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Community Structure and Population Dynamics of Wetland Birds in Man-Made Sacred Wetland of Kurukshetra, Haryana, India

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Abstract Bird surveys were conducted at Jyoti Sarovar, one of the most revered of holy ponds of Kurukshetra, from April 2014 to March 2015 to assess the species composition and richness of wetland bird community. Point counts and direct observations were used to record bird species. A total of 49 species of wetland birds belonging to 17 families and 8 orders were recorded. Anátidae and Ardeidae (n=8 each) were the most diverse families in the study area. Of recorded bird species, 5 were summer migrants, 22 were winter migrants and 22 were residents. January was found to be the peak of wetland bird assemblage. Species richness, species diversity and evenness of wetland birds in different months varied between 22-44, 2.59-3.30 and 0.80-0.90 respectively. Among the bird species recorded, Painted Stork *(Mycteria leucocephala),* Black-headed Ibis *(Threskiornis melanocephalus)* and River Tern *(Sterna aurantia)* are listed as near threatened species in the Red List of the International Union for the Conservation of Nature. This study underlines the importance of Jyoti Sarover as an important habitat for wetland birds including migratory species as well as species with conservation priorities.

Keywords Wetland birds, Species diversity, Conservation, Jyoti Sarovar, Kurukshetra.

Introduction

Wetlands are transitional areas between terrestrial and aquatic ecosystems where the water table in usually at or near the surface, or land is covered by shallow water [1]. In addition to providing important ecosystem services [2], wetlands harbor a huge biodiversity including invertebrates, fish, amphibians, reptiles, birds, mammals and plants [3]. Thus, wetlands are often considered as treasuries of biodiversity within a region or landscape [4].

Bird species, which exploit wetlands directly or indirectly for feeding, breeding, roosting and overwintering are often called as wetland birds [5]. Of 1263 bird species reported from India [6], 310 species are known to be dependent on wetlands [7]. However, wetlands in India are facing tremendous anthropogenic threats [3]. Encroachment of wetland habitats, unsustainable harvesting of resources, industrial pollution, agricultural runoff, cutrophication, siltation and invasion of alien species often put wetland biodiversity under threat [8, 9]. These anthropogenic activities have severe consequences on water birds, leading to change in community structure of wetland birds and their population declines [7-9]. The importance of local landscapes for conservation of avifauna

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can only be understood by knowing the structure of the bird community of that region [3]. The present study was, therefore, conducted to ascertain the status of wetland birds and their richness in different seasons of the man-made sacred wetland of Kurukshetra.

Materials and Methods

Jyoti Sarovar ($29^0$57´42. 42´´N and $76^0$46´16. 12´´E), one of the most revered of holy ponds of Kurukshetra, is located at outskirt of village Jyotisar in Kurukshetra district of Haryana. Of three adjacently located man-made ponds at Jyotisar, first one is perennial and religious pond, and people from all over India take holy dip in it to perform various religious ceremonies. Second one is used for either recreation purposes or occasionally for *Nelumbo* cultivation. Third pond is used by local people for domestic purposes. The agricultural fields were flanking the wetland; with wheat and paddy as main crops provided extra foraging grounds for certain wetland bird species. The ponds are fringed by emergent macrophytes of which common reed *(Phragnites karka),* cattail narrow-leaved *(Typha angustata)* and nut-sedge *(Cyperus rotundus)* are widespread and abundant. Hydrilla *(Hydrilla verticillata),* eel weed *(Vallisneria spiralis),* curly leaf pond weed *(Potamogeton crispus),*slimy green algae (*Spirogyra* spp.), musk grass *(Chara zeylanica)*, hornwort *(Ceratophyllum demersum)* are common submerged macrophytes whereas water hyacinth *(Eichhornia crassipes),* duckweed *(Lemna minor),* smartweed (*Polygonum* spp.) and lotus *(Nelumbo nucifera)* are the free floating macrophytes found in these ponds.

Bird surveys were conducted in the selected wetland at a 2-week interval from April 2014 to March 2015 following the point count method [10]. A total of nine vantage points, at least 250 m apart, were selected at the perimeter of the wetland. Birds were counted directly, aided by 7 × 35 Nikon binoculars, during hours of peak activity 0600-1000 h and 1600-1800 h. Identification of birds was done using field guides [11]. Taxonomy and nomenclature follows Praveen et al. [6]. For residential status, birds were categorized as resident, winter visitor and sunmer visitor on basis of the presence in the study area. The local status of individual bird species was assessed following Kumar and Gupta [5]. Species richness (n) was calculated as total number of species observed in a habitat. Species diversity was calculated using Shannon-Wiener's index (H) as $H=-\Sigma\, pi \ln pi$; where, H is index of species diversity and *pi* is the proportion of the total sample belonging to the *i*th species. Evenness index (E) was determined by the equation E= H/ In S, where, H is Shannon-Wiener's diversity index and S is species richness.The conservation status of species was assessed according to the Indian Wildlife (Protection) Act, 1972. Convention on International Trade in Endangered Species of Wild Fauna and Flora [12] and International Union for Conservation of Nature [13].

Results and Discussion

A total of 49 species of wetland birds belonging to 17 families and 8 orders were recorded from the study area (Table 1). Pelecaniformes dominated the list with 16 species followed by Charadriiformes (n=11), Anseriformes (n=8) Passerformes (n=6), Gruiformes (n=4), Coraciiformes (n=2 each), and Phoenicopteriformes and Accipitriformes (n=1 each) (Fig. 1). The proportion of species richness of wetland birds by family varied from 2.04 to 16.33% (Table 2). Anatidae and Ardeidae were the most diverse families comprising of 8 species each, and both constituted 32.66% of the wetland bird community in the study area. However, Podicipedidae, Rostratulidae,Laridae, Accipitridae and Hirundinidae were poorly represented families in the study area, each with single species. For comparison, Kumar et al. [4] recorded 69 species of wetland birds from rural ponds of Kurukshetra district of Haryana. However, Alfred et al. [14] showed that 216 wetland bird species from various wetland habitats in the much more expansive Sub-Himalayan Terai and Indo-Gangetic Plains of North India.

Of total 49 bird species recorded in the present study, 5 (10.20%) were summer migrant, 22 (44.90%) were resident, and 22 (44.90%) were winter migrant (Table 1). This occurrence of significant number of winter migratory birds can be attributed to the fact that the study area is located in the Central Asian Flyway of migratory birds and serve as a wintering and stopover site for migratory birds that breed in the

Table 1. List of wetland bird species recorded at Jyoti Sarovar, Kurukshetra, Haryana. *Species included in Appendix II of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora, 2012); WM-Winter Migrant; R-Resident; SM-Summer Migrant; C-Common; FC-Fairly Common; UC-Uncommon; RA-Rare ; IUCN-International Union for Conservation of Nature and Natural Resources ; IWPA-Indian Wildlife Protection Act; NT-Near threatened ; LC-Least concern; IV-Schedule IV of IWPA, I-Schedule I of IWPA.

Sl. No.	Order/Family/Common name	Scientific name	Residential status	Local abundance	Conservation status IUCN (2017)	IWPA (1972)
	ANSERIFORMES					
	Anatidae					
1.	Lesser Whistling Duck	*Dendrocygna javanica* (Horsfirld, 1821)	SM	FC	LC	IV
2.	Northern Shoveler	*Spatula clypeata* (Linnaeus, 1758)	WM	C	LC	IV
3.	Gadwall	*Mareca strepera* (Linnaeus, 1758)	WM	FC	LC	IV
4.	Indian Spot-billed Duck	*Anas poecilorhynca* J.R. Forster, 1781	WM	UC	IC	IV
5.	Mallard	*Anas platyrhyncos* Linnaeus, 1758	WM	RA	IC	IV
6.	Common Teal	*Anas crecca* Linnaeus, 1758	WM	RA	IC	IV
7.	Comb Duck	*Sarkidiornis melanotos* (Pennant, 1769)	SM	RA	LC	IV
8.	Cotton Teal	*Nettapus coromandelianus* (J. F. Gmelin, 1789)	SM	FC	LC	IV
	PHOENICOPTERIFORMES					
	Podicipedzidae					
9.	Little Grebe	*Tachybaptus ruficollis* (Pallas, 1764)	R	C	LC	IV
	GRUIFORMES					
	Rallidae					
10.	White-breasted Waterhen	*Amaurornis phoenicurus* (Pennant, 1769)	R	FC	LC	IV
11.	Purple Swamphen	*Porphyrio porphyrio* (Linnaeus, 1758)	R	FC	LC	IV
12.	Common Moorhen	*Gallinula chloropus* (Linnaeus, 1758)	WM	FC	LC	IV
13.	Common Coot	*Fulica atra Linnaeus,* 1758	WM	C	LC	IV
	PELECANIFORMES					
	Ciconiidae					
14.	Painted Stork	*Mycteria leucocephala* (Pennant, 1769)	WM	RA	NT	IV
15.	Asian Openbill	*Anastomus oscitans* (Boddaert, 1783)	WM	RA	LC	IV
	Ardeidae					
16.	Black-crowned Night Heron	*Nycticorax nycticorax* (Linnaeus, 1758)	R	UC	LC	IV
17	Indian Pond Heron	*Ardeola grayii* (Sykes, 1832)	R	C	LC	IV
18.	Cattle Egret	*Bulbulcus ibis* (Linnaeus, 1758)	R	C	LC	IV
19.	Grey Heron	*Ardea cinerea* Linnaeus, 1758	R	FC	LC	IV
20.	Purple heron	*Ardea purpurea* Linnacus, 1766	R	FC	LC	IV
21.	Great Egret	*Ardea alba* Linnaeus, 1758	WM	FC	LC	IV
22.	Intermediate Egret	*Ardea intermedia* Wagler, 1829	WM	FC	LC	IV
23.	Little Egret	*Egretta garzetta* (Linnaeus, 1766)	R	C	LC	IV
	Threskiornithidae					
24.	Black-headed lbis	*Threskiornis melanocephalus* (Latham, 1790)	R	RA	NT	IV
25.	Indian Black lbis	*Pseudibis papillosa* (Temminck, 1824)	R	RA	LC	IV
26.	Glossy lbis	*Plegadis falcinellus* (Linnaeus, 1766)	R	RA	LC	IV
	Phalacrocoracidae					
27.	Little Cormorant	*Microcarbo niger* (Vieillot, 1817)	R	C	LC	IV
28.	Great Cormorant	*Phalacrocorax carbo* (Linnaeus, 1758)	WM	FC	LC	IV
29.	Indian Cormorant	*Phalacrocorax fuscicollis* Stephens, 1826	WM	UC	LC	IV
	CHARADRIIFORMES					
	Recurvirostridae					
30.	Pied Avocet	*Recurvirostra avosetta* Linnaeus, 1758	WM	RA	LC	IV
31.	Black-winged Stilit	*Himantopus himantopus* (Linnaeus, 1758)	R	C	LC	IV
	Charadriidae					
32.	Red-wattled Lapwing	*Vanellus indicus* (Boddaert, 1783)	R	C	LC	IV
33.	White-tailed lapwing	*Vanellus leucurus* (M.H.C. Lichtenstein, 1823)	WM	FC	LC	IV
	Rostratulidae					
34.	Greater Painted-snipe	*Rostratula benghalensis* (Linnaeus, 1758)	SM	RA	LC	IV

Table 1. Continued.

Sl. No.	Order/Family/Common name	Scientific name	Residential status	Local abundance	Conservation status IUCN (2017)	IWPA (1972)
	Jacanidae					
35.	Pheasant-tailed Jacana	*Hydrophasianus chirurgus* (Scopoli, 1786)	SM	RA	LC	IV
36.	Bronze-winged Jacana	*Metopidius indicus* (Latham, 1790)	R	FC	LC	IV
	Scolopacidae					
37.	Common Sandpiper	*Actitis hypoleucos* (Linnaeus, 1758)	WM	UC	LC	IV
38.	Common Greenshank	*Tringa nebularia* (Gunnerus, 1767)	WM	FC	LC	IV
39.	Common Redshank	*Tringa totanus* (Linnaeus, 1758)	WM	FC	LC	IV
	Laridae					
40.	River Tern	*Sterna aurantia* J. E. Gray,1831	R	FC	NT	IV
	ACCIPITRIFORMES					
	Aceipitridae					
41.	Brahminy Kite*	*Haliastur Indus* (Boddaert, 1783)	R	FC	LC	I
	CORACIIFORMES					
	Alcedinidae					
42.	Pied Kingfisher	*Ceryle rudis* (Linnaeus, 1758)	R	UC	LC	IV
43.	White-throated Kingfisher	*Halcyon smyrnensis* (Linnaeus, 1758)	R	FC	LC	IV
	PASSERIFORMES					
	Motacillidae					
44.	White Wagtail	*Motacilla alba* Linnaeus, 1758	WM	FC	LC	IV
45.	White-browed Wagtail	*Matacilla maderaspatensis* J.F. Gmelin, 1789	R	FC	LC	IV
46.	Citrine Wagtail	*Motacilla flava Linnaeus,* 1758	WM	FC	LC	IV
47.	Western Yellow Wagtail	*Motacilla flava Linnaeus,* 1758	WM	FC	LC	IV
48.	Grey Wagtail	*Motacilla cinerea Tunstall,* 1771	WM	UC	LC	IV
	Hirundinidae					
49.	Wire-tailed Swallow	*Hirundo smithii* Leach, 1818	R	FC	LC	IV

Palaearctic region. These migratory birds constitute a major component of water bird assemblage in various wetland habitats of northern India [4, 14–17]. Majority of winter migrants were recorded to stay at Jyoti Sarovar from November to March. On the basis of local abundance, 11 species were assessed to be

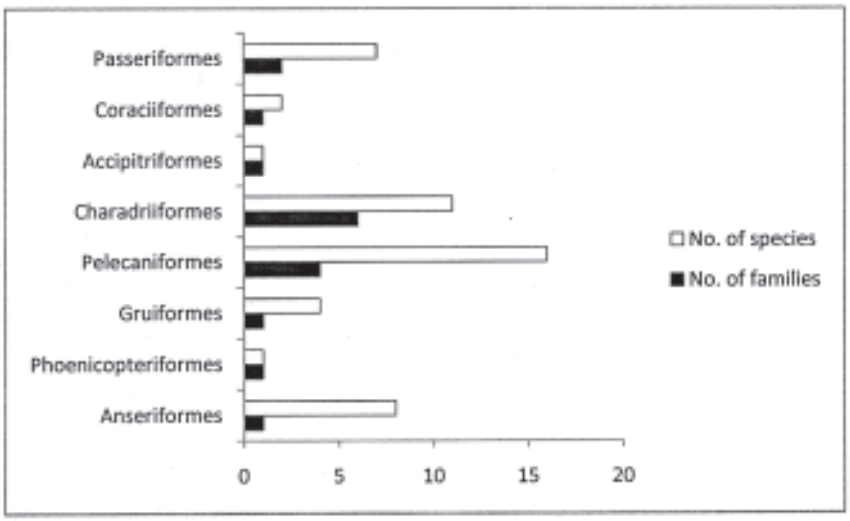

Fig. 1. Distribution of recorded wetland birds in different avian orders and families.

Table 2. Family wise distribution of wetland bird species recorded in the study area.

Sl. No.	Family	No. of species recorded	Proportion of the family (%)
1.	Anatidae	8	16.33
2.	Podicipedidae	1	2.04
3.	Rallidae	4	8.16
4.	Ciconiidae	2	4.08
5.	Ardeidae	8	16.33
6.	Threskiornithidae	3	6.12
7.	Phalacrocoracidae	3	6.12
8.	Recurvirostridae	2	4.08
9.	Charadriidae	2	4.08
10	Rostratulidae	1	2.04
11.	Jacanidae	2	4.08
12.	Scolopacidae	3	6.12
13.	Laridae	1	2.04
14.	Accipitridae	1	2.04
15.	Alcedinidae	2	4.08
16.	Motacillidae	5	10.20
17.	Hirundinidae	1	9.76

rare, 6 species as uncommon, 23 species as fairly common and 9 species as common in the study area (Table 1).

A peak in wetland bird assemblage (443 individuals) was recorded in the month of January 2015, whereas lowest count (99 individuals) was observed in the month of August 2014 (Table 3). Species richness was recorded to be highest (n=44) in the month of January and lowest (n=22) during the months of August and September. Similarly, species diversity was calculated to be maximum (H=3.30) in the month of January and minimum (H=2.59) in the month of June. The wetland birds were recorded to be more evenly distributed (E=0.90) in the month of May and less evenly distributed in the month of June (E=0.80). January is winter month when most of the migratory birds visited the religious wetland, and constituted the highest species diversity along with resident birds.In contrast, in the warmer months of August and September, the absence of migratory bird species resulted in low species diversity [5, 15–17]. After the peak population of wetland birds in the month of January, species richness and species diversity started declining through March with the important observation of migratory birds departing in larger flocks. This reduction in the population of wetland birds during summer months may be due to rise in temperature, low food availability and movement of migratory avifauna to other suitable wetlands [17]. The sacred wetland by supporting different aquatic fauna (crustaceans, aquatic insects, fish, and amphibians), aquatic plants and planktons as the primary feed, and also irrigated crop fields flanking the religious wetland probably provided suitable foraging grounds for the resident as well as few migratory wetland birds, which further added to their diversity [5]. The trees at the banks of the ponds were utilized by cormorants, egrets, herons, storks, kites and kingfishers, for roosting and nesting.

Table 3. Monthly variations in species richness, species diversity and species evenness of wetland birds in the study area.

Sl. No.	Month	Species richness (n)	No. of birds recorded (N)	Shannon index (H)	Evenness index (E)
1.	Apr	26	132	2.88	0.88
2.	May	27	135	2.95	0.90
3.	Jun	25	149	2.59	0.80
4.	Jul	23	119	2.68	0.85
5.	Aug	22	99	2.68	0.87
6.	Sep	22	108	2.60	0.84
7.	Oct	25	140	2.69	0.83
8.	Nov	32	262	2.91	0.84
9.	Dec	41	370	3.27	0.88
10.	Jan	44	443	3.30	0.87
11.	Feb	37	251	3.20	0.88
12.	Mar	32	169	3.04	0.87
	Overall	49	2377	3.34	0.8590

Among recorded species, Painted Stork *(Mycteria leucocephala)*, Black-headed Ibis *(Threskiornis melanocephalus)* and River Tern *(Sterna aurantia)* are listed as Near Threatened species, and all the remaining species (n=46) are placed in the Least Concern category in the Red List of IUCN (Table 1). Additionally, Brahminy Kite *(Haliastur indus)* is listed in Appendix II of CITES [14]. All the recorded wetland bird species have a protected status under the Schedule IV of Indian Wildlife (Protection) Act, 1972, except Brahminy Kite, which is listed in the Schedule 1 (Table 1). The results of this study underline the importance of sacred wetland as a habitat for wetland birds including migratory species as well as species with conservation priorities. Long-term monitoring of wetland bird assemblage over the years is an excellent means to assess the ecological health of this wetland and thus might be useful to foster its sustainable improvement.

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