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STRUCTURE AND COMPOSITION OF BIRD ASSEMBLAGE IN KESHOPUR WETLAND OF PUNJAB, INDIA

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ABSTRACT

Survey on avian diversity at Keshopur wetland, district Gurdaspur, Punjab, India revealed the presence of 121 species of birds belonging to 19 orders and 47 families. The maximum number (38) of species in the area belonged to order Passeriformes. 27 winter migratory, 3 summer migratory and 91 resident species of birds were observed. One vulnerable (*Aythya ferina*) and six near threatened species were observed (*Aythya nyroca, Anhinga melanogaster, Mycteria leucocephala, Sterna aurantia, Psittacula eupatria, Threskiornis melanocephalus*) as per IUCN red list. A particular pattern of arrival and departure of migratory birds was observed. The winter migrants started to appear in October when the temperature started decreasing. The abundance of birds varied significantly during different seasons. Major variation was found in abundance of few species at three different sites of the same wetland. This study revealed that Keshopur Chhamb Community Reserve acts as a refuge site for many waterbirds including wader, waterfowl and many migratory and threatened species.

Key words: Avian diversity, community reserve, ecosystem, migratory birds, Passeriformes, Ramsar site, waterbirds, wetland, vulnerable, near threatened, arrival, departure pattern, season variation

Birds belong to a group of warm blooded vertebrates characterized by feathers, toothless beaked jaws, the hard shelled egg laying, high metabolic rate, a heart with four chambers and a strong yet light weight skeleton. About 10,000 species of birds are present on Earth in different ecosystems. Wetlands are areas of land that are permanently or temporarily covered with water. A large number of wetlands such as swamps, marshes, peatlands etc are present in India. Wetlands are considered to be most distinctive and high yielding ecosystems (Rajasekar et al., 2008) which can be characterized as a transitional world between aquatic and terrestrial ecosystems as they exhibit characters of both ecosystems. A wide diversity of aves depends upon wetlands during their migrant and procreation phase (Luo et al., 2019). Water birds and wetlands are inseparable components as they support an affluent arrangement of water bird communities. About 10% of the bird species globally rely entirely on wetlands, while approximately the same number again utilizing them at some phase in their life span (Gardner et al., 2016). This indicates that globally 20% (approximate) of the avian species utilize wetlands directly or indirectly for foraging, resting, breeding and overwintering (Rannestad et al., 2015). The population of birds dependent on wetlands is going through drastic decrease globally. These noticeable decreases are particularly due to immense loss of wetlands and conversion to land (Saunders et al., 2019).

In a survey conducted by Wildlife Institute of India, it was found that wetlands are dissipating every year @ 2 to 3% (Bal and Dua, 2010). In wetlands, the diversity and abundance of bird species is directly associated with the developing vegetation and compounding. The aquatic birds are fairly receptive to the variations in wetlands (Odewumi et al., 2017). Their population size is directly affected by the food availability (Jagruti and Geeta, 2017). With the changes in wetlands, the aquatic birdlife is entirely affected which is an indication for us to understand whether the region is environmentally sound or getting contaminated (Odewumi et al., 2017).

In Punjab, six wetlands are of international significance and Keshopur wetland is one such important wetland which has recently been declared as Ramsar site on 26 September, 2019. This wetland was the first declared community reserve of India (Mehta, 2014). The economy of rural areas surrounding it is intensely affected and the contribution from the local community has been recognized as a key factor for its protection. The reserve has many fresh water marshes (natural wetlands) extending to an area of 850 acres and is the main site for migratory birds during the winter season. Due to its conversion into productive agricultural land and fish farms in the past by drainage department of the government, the wetland area has been reduced to its present size which was once spread to many thousand acres. The ecosystem is now on the edge of extinction

and is highly threatened. The disturbance caused by humans directly or indirectly in wetland bird habitats led to decrease in strength of various populations of wetland birds. It is necessary to understand the causes for the decrease in the populations of various water birds and to find the effects of interference of humans. The inestimable information can be obtained on the standing and fitness of wetland by monitoring the birds of wetland (Moilinga and Hassan, 2019). Only by knowing the structure of any region, the significance of local scenery for the conservation of birds can be understood (Harisha, 2016). Wetlands in India cope with enormous anthropogenic pressures as elsewhere, due to which the structure of bird community is strongly influenced (Reginald et al., 2007). Anthropogenic actions are known to cause disruptions to aquatic birds in their natural surroundings including recreation (Aikins et al., 2018; Anderson et al., 2019). Even though these sites are adequately transformed by human actions, still providing suitable environment (Bal and Dua, 2010) and food (Jangral and Vashishat, 2022) to many bird species therefore, the present study was planned to study community structure of birds at Keshopur wetland, a ramsar site.

MATERIALS AND METHODS

The Keshopur wetland is a freshwater ecosystem and (32˚05' 16.3" N, 75˚24' 24.2" E) and 245 masl having an area of approximately 344 ha adjacent to the town of Gurdaspur, District Gurdaspur, Punjab. This region was announced as community reserve under Section 36 C of Wildlife protection Act 1972 ensuing a Punjab Government Notification Number 34/13/2007/ Ft-V/6133 dated June 25th 2007. The wetland comprised of fresh water marshes owned by Panchayats of five villages categorized into two parts. Miani (162 ha), Dalla (62 ha), Keshopur (55 ha), Matwa (20 ha) form the significant one conterminous block and Magarmudian (45 ha) is a separate patch. The wetland consists of diverse amount of vegetation. The study area was divided into three sites. Site I consisted of trees, shrubs, herbs, grasses, aquatic plants and climbers. It was located near the road and surrounded by agricultural fields. Site II was mainly consisted of small vegetation including herbs, shrubs, climbers, grasses, aquatic plants and some trees. Fish ponds were present at the site which was surrounded by agricultural fields. Site III which was a separate patch consisted of large number of aquatic plants and bamboo trees, herbs, shrubs and grasses. Watchtower was present at all the three sites to see the birds from a distance.

Point count method wad used to study and record the diversity of birds at different sites of Keshopur Chhamb Community Reserve. In point count method, all the viewable birds were counted by choosing an appropriate vantage point. Approximately 10-15 minutes were spent at each point to avoid repeated counting of same bird individual. Identification of birds residing and visiting selected sites was done on the basis of visual observations on their morphological features like shape, size, color of beak, feathers, wings, eyes, feet, legs and other parts of body by using binocular and comparing them with those described by Ali (2002). At different sites, observations of birds were recorded weekly for one and a half hour between 6:00-9:00 a.m. in the morning and 4:00-7:00 p.m. in the evening using binoculars (Bushnell 13-3450-C, 10×50). Regular observations were taken at weely intervals throughout the study but they were pooled together into a single monthly observation. Status of species was classified into resident (R), winter migrant (WM) and summer migrant (SM).

The data of four point counts recorded in one month was pooled together. The community features such as Species richness, diversity, evenness and abundance were calculated to determine the bird's community at selected sites. Species richness describes the total number of species of birds in a given area. Relative abundance of birds (%) was calculated using the formula: ni/N × 100. In this equation, ni represents the number of *ith* species and N represents the total number of birds seen. Species diversity was calculated using Shannon-Weiner index as explained by (Spellerberg and Fedor, 2003). Species evenness also called as equitability and written as E was determined by the equation: J= H/ H'max, Where, H is the observed species diversity and H' max is the log of total number of species richness. The value of E ranges from 0-1. Annual abundance of avifauna was tabulated and analyzed using two way analysis of variance. CPCS1 software was used to compare the number of species at each selected site. SPSS1 software (Kruskal-Wallis test) was used to compare the seasonal variation between the three sites.

RESULTS AND DISCUSSION

Total 121 species of birds belonging to 19 orders and 47 families were observed (Table 1). The maximum number of species i.e. 38 were belonging to order Passeriformes. Praveen et al. (2016) observed that Passeriformes forms the most predominant group in India with about 54% composition. Anatidae was the most abundant family belonging to order Anseriformes having 11 species. However, Muscicapidae family has

the highest number of birds in India as per the study of Manakadan and Pittie (2001). Similar results were recorded by Mukhopadhyay and Mazumdar (2017) in Bongaon, West Bengal and by Harisha and Hosetti (2017) at Dyamannana Lake, Karnataka. Rawat and Rao (2020) noticed Anatidae as least abundant family in Sheopur city of Madhya Pradesh. Total 107 species of birds were found at Site I where Eurasian coot, common moorhen and northern shoveler were recorded to be the predominant ones having annual abundance 14.10, 13.36 and 10.93%, respectively. 103 species of birds were found at Site II in which common moorhen and Eurasian coot were recorded as the abundant; 113 species were found at Site III where Eurasian coot, common moorhen and northern pintail were the predominant.

As per IUCN red list (IUCN 2020), out of total 121 species, one vulnerable species (*Aythya ferina*) and six near threatened species were observed (i.e. *Aythya nyroca*, *Anhinga melanogaster*, *Mycteria leucocephala*, *Sterna aurantia*, *Psittacula eupatria*, *Threskiornis melanocephalus*). Suryakant (2017) also reported *Mycteria leucocephala* and *Threskiornis melanocephalus* as near threatened species at Urban Wetlands of Kolhapur, Maharashtra. The endangered species can be conserved by studying and conserving their habitat. Most conservation plans for endangered species build on the conservation of habitats (Maleki et al., 2019). In present study, 27 winter migratory, 3 summer migratory and 91 resident birds were observed. This contributed to total composition as 22% of winter migrant, 2.5% of summer migrants and 75.5% of resident

Table 1. Abundance and status of birds (Keshopur wetland)

S. No.	Species	Scientific name	Annual abundance		
			Site I	Site II	Site III
	Order-Accipitriformes, Family-Accipitridae				
1.	Black kite	*Milvus migrans* (Boddaert, 1783)	0.47	0.42	0.56
2.	Lesser spotted eagle	*Clanga pomarina* (Brehm, 1831)	0.35	0.27	0.34
3.	Oriental honey buzzard	*Pernis ptilorhynchus* (Temminck, 1821)	0.05	0.05	0.06
4.	Western marsh harrier	*Circus aeruginosus* (Linnaeus, 1758)	0.02	0.03	0.02
	Order-Anseriformes, Family-Anatidae				
5.	Bar-headed goose	*Anser indicus* (Latham, 1790)	1.18	-	0.68
6.	Common pochard	*Aythya ferina* (Linnaeus, 1758)	1.27	0.88	1.35
7.	Eurasian wigeon	*Mareca penelope* (Linnaeus, 1758)	7.02	5.57	7.92
8.	Ferruginous duck	*Aythya nyroca* (Güldenstädt, 1770)	1.03	-	0.91
9.	Gadwall	*Anas strepera* (Linnaeus, 1758)	7.54	5.95	8.01
10.	Greylag goose	*Anser anser* (Linnaeus, 1758)	1.55	1.15	1.59
11.	Indian spot billed duck	*Anas poecilorhyncha* (Forster, 1781)	3.73	0.19	3.35
12.	Lesser whistling duck	*Dendrocygna javanica* (Horsefield, 1821)	0.48	0.22	0.52
13.	Mallard	*Anas platyrhynchos* (Linnaeus, 1758)	5.68	5.56	6.15
14.	Northern pintail	*Anas acuta* (Linnaeus, 1758)	10.06	7.88	10.40
15.	Northern shoveler	*Spatula clypeata* (Linnaeus, 1758)	10.93	11.36	-
	Order-Apodiformes, Family-Apodidae				
16.	Little swift	*Apus affinis* (Gray, 1830)	0.60	0.62	0.49
	Order- Bucerotiformes, Family-Bucerotidae				
17.	Indian grey hornbill	*Ocyceros birostris* (Hume, 1873)	0.07	0.02	0.02
	Order-Bucerotiformes, Family-Upupidae				
18.	Common hoopoe	*Upupa epops* (Linnaeus, 1758)	0.40	0.28	0.34
	Order-Ciconiiformes, Family-Ciconiidae				
19.	Asian openbill	*Anastomus oscitans* (Boddaert, 1783)	0.06	0.18	0.04
20.	Painted stork	*Mycteria leucocephala* (Pennant, 1769)	0.03	0.02	0.01

(Table 1 contd.)

	Order-Charadriiformes, Family-Charadriidae				
21.	Little ringed plover	*Charadrius dubius* (Scopoli, 1786)	-	-	0.38
22.	Pacific golden plover	*Pluvialis fulva* (Gmelin, 1789)	-	-	0.08
23.	Red-wattled lapwing	*Vanellus indicus* (Boddaert, 1783)	1.13	0.82	1.51
24.	White tailed lapwing	*Vanellus leucurus* (Lichtenstein, 1823)	-	0.01	0.32
25.	Yellow-wattled lapwing	*Vanellus malabaricus* (Boddaert, 1783)	0.03	-	0.16
	Order-Charadriiformes, Family-Jacanidae				
26.	Pheasant tailed jacana	*Hydrophasianus chirurgus* (Scopoli, 1786)	0.17	0.22	-
	Order-Charadriiformes, Family-Laridae				
27.	Brown headed gull	*Chroicocephalus brunnicephalus* (Jerdon, 1840)	-	-	0.28
28.	Black headed gull	*Chroicocephalus ridibundus* (Linnaeus, 1766)	-	-	0.29
29.	River tern	*Sterna aurantia* (Gray, 1831)	-	-	0.35
	Order- Charadriiformes, Family-Recurvirostridae				
30.	Black winged stilt	*Himantopus himantopus* (Linnaeus, 1758)	-	-	0.96
	Order-Charadriiformes, Family-Scolopacidae				
31.	Common greenshank	*Tringa nebularia* (Gunnerus, 1767)	-	-	0.55
32.	Common sandpiper	*Actitis hypoleucos* (Linnaeus, 1758)	-	-	0.52
33.	Marsh sandpiper	*Tringa stagnatilis* (Bechstein, 1803)	-	-	0.44
34.	Spotted redshank	*Tringa erythropus* (Pallas, 1764)	-	-	0.50
	Order- Columbiformes, Family-Columbidae				
35.	Eurasian collared dove	*Streptopelia decaocto*(Frivaldszky, 1838)	0.52	0.44	0.58
36.	Laughing dove	*Spilopelia senegalensis* (Linnaeus, 1766)	0.17	0.11	0.17
37.	Oriental turtle dove	*Streptopelia orientalis* (Latham, 1790)	0.06	-	0.02
38.	Red collared dove	*Streptopelia tranquebarica* (Hermann, 1804)	0.09	0.06	0.13
39.	Rock pigeon	*Columba livia* (Gmelin, 1789)	0.46	0.54	0.65
40.	Spotted dove	*Spilopelia chinensis* (Scopoli, 1786)	0.21	0.15	0.16
41.	Yellow-footed green pigeon	*Treron phoenicoptera* (Latham, 1790)	0.13	0.08	0.09
	Order-Coraciiformes, Family-Alcedinidae				
42.	Lesser pied kingfisher	*Ceryle rudis* (Linnaeus, 1758)	0.01	0.12	0.04
43.	White-throated kingfisher	*Halcyon smyrnensis* (Linnaeus, 1758)	0.05	0.72	0.17
	Order-Coraciiformes, Family-Coraciidae				
44.	Indian roller	*Coracias benghalensis* (Linnaeus, 1758)	0.15	0.07	0.11
	Order-Coraciiformes, Family-Meropidae				
45.	Green bee eater	*Merops orientalis* (Latham, 1801)	0.05	0.05	0.08
46.	Blue tailed bee eater	*Merops philippinus* (Linnaeus, 1766)	0.02	-	0.03
	Order-Cuculiformes, Family-Cuculidae				
47.	Asian koel	*Eudynamys scolopaceus* (Linnaeus, 1758)	0.11	0.13	0.15
48.	Greater coucal	*Centropus sinensis* (Stephens, 1815)	0.50	0.27	0.58
	Order-Falconiformes, Family-Falconidae				
49.	Peregrine falcon	*Falco peregrines* (Tunstall, 1771)	0.07	0.05	0.06
	Order-Galliformes, Family-Phasianidae				
50.	Black francolin	*Francolinus francolinus* (Linnaeus, 1766)	0.07	0.04	0.12

(Table 1 contd.)

	Order-Gruiformes, Family-Rallidae				
51.	White breasted waterhen	*Amaurornis phoenicurus* (Pennant, 1769)	0.36	0.22	1.22
52.	Purple swamphen	*Porphyrio porphyrio* (Linnaeus, 1758)	1.47	2.93	1.22
53.	Common moorhen	*Gallinula chloropus* (Linnaeus, 1758)	13.36	16.45	13.83
54.	Eurasian coot	*Fulica atra* (Linnaeus, 1758)	14.10	15.40	15.38
	Order-Passeriformes, Family-Alaudidae				
55.	Ashy-crowned sparrow lark	*Eremopterix griseus* (Scopoli, 1786)	0.22	0.08	0.41
56.	Crested lark	*Galerida cristata* (Linnaeus, 1758)	0.11	-	0.20
	Order-Passeriformes, Family-Campephagidae				
57.	White-bellied minivet	*Pericrocotus erythropygius* (Jerdon, 1840)	0.06	0.07	0.13
	Order- Passeriformes, Family-Cisticolodae				
58.	Yellow-bellied prinia	*Prinia flaviventris* (Delessert, 1840)	0.07	0.06	0.14
	Order-Passeriformes, Family-Corvidae				
59.	Common raven	*Corvus corax* (Linnaeus, 1758)	0.48	0.34	0.57
60.	House crow	*Corvus splendens* (Vieillot, 1817)	0.91	0.84	1.10
61.	Indian jungle crow	*Corvus macrorhynchos* (Wagler, 1827)	0.58	0.46	0.68
62.	Indian treepie	*Dendrocitta vagabunda* (Latham, 1790)	0.16	0.03	0.10
	Order-Passeriformes, Family-Dicruridae				
63.	Ashy drongo	*Dicrurus leucophaeus*	0.09	0.06	0.09
64.	Black drongo	*Dicrurus macrocercus* (Viellot, 1817)	0.17	0.14	0.25
	Order-Passeriformes, Family-Estrildidae				
65.	Scaly breasted munia	*Lonchura punctulata* (Linnaeus, 1758)	0.22	0.13	0.24
66.	Tricolour munia	*Lonchura Malacca* (Linnaeus, 1766)	0.03	0.01	0.02
	Order- Passeriformes, Family-Laniidae				
67.	Long tailed shrike	*Lanius schach* (Linnaeus, 1758)	-	-	0.58
	Order-Passeriformes, Family-Monarchidae				
68.	Asian paradise flycatcher	*Terpsiphone paradise* (Linnaeus, 1758)	0.05	0.05	0.03
	Order-Passeriformes, Family-Motacillidae				
69.	Western yellow wagtail	*Motacilla flava* (Linnaeus, 1758)	0.02	0.03	0.29
70.	Grey wagtail	*Motacilla cinerea* (Tunstall, 1771)	0.02	0.04	0.19
71.	Citrine wagtail	*Motacilla citreola* (Pallas, 1776)	0.02	0.02	0.12
72.	White browed wagtail	*Motacilla maderaspatensis* (Gmelin,1789)	0.07	0.07	0.17
73.	Paddy field pipit	*Anthus rufulus* (Vieillot, 1818)	0.13	0.14	0.24
74.	Long billed pipit	*Anthus similis* (Jerdon, 1840)	0.04	0.06	0.09
	Order-Passeriformes, Family-Muscicapidae				
75.	Oriental magpie robin	*Copsychus saularis* (Linnaeus, 1758)	0.12	0.05	0.12
76.	Indian black robin	*Copsychus fulicatus* (Linnaeus, 1766)	0.14	0.15	0.24
77.	Bluethroat	*Luscinia svecica* (Linnaeus, 1758)	0.03	0.03	0.07
	Order-Passeriformes, Family-Nectariniidae				
78.	Purple sunbird	*Cinnyris asiaticus* (Latham, 1790)	0.08	0.04	0.06
	Order-Passeriformes, Family-Passeridae				
79.	House sparrow	*Passer domesticus* (Linnaeus, 1758)	0.25	0.30	0.36

(Table 1 contd.)

	Order-Passeriformes, Family-Ploceidae				
80.	Baya weaver	*Ploceus philippinus* (Linnaeus, 1766)	0.09	0.06	0.19
81.	Streaked weaver	*Ploceus manyar* (Horsfield, 1821)	0.13	0.10	0.22
82.	Black breasted weaver	*Ploceus benghalensis* (Linnaeus, 1758)	0.10	0.07	0.17
	Order-Passeriformes, Family-Pycnonotidae				
83.	Red vented bulbul	*Pycnonotus cafer* (Linnaeus, 1766)	0.39	0.32	0.40
84.	White eared bulbul	*Pycnonotus leucotis* (Gould, 1836)	0.14	0.06	0.10
	Order- Passeriformes, Family-Rhipiduridae				
85.	White throated fantail	*Rhipidura albicollis* (Vieillot, 1818)	0.02	0.01	0.02
	Order-Passeriformes, Family-Sturnidae				
86.	Asian pied starling	*Gracupica contra* (Linnaeus, 1758)	0.12	0.06	0.15
87.	Bank myna	*Acridotheres ginginianus* (Latham, 1790)	0.36	0.29	0.54
88.	Common myna	*Acridotheres tristis* (Linnaeus, 1766)	0.73	0.80	0.88
	Order-Passeriformes, Family-Sylviidae				
89.	Common tailor bird	*Orthotomus sutorius* (Pennant, 1769)	0.06	0.05	0.12
	Order-Passeriformes, Family-Timaliidae				
90.	Common babbler	*Argya caudata* (Dumont, 1823)	0.19	0.12	0.20
91.	Jungle babbler	*Argya striata* (Lesson, 1831)	0.54	0.51	0.60
	Order-Passeriformes, Family-Zosteropidae				
92.	Oriental white eye	*Zosterops palpebrosus* (Temminck, 1824)	0.06	0.01	0.05
	Order-Pelecaniformes, Family-Ardeidae				
93.	Black crowned night heron	*Nycticorax nycticorax* (Linnaeus, 1758)	-	0.09	-
94.	Cattle egret	*Bulbulcus ibis* (Linnaeus, 1758)	0.49	0.93	0.35
95.	Eurasian bittern	*Botaurus stellaris* (Linnaeus, 1758)	-	0.02	0.13
96.	Great egret	*Ardea alba* (Linnaeus, 1758)	0.34	0.55	0.29
97.	Grey heron	*Ardea cinerea* (Linnaeus, 1758)	0.12	1.10	0.02
98.	Indian pond heron	*Ardeola grayii* (Skyes, 1832)	0.47	0.37	0.34
99.	Intermediate egret	*Ardea intermedia* (Wagler, 1827)	0.19	0.48	0.16
100.	Little egret	*Egretta garzetta* (Linnaeus, 1766)	0.06	0.11	0.08
101.	Purple heron	*Ardea purpurea* (Linnaeus, 1766)	0.08	0.61	0.04
102.	Yellow bittern	*Ixobrychus sinensis* (Gmelin, 1789)	0.30	0.24	0.43
	Order-Pelecaniformes, Family-Threskiornithidae				
103.	Glossy ibis	*Plegadis falcinellus* (Linnaeus, 1766)	0.09	0.91	0.97
104.	Indian black ibis	*Pseudibis papillosa* (Temminck, 1824)	0.16	0.50	0.49
105.	Black headed ibis	*Threskiornis melanocephalus* (Latham, 1790)	0.04	0.09	0.03
	Order-Piciformes, Family-Capitonidae				
106.	Blue throated barbet	*Psilopogon asiaticus* (Latham, 1790)	0.04	0.03	0.07
107.	Brown headed barbet	*Psilopogon zeylanicus* (Gmelin, 1788)	0.03	0.04	0.06
108.	Coppersmith barbet	*Psilopogon haemacephalus* (Muller, 1776)	0.06	0.05	0.08
	Order-Piciformes, Family-Picidae				
109.	Black rumped flameback	*Dinopium benghalense* (Linnaeus, 1758)	0.07	0.05	0.03

(Table 1 contd.)

(Table 1 contd.)

	Order-Podicipediformes, Family-Podicipedidae				
110.	Little grebe	*Tachybaptus ruficollis* (Pallas, 1764)	1.18	-	0.67
111.	Black necked grebe	*Podiceps nigricollis* (Brehm, 1831)	0.91	0.26	0.10
	Order-Psittaciformes, Family-Psittaculidae				
112.	Slaty headed parakeet	*Psittacula himalayana* (Lesson, 1832)	0.17	0.11	0.15
113.	Plum headed parakeet	*Psittacula cyanocephala* (Linnaeus, 1766)	0.13	0.24	0.16
114.	Rose ringed parakeet	*Psittacula krameri* (Scopoli, 1769)	0.81	0.68	0.77
115.	Alexandrine parakeet	*Psittacula eupatria* (Linnaeus, 1766)	0.29	0.15	0.16
	Order-Suliformes, Family-Anhingidae				
116.	Oriental darter	*Anhinga melanogaster* (Pennant, 1769)	0.43	0.20	0.23
	Order-Suliformes, Family-Phalacrocoracidae				
117.	Indian cormorant	*Phalacrocorax fuscicollis* (Stephens, 1826)	0.17	1.54	-
118.	Great cormorant	*Phalacrocorax carbo* (Linnaeus, 1758)	0.33	1.98	-
119.	Little cormorant	*Microcarbo niger* (Vieillot, 1818)	0.13	3.44	-
	Order-Strigiformes, Family-Strigidae				
120.	Indian eagle owl	*Bubo bengalensis* (Franklin, 1831)	0.01	0.01	-
121.	Spotted owlet	*Athene brama* (Temminck, 1821)	0.01	0.01	-

bird species. However, Mehta (2014) reported 39% of winter migrant and 55% of resident bird species while rest were indigenous species (2013). There was no seasonal variation seen in the resident bird species as they were observed throughout the year, but there was a particular pattern of arrival and departure of migratory birds. The winter migrants started to appear in October when the temperature starts decreasing, elevating the diversity in winter season. Major variation was found in abundance of few species at the three sites of the same wetland. Most of the migratory species recorded were winter visitors only as the maximum abundance was recorded during January. Maximum species richness was in January and minimum in June at all the sites. Highest species diversity was found in during May and lowest during October. Species evenness was maximum during May - July and lowest in October (Table 2). The seasonal variations in environmental factors within the same habitat affect the community structure of birds throughout the year (Xu et al., 2022). Several studies have shown that species richness and abundance of water birds inflates with the emerging vegetation cover in wetlands, especially during breeding periods when water birds are less mobile and more vulnerable to disturbance.

It was found that the Keshopur wetland having great vegetation diversity, is a major habitat site for waterfowl population especially during winters when winter migratory birds reside there. However, it appears that vegetation development affects the composition of the waterfowl breeding population at any wetland (Kristin et al., 1996). Apart from providing food for herbivorous waterbirds such as seeds, leaves, tubers, and rhizomes, vegetation is a crucial habitat element and significantly influences waterbird habitat usage. The Keshopur wetland provides a great diversity of vegetation for fauna. Emerging plants often provide protection and decrease human interference, which occurs very often at roosting and breeding sites in artificial wetlands (Hattori and Mae, 2001). Dense vegetation often supports invertebrate habitat and food requirements, and increases the viability of eggs or diapausing invertebrates, ultimately increasing their abundance, biomass, and diversity which increases food for water birds (Anderson and Smith, 2000).

The species were not uniformly distributed at the three sites under study area as the majority of winter migratory birds were observed in flocks preferring the ponds away from the road. It was because of more dense aquatic vegetation which protects the birds from severe climatic conditions and predators. Brandolin and Blendinger (2015) also showed in their study that more vegetated ponds provide better shelter to avifauna for their survival. The eurasian coot was most abundant species found at this site. An important pond variable for habitat selection by coots was emerging vegetation, probably because it contributed in protection against aerial predators. As the northern shoveler was one of the most abundant species at the Keshopur a freshwater wetland, the best supporting evidence is from the study of Tietje and Teer, (2015) who observed that freshwater wetlands are of higher quality than saltwater wetlands for wintering shovelers. The flocks of Cormorants were

Table 2. Community structure of birds at three sites (Keshopur wetland)

Month	Site I			Site II			Site III		
	Richness	Diversity	Evenness	Richness	Diversity	Evenness	Richness	Diversity	Evenness
Jun	43.00	3.34	0.89	40.00	3.29	0.89	41.00	3.29	0.89
Jul	59.00	3.45	0.85	55.00	3.59	0.89	60.00	3.72	0.91
Sep	78.00	3.42	0.78	78.00	3.40	0.78	69.00	3.42	0.81
Oct	85.00	2.34	0.53	86.00	2.29	0.51	84.00	2.36	0.53
Nov	89.00	2.79	0.62	81.00	2.62	0.59	95.00	2.97	0.65
Dec	90.00	2.87	0.64	87.00	2.77	0.62	91.00	3.07	0.68
Jan	96.00	2.99	0.65	95.00	3.01	0.66	101.00	3.15	0.68
Feb	91.00	2.94	0.65	90.00	2.98	0.66	99.00	3.18	0.69
Mar	87.00	3.00	0.67	90.00	3.10	0.69	97.00	3.18	0.69
Apr	74.00	3.40	0.79	70.00	3.07	0.72	77.00	3.52	0.81
May	84.00	3.87	0.87	73.00	3.67	0.85	80.00	3.92	0.89

The data for the August was not taken due to rainfall and excessive water logging.

very frequently seen in one pond only near the poplar trees residing on the vegetation protruding from the water. They were also seen utilizing poplar trees for perching in groups and may be for nesting sites also. Previous studies concluded that the higher the nest tree height, the higher the success rate for the breeding (Park et al., 2011). Therefore, the great cormorants may have migrated to areas with higher nesting trees (Lee et al., 2019). Ardeids prefer places where wide areas of wetlands or long banks are located. The number of pheasant tailed jacana was noticed significantly more in lotus vegetation. Pheasant-tailed jacana is always found in reservoirs where the coverage of aquatic vegetation with wide floating leaves is comparatively high. The muddy reservoir beds deliver better foraging grounds for most migratory waders, such as plovers and sandpipers. Such small migratory wading birds are efficiently adapted for feeding on small insects, mollusks, worms, etc. (Henkanaththegedara and Amarasinghe, 2015). Black-winged stilts use a wide range of shallow water wetlands, both for breeding and forage (Pigniczki et al., 2019). They were mostly seen in muddy areas near ponds and shallow water ponds. Northern pintail were found more abundant at this site as compared to the other two sites. Yamaguchi et al. (2012) observed in their study that Northern pintails migratory stop-over sites contained more freshwater wetlands, freshwater lakes and rivers, and other agricultural lands. Shorebirds favoured small mudflats and large bulrush areas over environments with a limited area of high vegetation (Zhenming et al., 2006).

Birds use wetlands as a source of feeding, drinking water, roosting, breeding and social interactions. The richness of avifauna found in present study at Keshopur Chhamb Community Reserve is the magnificent indicator of ecological health. The current condition of its conservation has shown that Keshopur wetland reduced to about 300 acres of the thousands of acres of land at one point has been restored to about 850 acres by the efforts of forest officials. Present studies conclusively suggest that the habitation of various resident and migratory birds recorded in our study shows that Keshopur wetland is an important habitat for wild birds, which could be used as feeding, breeding, stopover and wintering site by the birds. It acts as a refuge site for many waterbirds including wader, waterfowl and many migratory and threatened species.

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AUTHOR CONTRIBUTION STATEMENT

NV conceptualized the research work and designed the experiments. SJ executed field/lab experiments and collected data. SJ and NV analyzed and interpreted the data. Both authors prepared and approved the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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