via reducing the use of chemical pesticides. Therefore, birds are not only important for preserving ecological balance but also useful for economic importance (Simeone *et al.*, 2002). Based on different habitats, anatomical differences in body colours, beak shape, and feet structures are found when we compare water birds and land inhabiting birds. Avian population and diversity at a particular time and area is a bio-indicator and helpful model for reviewing a range of environmental problems (Urfi *et al.*, 2005). In the Indian subcontinent, approximately 310 were wetland bird species out of more than 1200 species of bird and some of these were migrants (Kumar, 2005). Being ecologically important with high nutritional value and productivity, wetlands support good diversity of birds (Paracuellos, 2006; Gibbs, 1993). The presence of numerous water bodies provides food and shelter to birds, therefore Hastinapur wildlife sanctuary is one of the important habitats for native as well as migratory birds. Many studies have shown that the abundance of various bird species is decreasing in human-inhabited parts of the world, and it is of great concern because of urbanization and increasing population (Emlen, 1974; Donaldson *et al.*, 2007). Anthropogenic activities and expanding global urbanization, subsequently, have reduced avifaunal diversity. To understand the urban biodiversity bird surveys are required (McDonnell *et al.*, 2009; Marzluff *et al.*, 2008) and such studies are also helpful for human well-being (Fuller *et al.*, 2007) as well are an important indicator of change in environmental conditions (Dearborn and Kark, 2010). Hence, the regular evaluation of avifauna in a particular area helps to understand the abundance of birds and the variety of other organisms (Turner, 2003). According to Gregory *et al.*, 2003, birds are conspicuous elements and biological indicators of diversity for monitoring the health of an ecosystem. A well-designed bird survey can directly or indirectly provide a clear view about inhabiting organisms, their biological associations, and can also serve as a biological monitoring agent to understand the how organisms adapt with changing environmental conditions. The aim of this study is to investigate the diversity, abundance and

distribution of bird species, in two different habitats of the Hastinapur wildlife sanctuary.

## Material and Methods

### Study area

Hastinapur wildlife sanctuary covers a 2073 km<sup>2</sup> area (between 28°46'– 29°35'N and 77°30'– 78°30'E) of the upper Gangetic plain in the northwest region of Uttar Pradesh and represents the Gangetic grassland biome in biogeographic classification (Rodgers & Panwar, 1998). According to previous studies 83% area of the sanctuary was used for cultivation and presence of the township resulted in noticeable anthropogenic disturbance (Khan, 2010; Agarwal, 2009; Khan *et al.*, 2003). According to Khan *et al.*, 2003; the vegetated area (17%) of Hastinapur wildlife sanctuary comprised of tall wet grasslands (35.3%), short wet grasslands (23.5%), dry scrub grasslands (29.4%) and plantations (11.8%). We selected two major distinguishable habitats of the Hastinapur wildlife sanctuary.

**a): Forest (Arjun Van):** Arjun Van is located beside the middle Ganga canal (29°15'N and 77°09'E) and is densely vegetated with shrubs and trees. Major cultivators of this area include sugarcane, wheat in winters, and rice in summers.

**b): Wetland (Bhikund Jheel):** Characterized with low vegetation, Bhikund Jheel is located near river Ganga (29°17'N and 78°03'E) and have similar agricultural cultivars as of Arjun Van.

### Timing of the survey

The study was conducted in January 2019 to April 2019 at Hastinapur Wildlife Sanctuary, Uttar Pradesh. The periodic observation was done twice daily: morning hours (before and after sunrise) and evening hours (before sunset). Each point is chosen randomly and separate from the others with at least 250m in both the habitats of the sanctuary. In terrestrial habitats, bird species were recorded for the time duration of 20 minutes within a close circle of a 30m radius while for wetland habitats open radius circular plots were laid for the equal time. With the help of binoculars (Olympus: 8-16X40 Zoom DPS I, UV protective) eye observations were made to record the avian biodiversity. A digital camera (Sony cyber-shot (DSC-HX 100V; 16.2 megapixels with 30x optical zoom; full HD movie)) was used for photography. The identification of birds was done using a field

guide “A pictorial guide to the birds of the Indian subcontinent” (Grimmett and Inskipp, 2018; Ali *et al.*, 1987; Kumar, 2005).

**Data analysis**

Data were arranged to obtain the following parameters:

1) The relative abundance of bird species per habitat was determined using the:

$$\text{Relative abundance} = n/N$$

Where N is the total number of birds of all species and n represents the total number of birds of a particular species.

2) Diversity of bird species: The richness of species is the number of different species present in an area. Species richness was estimated for each habitat by:

a. Shannon-Weiner index (H’): Based on previous studies, Shannon-Weiner formula ( $H' = -\sum Pi * LN(Pi)$ ) was used to calculate species diversity based on species abundance (Hutcheson, 1970).

Where H’ is the Diversity Index, LN (Pi) is the natural logarithm of this proportion and Pi is the proportion of each species in the sample.

b. Evenness: to compare the similarity of the population size of each bird species, Evenness Index (J’) was calculated according to Kiros *et al.*, (2018); using the ratio of observed diversity to maximum diversity ( $J' = H'/Hmax$ ). Where H’ is the Shannon Wiener Diversity index and Hmax is the natural log of the total number of species.

c. Simpson Index (D): It measures the probability of any two individuals drawn from a noticeably large community belonging to different species (Simpson, 1949). It was calculated by the following formula:  $D = 1 - \sum n(n-1)/N(N-1)$ .

Where N is the total number of birds of all species and n is the total number of birds of a particular species.

**Results and Discussion**

**Composition**

A varied structure of the bird community was recorded at Hastinapur wildlife sanctuary. Table 1 shows the checklist of all bird species recorded in

two different areas (AV: Arjun Van and BJ: Bhikund Jheel) during the period January 2019 to April 2019. Out of 96 recorded bird species of 40 distinguished families and 15 orders, 29 and 67 bird species were migratory and residential species respectively. Passeriformes order was represented by 11 families including 26 species of which five were migratory and 21 were residents (Figure 1). Six families including 15 species, eight migratory, and seven residents were from Order Charadriiformes. Bird species of the only single family were recorded from seven orders, namely: Podicipediformes, Anseriformes, Galliformes, Columbiformes, Psittaciformes, Cuculiformes, and Strigiformes (Figure 1). Anatidae family with 12 species recorded as the highest number of species of a particular family. According to the IUCN Red List of Threatened Species (Table 1) among recorded avian species 87 species were Least Concern; five and four species were Near Threatened and Vulnerable categories, respectively. During the investigation, we recorded 56 water bird species, 26 migratory species, and 30 resident’s species. Throughout the study, 81 bird species were recorded from the BJ area and 45 from the AV area. 30 species were common as they were present in both AV and BJ areas (Table 1).

Figure 1

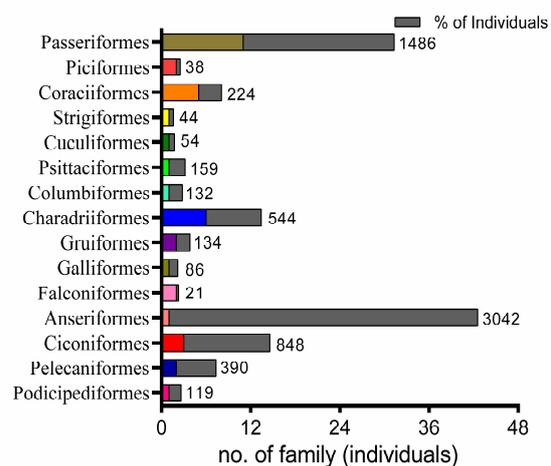


Figure 1: Colour bar diagram represents the number of families in a particular order and black bar represents the percentage of recorded individuals in Hastinapur Wildlife sanctuary, India. The total numbers of individuals are mentioned for each order

**Table 1: Composition and status of avifauna recorded from the two habitats of Hastinapur Wildlife Sanctuary**

Order	Family	Common name	Scientific name	Status	IUCN status	BJ	AV
PODICIPEDIFORMES	Podicipedidae	Little Grebe	<i>Tachybaptus ruficollis</i>	R	LC	+	-
PELECANIFORMES	Phalacrocoracidae	Little Cormorant	<i>Phalacrocorax niger</i>	R	LC	+	-
"	"	Indian Shag	<i>Phalacrocorax fuscicollis</i>	M	LC	+	-
"	"	Great Cormorant	<i>Phalacrocorax carbo</i>	M	LC	+	-
"	Anhingidae	Darter	<i>Anhinga melanogaster</i>	R	NT	+	-
CICONIFORMES	Ardeidae	Little Egret	<i>Egretta garzetta</i>	R	LC	+	+
"	"	Median Egret	<i>Mesophoyx intermedia</i>	R	LC	+	-
"	"	Large Egret	<i>Casmerodius albus</i>	R	LC	+	-
"	"	Cattle Egret	<i>Bubulcus ibis</i>	R	LC	+	-
"	"	Grey Heron	<i>Ardea cinerea</i>	R	LC	+	-
"	"	Purple Heron	<i>Ardea purpurea</i>	R	LC	+	-
"	"	Indian Pond-Heron	<i>Ardeola grayii</i>	R	LC	+	+
"	"	Black-crowned Night-Heron	<i>Nycticorax nycticorax</i>	R	LC	+	-
"	Ciconiidae	Painted Stork	<i>Mycteria leucocephala</i>	R	NT	+	-
"	"	Asian Openbill-Stork	<i>Anastomus oscitans</i>	R	LC	+	-
"	"	Black Stork	<i>Ciconia nigra</i>	M	LC	+	-
"	"	White-necked Stork	<i>Ciconia episcopus</i>	R	VU	+	-
"	Threskiornithidae	Oriental White Ibis	<i>Threskiornis melanocephalus</i>	R	NT	+	-
"	"	Black Ibis	<i>Pseudibis papillosa</i>	M	LC	+	-
"	"	Eurasian Spoonbill	<i>Platalea leucorodia</i>	R	LC	+	-
ANSERIFORMES	Anatidae	Lesser Whistling-Duck	<i>Dendrocygna javanica</i>	M	LC	+	-
"	"	Greylag Goose	<i>Anser anser</i>	M	LC	+	-
"	"	Bar-headed Goose	<i>Anser indicus</i>	M	LC	+	-
"	"	BrahminyShelduck	<i>Tadorna ferruginea</i>	M	LC	+	-
"	"	Cotton Teal	<i>Nettapus coromandelianus</i>	M	LC	+	-
"	"	Gadwall	<i>Anas strepera</i>	M	LC	+	-
"	"	Eurasian Wigeon	<i>Anas penelope</i>	M	LC	+	-
"	"	Northern Shoveller	<i>Anas clypeata</i>	M	LC	+	-
"	"	Northern Pintail	<i>Anas acuta</i>	M	LC	+	-
"	"	Common Teal	<i>Anas crecca</i>	M	LC	+	-
"	"	Common Pochard	<i>Aythya ferina</i>	M	VU	+	-

"	"	Red-crested Pochard	<i>Rhodonessa rufina</i>	M	LC	+	-
FALCONIFORMES	Accipitridae	Black Kite	<i>Milvus migrans</i>	R	LC	-	+
"	"	Shikra	<i>Accipiter badius</i>	R	LC	+	+
"	Falconidae	Laggar	<i>Falco jugger</i>	R	NT	-	+
GALLIFORMES	Phasianidae	Indian Peafowl	<i>Pavo cristatus</i>	R	LC	+	+
GRUIFORMES	Gruidae	Sarus Crane	<i>Grus antigone</i>	R	VU	+	-
"	Rallidae	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	R	LC	+	-
"	"	Common Moorhen	<i>Gallinula chloropus</i>	R	LC	+	-
"	"	Common Coot	<i>Fulica atra</i>	R	LC	+	-
CHARADRIIFORMES	Jacaniidae	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i>	R	LC	+	-
"	"	Bronze-winged Jacana	<i>Metopidius indicus</i>	R	LC	+	-
"	Charadriidae	Little Ringed Plover	<i>Charadrius dubius</i>	R	LC	+	-
"	"	River Lapwing	<i>Vanellus duvaucelii</i>	R	NT	+	-
"	"	Red-wattled Lapwing	<i>Vanellus indicus</i>	R	LC	+	+
"	"	White-tailed Lapwing	<i>Vanellus leucurus</i>	M	LC	+	-
"	Scolopacidae	Spotted Redshank	<i>Tringa erythropus</i>	M	LC	+	-
"	"	Common Redshank	<i>Tringa totanus</i>	M	LC	+	-
"	"	Common Greenshank	<i>Tringa nebularia</i>	M	LC	+	-
"	"	Green Sandpiper	<i>Tringa ochropus</i>	M	LC	+	-
"	"	Common Sandpiper	<i>Actitis hypoleucos</i>	M	LC	+	-
"	Recurvirostridae	Black-winged Stilt	<i>Himantopus himantopus</i>	M	LC	+	-
"	Glareolidae	Small Pratincole	<i>Glareo lalactea</i>	R	LC	+	+
"	Laridae	Pallas's Gull	<i>Larus ichthyaetus</i>	M	LC	+	-
"	"	River Tern	<i>Sterna aurantia</i>	R	VU	+	-
COLUMBIFORMES	Columbidae	Blue Rock Pigeon	<i>Columba livia</i>	R	LC	+	+
"	"	Eurasian Collared-Dove	<i>Streptopelia decaocto</i>	R	LC	+	+
"	"	Yellow-legged Green-Pigeon	<i>Treron phoenicoptera</i>	R	LC	-	+
PSITTACIFORMES	Psittacidae	Rose-ringed Parakeet	<i>Psittacula krameri</i>	R	LC	+	+
CUCULIFORMES	Cuculidae	Asian Koel	<i>Eudynamys scolopacea</i>	R	LC	-	+
"	"	Greater Coucal	<i>Centropus sinensis</i>	R	LC	-	+
STRIGIFORMES	Strigidae	Spotted Owlet	<i>Athene brama</i>	R	LC	+	+
CORACIIFORMES	Alcedinidae	White-breasted Kingfisher	<i>Halcyon smyrnensis</i>	R	LC	+	+
"	"	Lesser Pied Kingfisher	<i>Ceryle rudis</i>	R	LC	+	-
"	Meropidae	Small Bee-eater	<i>Merops orientalis</i>	R	LC	-	+
"	Coraciidae	Indian Roller	<i>Coracias benghalensis</i>	R	LC	+	+

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"	Upupidae	Common Hoopoe	<i>Upupa epops</i>	R	LC	+	+
"	Bucerotidae	Indian Grey Hornbill	<i>Ocyrceros birostris</i>	R	LC	-	+
PICIFORMES	Capitonidae	Brown-headed Barbet	<i>Megalaima zeylanica</i>	R	LC	-	+
"	Picidae	Yellow-fronted Pied Woodpecker	<i>Dendrocopos mahrattensis</i>	R	LC	-	+
PASSERIFORMES	Alaudidae	Ashy-crowned Sparrow Lark	<i>Eremopterix grisea</i>	R	LC	+	+
"	Hirundinidae	Common Swallow	<i>Hirundo rustica</i>	M	LC	+	-
"	Motacillidae	White Wagtail	<i>Motacilla alba</i>	M	LC	+	+
"	"	Large Pied Wagtail	<i>Motacilla maderaspatensis</i>	R	LC	+	+
"	"	Citrine Wagtail	<i>Motacilla citreola</i>	M	LC	+	-
"	"	Paddyfield Pipit	<i>Anthus rufulus</i>	R	LC	+	+
"	Campephagidae	Small Minivet	<i>Pericrocotus cinnamomeus</i>	R	LC	-	+
"	Pycnonotidae	Red-vented Bulbul	<i>Pycnonotus cafer</i>	R	LC	+	+
"	Muscicapidae	Bluethroat	<i>Luscinias vecica</i>	M	LC	-	+
"	"	Indian Robin	<i>Saxicoloides fulicata</i>	R	LC	+	+
"	"	Pied Bushchat	<i>Saxicola caprata</i>	R	LC	+	+
"	"	Common Stonechat	<i>Saxicola torquata</i>	M	LC	+	-
"	"	Indian Chat	<i>Cercomela fusca</i>	R	LC	+	+
"	"	Common Babbler	<i>Turdoides caudatus</i>	R	LC	+	+
"	"	Large Grey Babbler	<i>Turdoides malcolmi</i>	R	LC	-	+
"	"	Jungle babbler	<i>Turdoides striatus</i>	R	LC	+	+
"	Nectariniidae	Purple Sunbird	<i>Nectarinia asiatica</i>	R	LC	-	+
"	Passeridae	House Sparrow	<i>Passer domesticus</i>	R	LC	+	+
"	"	Baya Weaver	<i>Ploceus philippinus</i>	R	LC	-	+
"	Sturnidae	Asian Pied Starling	<i>Sturnus contra</i>	R	LC	+	+
"	"	Common Myna	<i>Acridotheres tristis</i>	R	LC	+	+
"	"	Bank Myna	<i>Acridotheres ginginianus</i>	R	LC	+	+
"	Dicruridae	Black Drongo	<i>Dicrurus macrocercus</i>	R	LC	+	+
"	Corvidae	Rufous Treepie	<i>Dendrocitta vagabunda</i>	R	LC	-	+
"	"	House Crow	<i>Corvus splendens</i>	R	LC	+	+
"	"	Jungle Crow	<i>Corvus macrorhynchos</i>	R	LC	+	+

AV- Arjun Van (forest habitat), BJ- Bhikund Jheel (wetland habitat); Status: M- Migratory, R- Resident; IUCN Status: NT- Near Threatened, VU- Vulnerable, LC- Least Concern; Sign (+) shows the presence of species, Sign (-) shows the absence of species; Bold common name = Waterbird.

### Diversity indices for the total number of birds in two different habitats

Table 2 showed the diversity index, BJ had a greater number of birds (5605) and species richness ( $r = 81$ ) than AV (1716,  $r = 45$ ). In contrast, evenness ( $J'$ ), Shannon-Weiner diversity ( $H'$ ), and Simpson's index of Diversity ( $D$ ) were higher in AV ( $J' = 0.90$ ), ( $H' = 3.42$ ), and ( $D = 0.96$ ) than in BJ ( $J' = 0.67$ ), ( $H' = 2.94$ ), and ( $D = 0.83$ ).

**Table 2: Diversity indices of birds at Hastinapur Wildlife Sanctuary**

Diversity index	Arjun van	Bhikundjheel
Overall abundance	1716	5605
Species richness	45	81
Evenness ( $J'$ )	0.898	0.669
Shannon-Weiner ( $H'$ )	3.420	2.940
Simpson diversity ( $D$ )	0.960	0.827

### Relative abundance of bird species

Supplementary Information Table 1 (SI Table 1) represented the bird species numbers for both habitats. In the BJ, species were recorded in descending order as follows: Bar-headed Goose, Brahminy Shelduck, Cattle Egret, and Gadwall and their numbers were the highest as follows: 2258, 278, 214, and 206 individuals, respectively. Their relative abundance was 0.403, 0.050, 0.038, and 0.037, respectively. In the AV, the species were recorded in descending order as follows: Rose-ringed Parakeet, Jungle Babbler, Common Myna, Asian Pied Starling, and Small Bee-eater (124, 118, 115, 97, and 92 individuals recorded, and their relative abundance was 0.072, 0.069, 0.067, 0.057 and 0.054, respectively. A timely bird survey is important for the health of an ecosystem. Richness of species indicates variability for the survival of various types of species while evenness of species indicates that a particular species survives in that ecosystem or environment. We found that wetland has more richness of the species of birds while the Arjun Van area (forest) has less species richness since the water of river Ganga throughout the year provides different types of habitats and opportunity to support this sanctuary to develop and maintain different types of ecosystems. Since India is an agriculture-dependent country, the use of Indo-Gangetic plains for food production has increased deforestation, extreme exploitation of natural resources, and pollution (Khan and Abbasi, 2015;

Khan *et al.*, 2013). This might be the reason for fewer species richness in the Arjun Van (forest). Also, bird species (migratory and resident) abundance and numbers were high in BJ; because of habitat suitability, which supports free running water and abundant food supply (insects, grasses, and aquatic fauna) as well as nesting and resting sites. On the other hand, the forest habitat has more evenness and diversity as compared to the wetland since the numbers of individuals per species were highly skewed in the wetland (BJ) (Table 2). The survey in the months of late winters or early summers showed migratory birds, especially Bar-headed Goose (2258 individuals, SI Table 1) which migrates from central Asia to India to overwinter (Hawkes *et al.*, 2011). However, the range of individuals was more even in forest habitats although less in number than in wetland areas. Almost 30 species were common between forest and wetland habitats which might be due to the amount and type of food resources available or the presence of water in the wetland area. A recent survey of the Hastinapur Wildlife sanctuary has shown that there is little to no protection of the habitats and encroachment has increased in the recent decade (Khan and Abbasi, 2015). Also, in the analysis of the social impact of conservation, it was found that the locals were mostly ignorant about the conservation and biodiversity status with around 25% of people admitting to having no idea about the trend in biodiversity in this sanctuary since the last decade (Khan and Abbasi, 2015). As evident from previous studies and conservation mechanisms that the action to sustain biodiversity and the progress of the local community in a viable way requires sharing of knowledge with the community and accurate use of natural resources since locals have a better understanding of the area and the bio-geographical and socio-economic aspects of their instant environment will be useful for designing a local policy for management and conservation of environment and its resources.

### Conclusion

The present study showed the variation in the distribution of bird species between two different habitats of Hastinapur Wildlife sanctuary. The composition, diversity, evenness, and richness were dependent on the area and the number of individuals present as AV showed more evenness

and diversity and BJ showed more numbers and richness. We also observed that BJ has more daily and seasonal human agricultural activities which disturb the birds. The anthropogenic activities and rapid urbanization (e.g. national highways passing near wetland areas) can be a potential reason for reduced avifaunal diversity by directly or indirectly causing habitat loss, noise pollution, and water pollution. More regular studies of these kinds will increase awareness and add to the conservation of biodiversity.

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## Conflict of interest

The authors declare that they have no conflict of interest.

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