

Assessment of winter migratory waterbirds diversity and distribution in Asan Conservation Reserve, Uttarakhand (Western Himalayas), India

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Abstract The current study presented information on waterbird diversity in the Asan Conservation Reserve (Western Himalayas), India. The waterbirds survey was conducted from October 2023 to April 2024 in and around the ACR, Dehradun, India. The findings revealed that 47 wetland bird species from 13 families and 8 orders have been observed during the study. Out of a total of 14 winter migrants (WM), 14 residents (R), 11 residents with local migrant (R/LM), 3 residents with influx and passage movement (R/WM/SM), 2 residents with altitudinal winter movement (R/AM/WM), one species is winter migrant with passive migration (WM/PM) and one species is resident with summer and winter movement (R/SM/WM) observed during the study. The Anatidae family has the most species (15) and the maximum relative diversity value (31.91). The result of Bird Species Diversity (BSD) showed that the value of BSD was highest (2.49) in December compared to other months. Similarly, the analysis of Bird Species Richness (BSR) showed that the maximum BSR was found in December (5.96) when compared to other months. The results showed that the Eurasian Coot was the most dominating species, accounting for 23.11% of overall abundance when compared to other species. A total of 23 omnivorous, 17 carnivorous, and 7 insectivorous species were recorded based on their feeding guilds. During the study period four threatened species were observed as per IUCN. Out of total three species such as River Lapwing, Painted Stork, and Ferruginous Duck were listed as Near Threatened (NT), one, Pallas's Fish-Eagle as Endangered (EN), and the remaining 43 as Least Concern (LC) in the IUCN Red data book.

Keywords: diversity, migration, threatened species, waterbirds, Western Himalayas

Összefoglalás A jelenlegi vizsgálat az indiai Asan Természetvédelmi Terület (Nyugat-Himalája – rövidítve ACR) vízimadaraik diverzitási mintázatait elemzi. A vízimadár-felmérések 2023 októbertől 2024 áprilisáig zajlottak a vizsgált területen. Eredményeink alapján nyolc madárrend 13 családjába tartozó 47 madárfajt regisztráltunk. Ezek közül 14 áttelelő (WM), 14 állandó illetve áttelelő faj (R/WM), 11 állandó vagy rövidtávon vonuló (R/LM); 3 állandó beáramlási és átvonulási mintázatokkal (R/WM/SM), 2 állandó faj, magassági vonulási és telelési mozgalmakkal (R/AM/WM), 1 téli vonuló és passzív vonuló (R/WM/SM), 1 állandó nyári és téli vonulási mozgalmakkal (R/SM/WM), valamint 1 állandó faj. A legnagyobb fajszámot (15) és legmagasabb relatív diverzitás indexet (31,91) az Anatidae család fajai alapján becsültük. A madarak fajdiverzitási indexe (BSD) decemberben volt a legmagasabb (BSD = 2,49). Hasonlóképpen, a madarak fajgazdagsági indexe (BSR) is decemberben volt a legmagasabb (BSD = 5,96). A felmérések alapján a szárcsa volt a legmagasabb dominanciájú faj, amely a teljes abundancia 23,11%-át képviselte az összes faj közül. A táplálkozási guildákat tekintve, a regisztrált fajok közül 23 mindenevő, 17 ragadozó és 7 rovarévo volt. A vizsgálat időtartama alatt négy fajt figyeltünk meg, amely az IUCN besorolása alapján veszélyeztetettnek minősül. Három faj esett a Mérsékelt Fenyégetett (NT: folyami bibic, hindu gólya, cigányréce), egy a Veszélyeztetett (EN: szalagos sas), 43 a Nem Fenyégetett (LC) kategóriába.

Kulcsszavak: diverzitás, vonulás, veszélyeztetett faj, vízimadár, Nyugat-Himalája

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Introduction

Wetlands, both natural and artificial, host a variety of resident and migrant water-dependent birds (Cowardin *et al.* 1979, Amezaga *et al.* 2002). The wetland zone occurs between the aquatic and terrestrial systems (Cowardin *et al.* 1979, Joshi *et al.* 2021), and wetland areas are among the most biologically diverse ecosystems on the globe (Bachheti *et al.* 2023). In India, wetlands account for around 5.16% of total geographical area (SAC 2011, Arya *et al.* 2020). Currently, these aquatic ecosystems have declined due to numerous human activity-related causes, so regular survey of wetland species of birds is essential to determine the health of the natural ecosystem. Water-dependent birds are an essential indication of the health of wetland ecosystems because they play critical roles in the global food web and nutrient cycles. According to reports, there has been a major drop in the population of wetland birds (Saikia & Bhattacharjee 1993, Wetlands (Conservation and Management) Rules 2017). The decline in migrating bird populations may be due to environmental changes and wetlands degradation, while the specific cause is unknown. Long-term research on the status of wetlands and migratory birds in Uttarakhand is quite low. According to reports, over-exploitation of resources, population growth, and fast industrialization have all contributed to the degradation of India's wetlands (Islam & Rahmani 2004). Several duck species in India are experiencing population declines (Islam & Rahmani 2004, Wetlands International 2006). Due to significant bird endemism, the western part of the Indian Himalayas has been designated an Endemic Bird Area (EBA 128), which includes 27 Important Bird Areas (IBAs) (Islam & Rahmani 2004). Out of 310 wetland-dependent avian species, 175 (56%) were found in Uttarakhand. The lower elevations of the northwestern Indian Himalayan Range (Dehradun, Haridwar, and Corbett Landscape) provide appropriate environments for both long and short-distance migratory bird species (Bhatt *et al.* 2015, Saini *et al.* 2017, Arya *et al.* 2019, Arya *et al.* 2021). Monitoring a bird species' abundance, habitat preference, and association with habitat quality can help identify factors causing population swings. Monitoring the distribution of a species population at the regional level is crucial for understanding the status of that species globally. This study focuses on the diversity and distribution of selected winter migratory bird species at the Asan Conservation Reserve (ACR), a critical habitat in northern India. By analyzing these patterns, we aim to understand the factors influencing bird migration and the conservation needs of these species.

Material and Methods

Study area

Asan Conservation Reserve (ACR) is in the Dehradun district of Uttarakhand, India (30°25'60'' N, 77°42'00'' E, 389.4 m asl. (*Figure 1*). It is located between the Asan and Yamuna rivers, creating a unique wetland ecosystem that supports a broad diversity of different species of animals and plants. The reserve covers an area of approximately 4.44 km² and it has been designated to be an Important Bird Area (IBA) and Ramsar Site due to its significance for

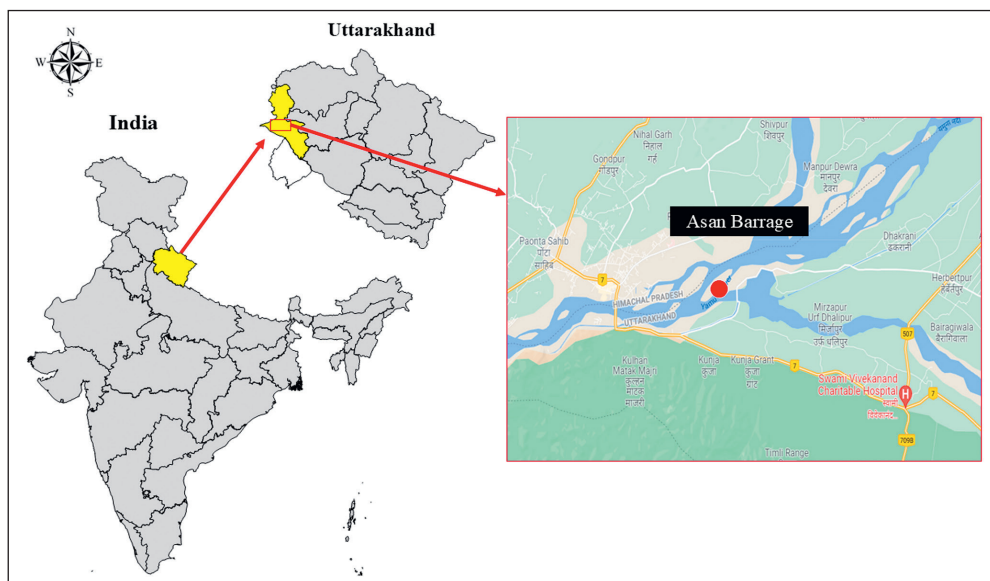


Figure 1. Map of study area (Source: Google Maps)

1. ábra A vizsgálati terület földrajzi elhelyezkedése

migratory birds. The ACR provides a variety of habitats, including open water, marshes, and mudflats, which are essential for different bird species. The wetland is particularly important during the winter months when it serves either stopover or wintering location for numerous avian migrant species. The reserve's strategic location along the Central Asian Flyway makes it a crucial site for monitoring migratory bird populations. The climatic conditions of the region are characterized by very low temperatures found in winter and pleasant time of summer, with the wetland receiving significant rainfall during the monsoon season.

Methodology

The waterbirds survey was conducted from October 2023 to April 2024 in and around the ACR, Dehradun, India. The number and abundance of avian species were recorded. Field survey was averted during the non-favorable climatic conditions such as rainy or foggy weather. Field trips were done during the morning session (10:00–13:00). The field equipment kit included Nikon 1050 prismatic field binoculars, a Nikon field scope ED 82 with 72 zooms, a tally counter and a Nikon P1000 camera for observation counts and pictures. Avian species identification was made through the field guides such as *The Book of Indian Birds* (Ali 1996), *Birds of the Indian Subcontinent* (Grimmett *et al.* 1998), *A Field Guide to the Birds of India* (Kazmierczak & Perlo, 2006), and *Handbook on Indian Wetland Birds* (Kumar *et al.* 2005). The point count method was adopted in the bird survey (Bibby *et al.* 2000). Data from the citizen science database (e-Bird) was also used for analysis. The checklist contains the Family, Common Name, Scientific Name (Praveen *et al.* 2021), and IUCN Status (IUCN 2022). The evaluation of the feeding guilds was made through the direct observation Ali (1996) and Grimmett *et al.* (1998).

Data analysis

Shannon's diversity index

The species diversity was calculated through the Shannon's diversity index H'

$$H' = H' = S * \sum P_i * \ln P_i$$

where: S = total no. of species in the sample

P_i = proportion of individuals belonging to a species

$\ln$ = natural logarithm

Relative abundance

The Relative abundance was calculated by the given formula

$$RA = n/N * 100$$

where:

n = the number of particular species

N = the total individuals detected for all species.

Species richness

Margalef's richness index (Mg) was used as a simple measure of species richness (Margalef 1963).

$$Mg = (S - 1) / \ln N$$

where:

S = total number of species

N = total number of individuals in the sample

$\ln$ = natural logarithm

Relative diversity (RDi)

The relative diversity value (RDi) was calculated by the formula of Torre-Cuadros *et al.* (2007). The formula is following:

$$RDi = \text{Number of species in a family} \div \text{Total number of species} * 100$$

The Microsoft Excel 2011 was used for the Data Analysis.

Results

During the study period, a total of 47 wetland bird species belonging to 13 families and 8 orders were observed. The species belonging to family Anatidae was dominantly found in the study area with the total number of 15 species followed by Scolopacidae (7), Laridae (5), Charadriidae, Motacillidae, Rallidae with three species, Ardeidae, Alcedinidae, Phalacrocoracidae, Podicipedidae with two species each and Accipitridae, Ciconiidae, Recurvirostridae with one species (*Table 1*). The RDi value indicated that Anatidae was the most dominated family with highest relative diversity value (31.91%) (*Table 2*).

The value of Bird Species Diversity (BSD) indicated that the maximum diversity was found in December (2.49) compared to other months. Similarly, the value of (BSR) was maximum in December (5.96) as compared to different months of the study (*Table 3*).

Table 1. A checklist of water-dependent birds observed during the study period
 1. táblázat A vizsgált periódusban megfigyelt madárfajok listája

Common name	Scientific name	IUCN status	Status	Feeding habit
Anseriformes: Anatidae				
Lesser Whistling-duck	<i>Dendrocygna javanica</i>	LC	R/LM	Omnivorous
Bar-headed Goose	<i>Anser indicus</i>	LC	R/WM	Omnivorous
Ruddy Shelduck	<i>Tadorna ferruginea</i>	LC	R/WM/PM	Omnivorous
Green-winged Teal	<i>Anas crecca</i>	LC	R/LM	Omnivorous
Gadwall	<i>Mareca strepera</i>	LC	WM	Omnivorous
Eurasian Wigeon	<i>Mareca strepera</i>	LC	WM	Omnivorous
Mallard	<i>Anas platyrhynchos</i>	LC	R/WM	Omnivorous
Northern Shoveler	<i>Spatula clypeata</i>	LC	WM	Omnivorous
Garganey	<i>Spatula querquedula</i>	LC	WM	Omnivorous
Red-crested Pochard	<i>Netta rufina</i>	LC	WM	Omnivorous
Common Pochard	<i>Aythya ferina</i>	LC	WM	Carnivorous
Ferruginous Duck	<i>Aythya nyroca</i>	NT	R/WM	Omnivorous
Tufted Duck	<i>Aythya fuligula</i>	LC	WM	Omnivorous
Knob-billed Duck	<i>Sarkidiornis melanotos</i>	LC	WM	Omnivorous
Northern Pintail	<i>Anas acuta</i>	LC	WM	Omnivorous
Phoenicopteriformes: Podicipedidae				
Little Grebe	<i>Tachybaptus ruficollis</i>	LC	R/LM	Carnivorous
Great Crested Grebe	<i>Podiceps cristatus</i>	LC	R/WM	Carnivorous
Pelecaniformes: Ciconiidae				
Painted Stork	<i>Mycteria leucocephala</i>	NT	R/LM	Carnivorous
Pelecaniformes: Ardeidae				
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	LC	R/LM	Omnivorous
Purple Heron	<i>Ardea purpurea</i>	LC	R/LM	Carnivorous
Pelecaniformes: Phalacrocoracidae				
Little Cormorant	<i>Microcarbo niger</i>	LC	R/LM	Carnivorous
Great Cormorant	<i>Phalacrocorax carbo</i>	LC	R/WM	Carnivorous
Gruiformes: Rallidae				
Eurasian Coot	<i>Fulica atra</i>	LC	R/WM	Omnivorous
Eurasian Moorhen	<i>Gallinula chloropus</i>	LC	R/WM	Omnivorous
Gray-headed Swamphen	<i>Porphyrio poliocephalus</i>	LC	R/LM	Carnivorous
Charadriiformes: Scolopacidae				
Common Redshank	<i>Tringa totanus</i>	LC	R/WM	Carnivorous
Common Greenshank	<i>Tringa nebularia</i>	LC	WM	Carnivorous
Wood Sandpiper	<i>Tringa glareola</i>	LC	WM	Carnivorous
Green Sandpiper	<i>Tringa ochropus</i>	LC	R/WM	Carnivorous

Common name	Scientific name	IUCN status	Status	Feeding habit
Common Sandpiper	<i>Actitis hypoleucos</i>	LC	R/WM	Insectivorous
Spotted Redshank	<i>Tringa erythropus</i>	LC	WM	Carnivorous
Temminck's Stint	<i>Calidris temminckii</i>	LC	WM	Insectivorous
Charadriiformes: Laridae				
Pallas's Gull	<i>Ichthyaeetus ichthyaeetus</i>	LC	WM	Omnivorous
Brown-headed Gull	<i>Chroicocephalus brunnicephalus</i>	LC	R/WM	Omnivorous
Black-headed Gull	<i>Chroicocephalus ridibundus</i>	LC	WM/PM	Omnivorous
Whiskered Tern	<i>Chlidonias hybridus</i>	LC	R/WM/PM	Omnivorous
River Tern	<i>Sterna aurantia</i>	LC	R	Omnivorous
Charadriiformes: Recurvirostridae				
Black-winged Stilt	<i>Himantopus himantopus</i>	LC	R/LM	Carnivorous
Charadriiformes: Charadriidae				
River Lapwing	<i>Vanellus duvaucelii</i>	NT	R/LM	Omnivorous
Little Ringed Plover	<i>Charadrius dubius</i>	LC	R/WM	Insectivorous
Kentish Plover	<i>Charadrius alexandrinus</i>	LC	R/WM	Insectivorous
Accipitriformes: Accipitridae				
Pallas's Fish-Eagle	<i>Haliaeetus leucoryphus</i>	EN	R/WM	Carnivorous
Coraciiformes: Alcedinidae				
Common Kingfisher	<i>Alcedo atthis</i>	LC	R/WM/SM	Carnivorous
White-throated Kingfisher	<i>Halcyon smyrnensis</i>	LC	R/LM	Carnivorous
Passeriformes: Motacillidae				
White Wagtail	<i>Motacilla alba</i>	LC	R/WM/PM	Insectivorous
Gray Wagtail	<i>Motacilla cinerea</i>	LC	R/AM/WM	Insectivorous
Citrine Wagtail	<i>Motacilla citreola Pallas</i>	LC	R/AM/WM	Insectivorous

R – Resident; **WM** – Winter migrant; **R/LM** – Resident with local migrant; **R/WM** – Resident and winter migrant; **R/AM** – Resident and altitudinal movement; **R/SM** – Resident with Summer migrant; **WM/PM** – Winter migrant as well as passive migrant; **R/WM/PM** – Resident with influx as well as passage movement; **R/AM/WM** – Resident with altitudinal and winter movement; **R/WM/SM** – Resident with summer and winter movement; **R/LM/SM** – Resident local as well as summer movement; **LC** – Least concern; **NT** – Near Threatened; **EN** – Endangered

Table 2. Family-wise distribution and relative diversity (RDi) of the birds

2. táblázat A megfigyelt madárfajok családok szerinti eloszlása és relatív diverzitása (RDi)

S.No.	Family	Number of species	RDi value (%)
1.	Anatidae	15	31.91
2.	Podicipedidae	2	4.26
3.	Ciconiidae	1	2.13
4.	Ardeidae	2	4.26
5.	Phalacrocoracidae	2	4.26
6.	Rallidae	3	6.38
7.	Scolopacidae	7	14.89
8.	Laridae	5	10.64
9.	Recurvirostridae	1	2.13
10.	Charadriidae	3	6.38
11.	Accipitridae	1	2.13
12.	Alcedinidae	2	4.26
13.	Motacillidae	3	6.38

Table 3. Monthly indices of water-dependent birds' species

3. táblázat A megfigyelt vízimadárfajok időbeli eloszlási adatai

Parameters	Oct	Nov	Dec	Jan	Feb	Mar	Apr
No. of species observed	28	29	47	39	36	29	8
No. of individuals	180	887	2250	3552	1723	590	78
Bird species diversity	1.52	2.21	2.49	2.44	2.33	2.36	1.18
Bird species richness	5.20	4.13	5.96	4.65	4.70	4.39	1.61

The result revealed that the Eurasian Coot (*Fulica atra*) was the most dominant species with 23.11% of the total abundance of the species followed by Red-crested Pochard (*Netta rufina*) (14.45), Common Pochard (*Aythya ferina*) (12.96), Tufted Duck (*A. fuligula*) (11.94), Gadwall (*Mareca strepera*) (6.38). The relative abundance of the top 10 dominant species is shown in (Table 4).

Three species viz., River Lapwing (*Vanellus duvaucelii*), Painted Stork (*Mycteria leucocephala*), Ferruginous Duck (*A. nyroca*) were Near Threatened (NT), one species Pallas's Fish Eagle (*Haliaeetus leucoryphus*) was Endangered (EN) and the remaining species were categorized under the Least Concern (LC) category as per IUCN. A total of 23 omnivorous, 17 carnivorous, and 7 insectivorous species were recorded according to their feeding habitat.

Out of a total of 14 winter migrants (WM), 14 residents (R), 11 residents with local migrant (R/LM), 3 residents with influx and passage movement (R/WM/SM), 2 residents with altitudinal winter movement (R/AM/WM), and one species are winter migrant with passive migration (WM/PM) and one species is resident with summer and winter movement (R/SM/WM) observed during the study (Figure 2).

Table 4. Relative abundance (RA) of the top 10 dominant species during the study period
4. táblázat A 10 legmagasabb dominanciájú madárfaj relatív dominanciája (RA) a vizsgálat időtartama alatt

S.No.	Common name	Scientific name	RA (%)
1	Eurasian Coot	<i>Fulica atra</i>	23.11
2	Red-crested Pochard	<i>Netta rufina</i>	14.45
3	Common Pochard	<i>Aythya ferina</i>	12.96
4	Tufted Duck	<i>Aythya fuligula</i>	11.94
5	Gadwall	<i>Mareca strepera</i>	6.38
6	Ruddy Shelduck	<i>Tadorna ferruginea</i>	6.32
7	Little Cormorant	<i>Microcarbo niger</i>	5.31
8	Great Cormorant	<i>Phalacrocorax carbo</i>	2.84
9	Eurasian Wigeon	<i>Mareca strepera</i>	2.20
10	Northern Pintail	<i>Anas acuta</i>	2.18

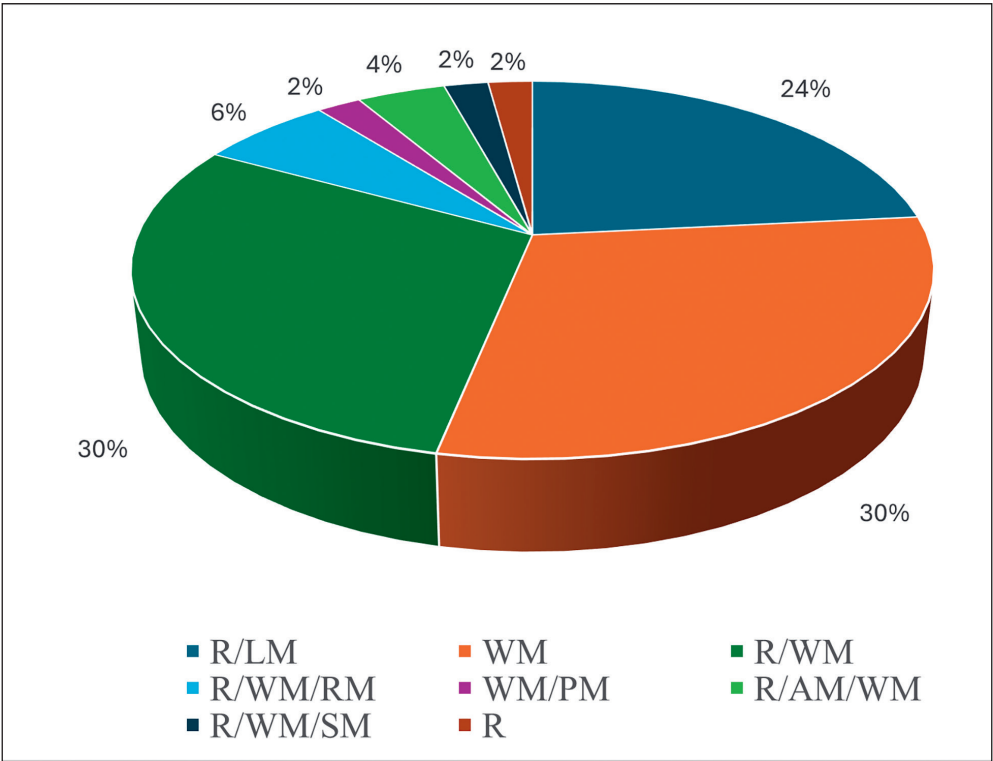


Figure 2. Status of migratory species recorded during the study period
2. ábra A vonuló fajok vonulási stratégia szerinti eloszlása a vizsgálat időtartama alatt

Discussion

This study has provided baseline information on winter migrant avian species in Asan Conservation Reserves. A total of 47 water dependent species were reported throughout the study period. During the winter, many high-altitude bird species migrate to lower-altitude areas such as ACR (Chopra & Sharma 2012). The highest number of species indicates that the ACR provides suitable habitat for many winter migrants, as well as this area is an essential wintering and stopover location (Kaushik & Gupta 2013). The results showed that the Anatidae family was the most abundant during this study. The significant domination of Anatidae indicates that this area significantly contributes to providing adequate habitat and substantial food for different waterbirds such as geese and ducks (Bachheti *et al.* 2023).

The feeding pattern of observed species revealed that 17 of the bird species were carnivorous, 7 were insectivorous, and 23 species were omnivorous. The Alcedinidae and Accipitridae are strong indicators of the health of ecosystems since they exist at the highest level of the native food chain. As top predators, the Alcedinidae are important biological indicators for understanding the structure and function of regional ecosystems. Their prevalence in ACR most possibly represents the abundance of modest animals such as avian species, reptiles, fish, and insects (Jamwal *et al.* 2017).

The total number of individuals of various species fluctuated, and there were minor seasonal fluctuations in bird species diversity (BSD) and richness (BSR) in the study sites. These monthly fluctuations may be attributable to the species' regional movement from one wetland to elsewhere (Arya *et al.* 2019). The different ecological factors such as the total cover and composition of vegetation are essential elements that influence habitat structure as well as the distribution, diversity, and abundance of wetland dependent avian species. Rajpar and Zakaria (2011) found that vegetation type effects the availability of food supplies, which increases the abundance of waterbird species in the area.

Furthermore, we have identified four threatened species (8% of the total). It has been observed that the population of water-dependent birds, both resident and migrant, has decreased substantially (Saini *et al.* 2017). The threatened species highlight the importance of additional management and conservation initiatives in ACR and its surrounding areas. As a result, the ACR wetland is not only a great location for the protection of rare and internationally vulnerable species, but also its known for a significant diversity of plants and animal species which they help to attract such a wide range of avifaunal diversity.

Conclusions

The winter migratory avian species was commonly found in the study area and the summer migratory species was very infrequent highlighting the region's value for serving as wintering site for high-altitude native birds. The continued existence of internationally threatened species considers the conservation of this wetland significantly more important. This study provides basic information to helpful with subsequent observations in this particular area, as well as an example to begin implementing conservation programs in other distant IBAs.

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