Human interference and avifaunal diversity of two wetlands of Jalpaiguri, West Bengal, India

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Abstract: Avifaunal diversity and abundance were studied in two wetlands of Jalpaiguri District, West Bengal, India, in relation to eight wetland characteristics supposedly directly or indirectly affected by human activities. Although the climatic and geophysical conditions of both the wetlands are almost similar, a total of 80 bird species were recorded from one wetland and the other supported only 42 species. The relationship between habitat characteristics and community structure varied throughout the year, suggesting that the birds respond differently to one or other habitat characteristic depending on the season. Larger wetland size supported higher bird diversity and abundance as far as resident and local migrants are concerned. Winter migrant density and diversity, however, reached higher values in structurally more heterogeneous wetlands having fewer submerged aquatic vegetation. All these habitat characteristics become highly influenced by intense agricultural practices in the wetland with fewer bird diversity and density.

Keywords: Habitat heterogeneity, human interference, Jalpaiguri, submerged aquatic vegetation, waterbirds, wetlands.

INTRODUCTION

Although wetlands are one of the most productive ecosystems and most severely affected habitats next to tropical forests, they are being neglected in densely populated countries like India. In the last century, over 50% of wetlands in the world have been lost, and the remaining wetlands have been degraded to different degrees because of the adverse influence of human activities (Fraser & Keddy 2005).

Wetlands harbour a large number of threatened birds, in addition to a variety of wildlife and are vital to their conservation. At least 20% of the threatened bird species inhabit wetlands in the Asiatic region which is far more than the 10% of the globally threatened brids (Kumar et al. 2005). Out of 310 Indian wetland birds, 107 species are winter migrants (Kumar et al. 2005). Migratory waterfowls are one of the most remarkable components of global biodiversity (Li & Mundkur 2004). Waterbirds are not only the most prominent groups which attract people to wetlands, but also are good bioindicators and useful models for studying a variety of environmental problems (Urfi et al. 2005).

The wetlands of South Asia are facing tremendous anthropogenic pressure, which can greatly influence the structure of the bird community (BirdLife International 2003). The loss of waterbird habitats through direct and indirect human interferences has led to a decline in several waterbird populations. Therefore, it is vital to understand the underlying causes for the decline in populations and to control these trends in order to prevent the loss of key components of the biodiversity of wetland habitats. In this study, the diversity and richness of waterbirds of two almost similar wetlands were analyzed, to identify the consequences of direct and indirect human interferences.

STUDY AREA

Both the study sites (Gajoldoba Beel and Domohani Beel) are perennial cut-off meanders by the left side of Teesta River in Jalpaiguri District of West Bengal, India. Gajoldoba Beel (26.763897N & 88.597498E) with an area of about 148ha is situated by the side of the Gajoldoba barrage and about 26km upstream to Domohani Beel (26.569688N & 88.765644E) having an area of about 52ha. The Gajoldoba Beel is managed by the state-owned Teesta Barrage Division, Odlabari, while the Domohani Beel is privately owned. The average rainfall of this region is about 3160mm and the average temperature ranges from 32.8^0C (max) to 6.9^0C (min).

The Gajoldoba Beel is connected with the river Teesta, therefore, its water level fluctuates in synchrony with the river. The region experiences about 78% rainfall during the monsoon (June to September) and only 0.98% rainfall during winter (December to February), however, Gajoldoba Beel experiences the highest water level during the winter season because during that period most of the gates of the barrage remain closed. Domohani Beel, on the other hand, becomes connected with the river Teesta only during the period of the monsoon and the water level in this wetland fluctuates with the normal hydrological cycle of the region.

The flora of both the wetlands is typical of this region; but Domohani Beel is infested with more pollution tolerant aquatic plants. There is no floating vegetation in about 50% of the area of Gajoldoba Beel, however, all parts of Domohani Beel is infested with floating vegetation like *Eichornia crassipes, Trapa natans, Wolffia arrhiza, Nymphea odorata, Nymphea pubescens, Nymphoides cristatum, Jussiaea repens, Neptunia natans, Hygrophila polysperma*, etc. Prominent floating hydrophytes at Gajoldoba Beel are *Nymphea odorata, Nymphoides cristatum, Spirodela polyrrhiza* and few patches of *Eichornia crassipes*. Among suspended and submerged vegetation *Ceratophyllum demersum, Utricularia flexuosa,* and *Hydrilla verticillata* were found in both the wetlands but *Vallisneria spiralis* was found only at Gajoldoba. Emergent vegetations were predominant in many parts of Gajoldoba Beel, which were not so common in most parts of Domohani Beel. The most notable emergent hydrophytes were *Ammania baccifera, Cyperus corymbosus, Cyperus cephalotes, Limnophila indica, Scirpus articulatus, Potamogeton nodosus,* and *Potamogeton pectinatus*. *Typha latifolia* was found only in Gajoldoba Beel but not in Domohani; similarly wetland grasses like *Phragmites* were common in Domohani Beel but were totally absent in Gajoldoba.

METHODS

Both the wetlands were surveyed twice a month from March 2009 to August 2010. To estimate the number of individuals of each species and to record all sorts of birds and human activities more than 200 hours were spent in each wetland from dawn to dusk.

Each wetland was divided into three zones (viz. G1, G2, G3 for Gajoldoba and D1, D2, D3 for Domohani) for convenience of study considering the physical boundaries (mainly spurs of embankment), vegetation characteristics, bird species and human activities. The presence of humans was documented separately in each zone by instantaneous sampling during the morning (at about 0730hr) and afternoon (at about 1630hr) when such activities touch the highest magnitude. Direct human interference was measured in terms of average number of persons present in a one-hour duration in a particular zone. Besides getting data about direct human interference from direct observations, on site queries were made to several people to learn about the types and magnitude of indirect human interference.

Major impacts of human interference in wetlands were eutrophication and conversion of land. To measure these effects, six parameters, namely, water phosphate content, percentage of floating vegetation (mostly water hyacinth), relative abundance of submerged aquatic vegetation (in terms of percentage of submerged aquatic vegetation present in a unit area of water), depth of water (average value of various records of depths measured about the center of the zone), total water covered area and heterogeneity of the zones (in terms of differential topographical and vegetation characteristics and human use; e.g. deep/ shallow/no water zones, with floating/submerged/ emergent vegetations, with cultivated/noncultivated areas, etc.) were recorded periodically. Also data regarding magnitude of grazing (in terms of the average number of cattle present) were collected to predict the impact of human interference.

Bird counts were done between sunrise and 1000hr and between 1500hr and sunset, using binoculars (Olympus 10×50). On each day of observations, surveys began from vantage points, from where most of the surface area and edge were visible, and bird species were identified and counted (Bibby et al. 2000). Hidden and cryptic birds were flushed by walking around the perimeter and identified. Additionally, a walk was undertaken through the emergent vegetation zone and inaccessible parts of the wetlands were accessed by boat to count all the birds seen or heard within the wetlands. Species were identified using Grimmett et al. (1998), Kazmierczak & van Perlo (2000) and Kumar et al. (2005).

For every zone of both wetlands, nesting status of each species was determined. A species was considered nesting if its nest, eggs or young were found; and a probable nester if it displayed behaviour consistent with nesting and there were suitable nesting sites available. Status of the migratory birds was ascertained as per the available literature (Ali & Ripley 1988; Grimmett et al. 1998; Kumar et al. 2005).

The Pearson's Correlation Coefficient (r_p) was used for the simple relationship analyses between the variables. Data, which departed from normal distribution were logarithmically transformed. Forward stepwise multiple regression analysis was done for each period, using premonsoon (April–May), Monsoon (July–August) and Winter (December–January), with the number of birds as dependent variable and the characteristics of the wetlands having simple significant relationship with the number of species in the wetlands as independent variables.

RESULTS

Bird assemblages

In the two wetlands, a total of 86 bird species were recorded (Appendix 1). Eighty species were recorded at Gajoldoba Beel, and 42 species were recorded at Domohani Beel. Out of the 80 species recorded at Gajoldoba, 44 species were exclusive to this wetland. Of these 44 exclusive species, 32 species (Anatidae being dominant) were winter migrants or passage migrants, one summer migrant and 11 were residents or local migrants. Out of 42 species recorded from Domohani Beel, only six species were exclusive to this wetland. Of these six species, only one (*Vanellus cinereus*) was a winter migrant and the remaining five were residents or local migrants. Winter migrating duck avoided Domohani Beel. During this study period only twice, for very short periods, wintering ducks (total eight in number) were found to settle at Domohani Beel. Most of the winter migrants at the Domohani Beel were shorebirds (mainly wagtails, sandpipers and plovers). The density (number per unit area) of winter migrants at Gajlodoba Beel was significantly higher than at Domohani Beel (Table 1). However, population density of resident or local migrants (in pre-monsoon and winter season) and nesting bird density were significantly higher at Domohani Beel. Only the resident/local migratory birds used these wetlands for breeding and other purposes during the monsoon period and their density was not significantly different (Table 1) at the two wetlands.

Types and magnitude of direct human interferences

Local people used both the wetlands for various purposes (Table 2) for their livelihood, fishing being most common activity. At Gajoldoba Beel the type

Table 1. Density (number per hectare) of birds of different status and season

	Season	Gajoldoba		Domohani			
		Mean	SD	Mean	SD	t	p
Winter migrants	Winter	28.2	3.61	10.8	1.14	9.16	<0.001
Nesting birds	Monsoon	1.89	0.23	5.69	2.1	6.16	<0.001
Residents/local migrants	Pre-monsoon	7.28	0.87	35.38	1.86	27.36	<0.001
	Monsoon	8.03	0.56	8.97	1.31	1.3	>0.05
	Winter	6.54	0.32	17.05	2.14	9.7	<0.001

t - value of t-test; p - probability value to determine statistically significant result.

Table 2. Types and magnitude (number of persons involved per hour) of human interferences.

Activities	Gajoldoba			Domohani		
	PM	M	W	PM	M	W
Fishing	14.7	16.8	16.1	6.2	16.6	14.5
Agricultural works	0.1	0.2	0	19.3	4.7	6.8
Collection of plants	0.2	0.2	0.3	1.8	0.2	0.2
Hunting of birds	0	0	0	0	0	0.1
Other activities	0.2	0.2	2.2	0.7	0.9	1.1

PM - Pre-monsoon, M - Monsoon, W - Winter

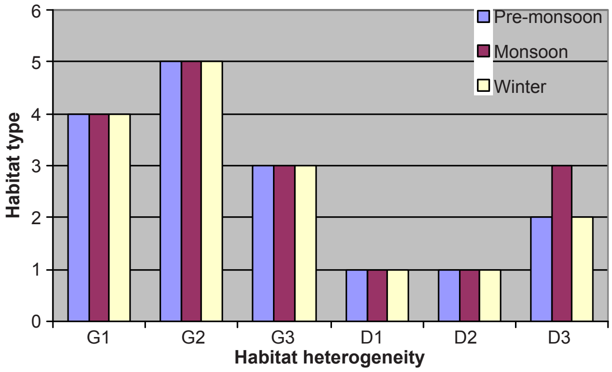

Figure 1. Degrees of habitat heterogeneity at different zones of Gajoldoba (G1, G2, G3) and Domohani (D1, D2, D3) beels at different seasons. Scale on the Y axis signifies type of habitat within each zone.

and magnitude of human use remained almost the same through all the seasons. At Domohani Beel also the fishing activity was high during monsoon and winter. However, during the drier parts of the year intense agricultural work (in almost 80% area) was observed. During winter, a considerable number of tourists and picnic parties visited Gajoldoba, however, the birds were indifferent to such disturbances. Hunting of birds (with indigenous weapons) was reported only twice during winter at Domohani. During January to March, most parts of the Domohani Beel are used for 'Rabi' (Boro) rice cultivation. For that purpose, the land was cleared and leveled, ridges and embankments were built up, cultivated land was flooded with the remaining wetland water, and insecticides were sprayed indiscriminately. As a result, the areas with intense agricultural activities seemed as having no vegetative or topographical heterogeneity (Fig. 1).

Relationships between bird assemblages and human influenced wetland variables

Out of eight parameters only five were significantly correlated with the number of waterbird species (Table 3). Direct human interference, grazing, and phosphorus content in the covered area and the percentage of submerged aquatic vegetation were significantly correlated with bird species numbers in all the seasons. Average depth of wetland and habitat heterogeneity were significant in the premonsoon and winter seasons but not during the monsoon period. Floating vegetation percentage was significantly correlated with waterbird species numbers only during the monsoon period.

The five significantly correlated parameters were entered in forward stepwise multiple regression analysis separately for the resident / local migratory birds (for all seasons), winter migrants (for winter period), and nesting birds (Table 4). In winter, the number of migratory birds was best predicted by habitat heterogeneity. Habitat heterogeneity was also the major characteristic that best predicted the wintering migratory duck assemblage. However, wintering migratory bird density was best predicted by the percentage of submerged aquatic vegetation. The number of resident or local migratory birds was best predicted by the total water covered area and also it was positively related to the presence of submerged vegetation. However, average depth of the water body and the presence of floating vegetation had a negative impact on the number of resident or local migrants through all the seasons (Table 4). The nesting bird population was best predicted by the percentage of floating vegetation covered area and the total water covered area.

DISCUSSION

Although the climatic and geophysical conditions of these two wetlands are almost identical, there is a considerable difference in waterbird diversity. Winter migrants, particularly the wintering ducks, are not attracted to Domohani Beel. However, residents and local migrants use both the wetlands with almost the same zest. As far as type and magnitude of human interferences are concerned, both the wetlands face almost similar problems during the monsoon and pre-monsoon periods. In winter, the boro cultivation, which is practised intensively only at Domohani Beel

Table 3. Statistical relationships between wetland characteristics and number of waterbird species

Variables	Premonsoon period		Monsoon period		Winter period	
	r	p	r	p	r	p
1. Direct human interference (encounter rate)	-0.12	n.s.	0.4	n.s.	-0.11	n.s.
2. Coverage of water surface by floating	-0.23	n.s.	0.88	<0.001	-0.34	n.s.
Vegetation (%)						
3. Average depth (m)	0.9	<0.001	0.14	n.s.	0.82	<0.001
4. Submerged aquatic vegetation (%)	-0.57	<0.05	0.74	<0.01	-0.91	<0.001
5. Water covered area (%)	0.96	<0.001	0.82	<0.001	0.88	<0.001
6. Habitat heterogeneity (number of types)	0.93	<0.001	-0.38	n.s.	0.96	<0.001
7. Total phosphorus in water (mg/l)	-0.4	n.s.	0.22	n.s.	-0.32	n.s.
8. Number of cattle per hectar	-0.38	n.s.	0.24	n.s.	-0.40	n.s

r - Pearson's correlation coefficient; p - probability value to determine statistically significant result; n.s. - not significant.

Table 4. Results of the forward stepwise multiple regression test for the resident/local migrants, winter migrants and nesting birds, using the number of birds as dependent variables and the wetland characteristics significantly correlated with the number of species as independent variables. Analysis based on logarithmically transformed data of the variables 2, 3, 4, 5 in the Table 3. Level of significance: *p ≤ 0.05, **p ≤ 0.001, ***p ≤ 0.0001.

Variables included in the Model	r^2	Adjusted r^2	F	b	t	p
Winter migrants			$F_{1,23}$			
	0.643	0.627	39.636			***
Habitat heterogeneity				0.802	6.296	***
Migratory wintering ducks						
	0.612	0.594	34.659			***
Habitat heterogeneity				0.782	5.887	***
Winter migrant density						
	0.642	0.626	39.52			***
Submerged aquatic vegetation (%)				-0.801	-6.286	***
Residents/Local migrants			$F_{4,53}$			
	0.788	0.77	45.475			***
Water covered area				1.765	9.484	***
Average depth				-0.959	-5.167	***
Submerged aquatic vegetation (%)				0.537	4.722	***
Floating vegetation covered area (%)				-0.328	-2.904	**
Nesting birds			$F_{2,23}$			
	0.88	0.869	77.155			***
Floating vegetation covered area (%)				0.9	11.913	***
Water covered area				0.27	3.578	**

r^2 - coefficient of determination; F - value of F test

and not attracting any migratory duck species, opens up the scope of exploring a possible relationship between the absence of wintering ducks and 'boro' cultivation.

As the results suggest, direct human interferences do not impose any real threat to the birdlife of these two wetlands. Possibly general awareness of the people of this region and the surveillance of the Gajoldoba barrage authority have restricted people from doing any harm to the birds. However, intense agricultural activities have changed the wetland habitat variables at Domohani Beel and that in turn has influenced the bird life.

There exists a strong positive correlation between habitat size and species diversity that consistently corresponds with results of other studies in a variety of environments (Sillen & Solbreck 1977; Brown & Dinsmore 1986; Opdam 1991; Andren 1994; Turner 1996; Babbitt 2000; Paracuellos & Telleria 2004; Gonzalez-Gajardo et al. 2009). The only other wetland characteristic, which is significantly correlated with waterbird species diversity during all the seasons, is submerged aquatic vegetation. Interestingly submerged aquatic vegetation percentage was positively correlated with avifauna diversity in the monsoon period but there exists significant negative correlation between these two parameters during winter and premonsoon periods. During the monsoon period, mostly nondiving wading and dabbling birds are found in this region and these birds prefer foraging for submerged vegetation in shallow water, even when food is in abundance in deeper water (Holm & Clausen 2006). Wintering birds, however, preferred to forage in water with less submerged vegetation.

As expected, a number of variables were associated with the densities of waterbirds during the monsoon period. Water covered area is the most important criterion that dictates bird number positively but the average depth of the water body has a negative impact on bird numbers. Many studies have indicated that water depth affects waterbird diversity (Velasquez 1992; Elphick & Oring 1998; Colwell & Taft 2000; Isola et al. 2002; Darnell & Smith 2004). Non-diving waterbirds generally prefer to forage in shallow water. As the wading and dabbling birds are the dominant waterbird groups in most regions worldwide, the greatest waterbird diversity and density generally occur at a relatively shallow water depth (Elphick & Oring 1998, 2003; Colwell & Taft 2000; Isola et al. 2002; Taft et al. 2002). Foraging in shallow water is also beneficial in terms of higher net energy intake (Kushlan 1978; Guillemain & Fritz 2002; Nolet et al. 2002; Sustainable Ecosystems Institute 2007). During the monsoon, when submerged areas are abundant, the greatest concentration of waterbirds is expected in shallow wetlands like Domohani Beel.

Only resident or local migratory birds nested in both the wetlands during the monsoon and the predominance of floating vegetation in the preferred nesting zone supports the views of many other studies that advocate the importance of floating vegetation in the breeding success of many waterbirds (Owen & Black 1990; Froneman et al. 2001; Sánchez-Zapata et al. 2005). Plenty of water hyacinth dominated floating vegetation at Domohani Beel possibly attributes to the higher nesting density in comparison to the Gajoldoba Beel. Lower nesting density at Gajoldoba Beel may also be due to higher water level fluctuation. During the monsoon (nesting season) periodically most of the gates of the barrage remain open resulting in huge fluctuations of water level. In fact the lowest water level at Gajoldoba Beel was recorded during the monsoon period. Water level fluctuations often create “ecological traps” and are detrimental for breeding birds (Kaminski et al. 2006). Many studies have shown that the brood densities of waterbirds are greater on wetlands with stable water levels than on seasonally flooded wetlands (e.g., Ogden 1991; Connor & Gabor 2006).

In this study habitat heterogeneity was found to be the key component to attract winter migrants and more specifically the wintering ducks. Many studies have demonstrated the importance of habitat heterogeneity in wetland bird richness and abundance (Svingen & Anderson 1998; Edwards & Otis 1999; Fairbairn & Dinsmore 2001; Riffel et al. 2001; Zárate-Ovando et al. 2008; Gonzalez-Gajardo et al. 2009). At present Domohani Beel does not attract the wintering ducks possibly because of its loss of habitat heterogeneity. Intense agricultural practices during drier parts of the season make it impossible to maintain structural heterogeneity, both in terms of vegetative heterogeneity and topographical heterogeneity. Thick submerged aquatic vegetation also appeared as a deterrent factor for winter migrants. Predominance of such vegetation at Domohani Beel possibly came as an artifact of agricultural eutrophication. The run-off from agricultural land enters the wetland causing an increase in the nutrient concentrations of soil and water. The most evident results of the nutrient input are the replacement of the primary native species with hypertrophy tolerant species. This in turn alters the ecosystem considerably. Nutrient-enriched water bodies thus get choked with excessive growths of aquatic macrophytes (Roelofs 1983; Wright 2009).

In summary, species richness and bird abundance was fundamentally affected by attributes of the size of the water covered area, particularly in case of local migrants and resident birds. Diversity and abundance of wintering migratory birds appears to be affected more by habitat heterogeneity, and preponderance of submerged aquatic vegetation played a negative role in this regard. Loss of habitat heterogeneity and predominance of submerged aquatic vegetation in turn appears to be an artifact of agricultural practices. Thus agricultural practices at Domohani Beel are supposed to be the main cause of avoidance by wintering migratory birds. However, local migrants and resident birds are still thriving and breeding successfully in both the wetlands, which indicate that the level of alteration and eutrophication borne out of agricultural practices have not impaired the birdlife totally at Domohani Beel and also it advocates the adaptability of local birds.

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Appendix 1. List and status of birds recorded at Gajoldoba and Domohani beels.

	Common name	Scientific name	Found at	Residential status	Conser-vation status	Abundance status
	Waterbirds					
1	Little Grebe	*Tachybaptus ruficollis*	B	R/LM		Com
2	Great Crested Grebe	*Podiceps cristatus*	G	WM		Ucom
3	Little Cormorant	*Phalacrocorax niger*	B	R/LM		Com
4	Great Cormorant	*Phalacrocorax carbo*	B	WM		Com
5	Little Egret	*Egretta garzetta*	B	R/LM		Com
6	Median Egret	*Mesophoyx intermedia*	B	R/LM		Com
7	Large Egret	*Casmerodius albus*	B	R/LM		Lcom
8	Grey Heron	*Ardea cinerea*	G	WM		Lcom
9	Purple Heron	*Ardea purpurea*	G	R/LM		Lcom
10	Cattle Egret	*Bubulcus ibis*	B	R/AM		Com
11	Indian Pond Heron	*Ardeola grayii*	B	R/LM		Com
12	Black-crowned Night Heron	*Nycticorax nycticorax*	B	R/LM		Lcom
13	Yellow Bittern	*Ixobrychus sinensis*	D	R/LM		Ucom
14	Chestnut Bittern	*Ixobrychus cinnamomeus*	B	R/LM		Lcom
15	Asian Openbill-Stork	*Anastomus oscitans*	B	R/LM		Lcom
16	Black Stork	*Ciconia nigra*	G	WM/PM		Ucom
17	Lesser Adjutant-Stork	*Leptoptilos javanicus*	B	R/LM	VU	Ra
18	Black Ibis	*Pseudibis papillosa*	B	R	BRS(11)	Ucom
19	Lesser Whistling-Duck	*Dendrocygna javanica*	B	R/LM		Lcom
20	Brahminy Shelduck	*Tadorna ferruginea*	G	WM/PM		Lcom
21	Cotton Teal	*Nettapus coromandelianus*	B	R/LM		Lcom
22	Gadwall	*Anas strepera*	G	WM		Com
23	Euresian Wigeon	*Anas penelope*	G	WM		Com
24	Mallard	*Anas platyrhynchos*	G	WM		Ucom
25	Spot-billed Duck	*Anas poecilorhyncha*	G	R/LM		Lcom
26	Northern Shoveller	*Anas clypeata*	G	WM		Com
27	Northern Pintail	*Anas acuta*	G	WM		Com
28	Garganey	*Anas querquedula*	G	WM		Com
29	Common Teal	*Anas crecca*	G	WM		Com
30	Red-crested Pochard	*Rhodonessa rufina*	B	WM		Lcom
31	Common Pochard	*Aythya ferina*	G	WM		Lcom
32	Ferruginous Pochard	*Aythya nyroca*	G	WM	NT	Lcom
33	Baer's Pochard	*Aythya baeri*	G	WM	VU	Ra
34	Tufted Pochard	*Aythya fuligula*	G	WM		Lcom
35	Smew	*Mergellus albellus*	G	WM		Ra
36	Blue-breasted Rail	*Gallirallus striatus*	G	R/LM		Ucom
37	Brown Crake	*Amaurornis akool*	G	R/LM		Ucom
38	White-breasted Waterhen	*Amaurornis phoenicurus*	B	R		Com
39	Common Moorhen	*Gallinula chloropus*	B	R/WM		Com
40	Watercock	*Gallicrex cinerea*	D	R/LM		Lcom
41	Bronze-winged Jacana	*Metopidius indicus*	B	R		Lcom
42	Greater Painted Snipe	*Rostratula benghalensis*	D	R/LM		Lcom
43	European Golden Plover	*Pluvialis aspricaria*	G	WM		Va
44	Little Ringed Plover	*Charadrius dubius*	G	R/WM		Com

	Common name	Scientific name	Found at	Residential status	Conser-vation status	Abundance status
45	Kentish Plover	*Charadrius alexandrinus*	B	R/WM		Lcom
46	Northern Lapwing	*Vanellus vanellus*	G	WM		Lcom
47	Yellow-wattled Lapwing	*Vanellus malabaricus*	D	R/LM	BRS(11)	Lcom
48	River Lapwing	*Vanellus duvaucelii*	B	R/LM		Lcom
49	Grey-headed Lapwing	*Vanellus cinereus*	D	WM		Ucom
50	Red-wattled Lapwing	*Vanellus indicus*	B	R/LM		Com
51	Common Snipe	*Gallinago gallinago*	B	R/WM		Com
52	Black-tailed Godwit	*Limosa limosa*	G	WM		Lcom
53	Common Redshank	*Tringa totanus*	G	R/WM		Com
54	Spotted Greenshank	*Tringa guttifer*	G	WM	EN	Va
55	Green Sandpiper	*Tringa ochropus*	G	WM/PM		Lcom
56	Wood Sandpiper	*Tringa glareola*	B	WM		Lcom
57	Common Sandpiper	*Actitis hypoleucos*	B	R/WM		Lcom
58	Black-winged Stilt	*Himantopus himantopus*	G	R/LM		Com
59	Small Pratincole	*Glareola lactea*	B	R/LM		Lcom
60	Common Tern	*Sterna hirundo*	G	R/WM		Lcom
61	Whiskered Tern	*Chlidonias hybridus*	G	R/WM/PM		Lcom
62	White-winged Black Tern	*Chlidonias leucopterus*	G	WM/PM		Ucom
	Water Associated Birds					
63	Brahminy Kite	*Haliastur indus*	G	R/LM		Lcom
64	Pallas's Fish-Eagle	*Haliaeetus leucoryphus*	G	R/WM	VU	Ra
65	Greater Grey-headed Fish-Eagle	*Ichthyohaga ichthyaetus*	G	R	NT	Ucom
66	Eastern Marsh Harrier	*Circus spilonotus*	B	WM		Lcom
67	Osprey	*Pandion haliaetus*	G	WM		Ucom
68	Peregrine Falcon	*Falco peregrinus*	G	WM		Ucom
69	Small Blue Kingfisher	*Alcedo atthis*	B	R/WM/SM		Com
70	White-breasted Kingfisher	*Halcyon smyrnensis*	B	R/LM		Com
71	Lesser Pied Kingfisher	*Ceryle rudis*	B	R		Com
72	Blue-tailed Bee-eater	*Merops philippinus*	B	R/WM		Lcom
73	Chestnut-headed Beeeater	*Merops leschenaulti*	G	R		Lcom
74	Sand Martin	*Riparia riparia*	G	R/WM		Lcom
75	Pale Martin	*Riparia diluta*	B	R/WM		Lcom
76	Plain Martin	*Riparia paludicola*	G	R/LM		Com
77	Common Swallow	*Hirundo rustica*	G	R/WM		Lcom
78	Red-rumped Swallow	*Hirundo dauria*	G	R/SM/WM		Lcom
79	Streak-throated Swallow	*Hirundo fluvicola*	G	R/SM		Lcom
80	White Wagtail	*Motacilla alba*	B	R/WM/PM		Com
81	Large Pied Wagtail	*Motacilla maderaspatensis*	G	R		Lcom
82	Citrine Wagtail	*Motacilla citreola*	B	R/AM/WM		Lcom
83	Grey Wagtail	*Motacilla cinerea*	B	R/AM/WM		Lcom
84	Water Pipit	*Anthus spinoletta*	B	WM		Lcom
85	White-tailed Stonechat	*Saxicola leucura*	G	R/LM		Lcom
86	Rufous-rumped Grass-Warbler	*Graminicola bengalensis*	D	R		Lcom

B - Both wetlands; G - Gajoldoba beel; D - Domohani beel; R - Resident; LM - Local migrant; AM - Altitudinal migrant; PM - Passage migrant; SM - Summer migrant; WM - Winter migrant; EN - Endangered; VU - Vulnerable; NT - Near Threatened; BRS - Biome-Restricted Species; 11 - Indo-Malayan Tropical Dry Zone; Com - Common (flocks of more than 50 birds recorded regularly/seasonally in this region); Ucom - UnCommon (flocks of 10–50 birds recorded regularly/seasonally); Lcom - Locally common (flocks of more than 50 birds recorded regularly/seasonally in these wetlands); Ra - Rare (flocks of 5–20 birds recorded on a few occasions); Va - Vagrant (a very rare or vagrant species encountered only once during this study period and also recorded from India on only a few occasions).

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