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## Diversity and status of migratory and resident wetland birds in Haridwar, Uttarakhand, India

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### Abstract

Migration is the seasonal habitual movement, exhibited by many avian species along a flyway from breeding to wintering grounds and vice versa all over the world. Migratory birds are very sensitive to even small changes in water level which may be affected by flood or drought on their breeding and wintering grounds. High rains during monsoon season can cause flood conditions in the lower hills and Gangetic plains including Haridwar district. In our study, conducted during last ten years (2009-2018), we covered Bheemgoda Barrage and Missarpur Ganga Ghat of Haridwar, Uttarakhand, where 46 species of Migratory (M) and Resident Migratory (RM) wetland birds were observed. Bird survey indicated that there was a significant increase ( $p = 0.064$ , t-test) in the population of certain species such as Bhraminy Shelduck (67%), Black Headed Gull (31%), Gadwall (7%), Northern Pintail (59%), Red Crested Pochard (10%) and Tufted Pochard (47%) in Missarpur Ganga Ghat as compared to Bheemgoda Barrage (based on the average abundance of the species observed during study period). It may be pointed out that after flood and loss of vegetated island, there was significant decrease ( $p = 0.023$ , t-test) in the population of species such as Black necked stork (76%), Great crested grebe (56), Pallas gull (47%) at Bheemgoda barrage, while some species such as Bar headed goose, Common pochard did not arrive in Bheemgoda barrage after the flood. The study would help to understand the effect of climatic change on water birds species distribution in natural and man-made wetlands.

**Keywords:** Avian Diversity, Migration, Population Status, Wetland birds

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### INTRODUCTION

Migration in bird is one of the fascinating stages of bird life subject to the changes in food availability, habitat or weather. They travel several kilometers across the geographical barriers. They don't have boundaries; many of them come to Indian sub-continent from Russia, Magnolia, China and other

parts of Pala arctic zone. The purpose of migration is to avoid extreme cold conditions of the temperate zone and to spend winter in warm countries like India where food availability is in plenty (Borale *et al.* 1994). The presence or absence of the waterbirds at the wetland is the natural indicator of the health of the ecosystem. Migration

among the birds has always attracted the researchers as well as bird watchers since long ago because of its glory and science behind migration. Water bird monitoring programme is being conducted by several researchers from all over the world which makes the waterbirds one of the most studied groups of animals existing on earth (Bhatt *et al.* 2015). Waterbird survey plays an important role in identification of wetlands of international importance as the waterbirds are thought to be a natural bio-indicators, and provides the basis for the so-called 1 % criterion, as described any wetland which continuously holds 1% or more of a waterbird population is considered to be internationally important under the Ramsar Convention on Wetlands also for identification of priorities for conservation and research for maintenance of wetland bird biodiversity (Kumar and Bhatt 2000). Water birds have many ecological values like aesthetic, sporting and economic values. Waterfowl has been defined as the species of birds that are "ecologically dependent upon wetlands" and "water bird" has been defined as being synonymous with waterfowl by the Ramsar Convention defines. Waterbird consists the families like Anatidae, Anhimidae, Anhingidae, Aramididae, Ardeidae, Balaenicipitidae, Burhinidae, Charadriidae, Ciconiidae, Dromadidae, Gaviidae, Glareolidae, Gruidae, Haematopodidae, Heliornithidae, Eurypygidae, Ibidorhynchidae, Laridae, Pedionomidae, Pelecanidae, Phalacrocoracidae, Phoenicopteridae, Podicipedidae, Rallidae, Recurvirostridae, Rostratulidae, Rynchopidae, Scolopacidae, Scopidae, Sternidae, Thinocoridae, Threskiornithidae etc. (Delany and scott 2002).

Studies have shown that wetlands of India are being degraded due to developmental activities, population growth and the over-exploitation of natural resources (Islam and Rahmani, 2004). The Indian Himalayan region has been explored and well-studied for its biological diversity and ecological values (Bhattacharjee and Bargali 2012). So far about 1313 species of birds have been identified in India and the Indian subcontinent which contributes about 13% of world avian population (Grimmett *et al.* 2013). The western part of Indian Himalayan Region has been recognised as Endemic Bird Area (EBA 128) by Bird Life International (2003) as it shows high regional endemism. It also has 27 Important Bird Areas (IBAs) (Islam and Rahmani 2004; Saini *et al.* 2017).

The populations of several duck species are also declining in India (Islam and Rahmani 2004; Delany and Scott 2006). About 1,186 species of bird (roughly 12% of world's avian species) are threatened with global extinction, out of which 182 are Critically Endangered which are facing a very high risk of complete extinction in near future. Wetlands are very important for conservation of

waterbirds as 20% population of the threatened bird species of Asia inhabit in wetlands. It is about twice of the globally threatened waterbird species (10%). Many avian species are very limited in population and hence these are very close to extinction because of disturbance, destruction or conversion of their habitats and hunting by humans and animals. Of the major waterbird families, the family Anatidae (the ducks, swans and geese) is among the most extensively studied and holding the greatest attraction for man. Illustrations of geese are found in five thousand-year-old Egyptian tombs. Many legends have evolved around wildfowl, particularly swans have been regarded as sacred and possessing magical qualities since ancient times all over the world (Kumar and Bhatt 2000; Saini *et al.* 2017).

Habitat change as conversion and degradation of natural wetlands are major causes of population decline of waterbird of the Asia, which affect nearly all the species categorised as Endangered, Critically endangered, and Vulnerable. Exploitation by humans is another reason for the population decline of waterbirds which affect more than 50% of all threatened bird species. Among this hunting for food and sport contribute 70% and 30% are captured for the wild bird trade. The major causes of wetland degradation are drainage and conversion, including the infilling (or 'reclamation') for agriculture and aquaculture purposes. Dams and irrigation projects are also negatively affecting wetlands (Tak *et al.* 2010). In this context, an attempt has been made to understand the present status of the migratory water birds of Ganga Valley, by compiling information of our study and from the studies based on fieldwork conducted by the other researchers about the migratory birds.

## MATERIALS AND METHODS

**Study area:** The present study was conducted during 2009 to 2018, in the foothills of Himalaya of district Haridwar, Uttarakhand. Comparative study was done between natural wetland (Missarpur) and man-made (Bheemgoda) wetlands. Indian wetlands have been categorized biogeographically by Hussain and Roy 1993. The Bheemgoda Barrage, 17 (water-storage) barrage, is situated at the upstream region (29°58' N, 78°13'E, 249.7m asl) between the Neeldhara and the tributaries of the Ganga river (Fig. 1A) under biogeographic province 4.8.4 (Indo-Gangatic Monsoon forest), covering an area of about 2.5 km<sup>2</sup> while Missarpur is a natural wetland situated 8 km away at the downstream (Fig. 1B) from Bheemgoda Barrage comprising an area of about 1.5 km<sup>2</sup>, under biogeographic province 4.8.4 (Indo-Gangatic Monsoon forest). Bheemgoda barrage area has some aquatic vegetations of *Potamogeton pectinatus*, *Eichhornia crassipes* and *Typha elephantina* with a tree species, *Dalbergia sissoo* is common

around the wetland. Contrary to this, Missarpur wetland has dominant aquatic vegetation of *Eichhornia crassipes*, *Typha elephantine*, *Ipomea fistulosa*, *Potamogeton pectinatus* and *Dalbergia sissoo* with mixed tree species. Haridwar has three prominent seasons like winter (October to March), summer (April to June) and Monsoon (July to September) and the temperature ranges from minimum of 4°C in winter to a maximum 44 °C in summer.

**Field data collection:** The study was conducted between November 2009 and March 2018 at Bheemgoda barrage and Missarpur wetland of Haridwar, Uttarakhand. Out of these wetlands Missarpur is a natural wetland while, Bheemgoda barrage is a manmade wetland. Surveys were carried out for migratory birds during the morning (06.30 - 11.00) and evening (15.30 - 17.00) period from October to March. Population was estimated with the help of point count method (Bibby et al.

2000). During the survey, we walked along the bank of river and selected vantage points 20 - 30 meter away from birds. Regular field visits were done through the study period on alternate days, while excessive foggy and rainy days were avoided as the visibility was decreases during this period. Migratory birds were identified with the help of field guide books viz. Ali (2002), Grimmett et al. (2013), Mohan and Sondhi (2014) and photographs of birds were taken for the record.

**Data analysis:** 'T'-test was applied to estimate the significant difference between natural and manmade wetland habitats. Mean abundance was calculated on the basis of the species composition of an organism of a particular kind relative to the total number of organisms in the area. The percentage of winter migratory and resident birds was calculated on the basis of total number of species. The Shannon- Weavers index [ $H' = - \sum p_i (\ln p_i)$ ] was



**Fig 1.** Showing the study area in Himalayan foothills of district Haridwar, Uttarakhand, India. **A.** Bheemgoda barrage **B.** Missarpur Natural Wetland in the Ganga River, India (Source: Google earth).



**Fig 2.** Water birds at natural and man-made wetland of Haridwar District, Uttarakhand, India. **A.** River Tern **B.** River Lapwing **C.** Painted Stork **D.** Black Necked Stork **E.** Pallas fish eagle **F.** Bar Headed Goose **G.** Ruddy Shelduck **H.** Northern pintail.

used to calculate species diversity indices (Shannon and Weaner 1949). Software was also used for statistical analysis.

**RESULTS AND DISCUSSION**

The avian diversity indices between natural and manmade wetland habitat showed that natural wetland (Missarpur wetland) had maximum diversity values in comparison to manmade wetland (Bheemgoda Wetland) of Haridwar Dist. (Table 1). The abundance of migratory bird species between

Bheemgoada Barrage and Missarpur Ganga Ghat on the basis of status of avifauna before and after flood occurred during 2010 is given in Table 2.

The present study showed forty six avian species (18024 individuals) belonging to 16 families at manmade Bheemgoda Barrage and natural Misarpur wetland area of Haridwar District. Among 46 waterbird species, 24 species were residential birds and 22 were reported as winter visitors (Table 3). The percentage of water bird species and residential bird species was found to be

**Table 1.** Comparison of diversity indices between manmade and natural wetland habitat at Haridwar (Uttarakhand).

Parameters	Bheemgoda Barrage (Manmade wetland)	Missarpur (Natural Wetland)
Location (latitude and longitude)	29°58' N, 78°13' E	29°89' N, 78°14' E
Elevation (m asl)	320m asl	314m asl
Shannon's Diversity (H') (mean diversity)	1.55	2.19
No. of Individual	8381	9643
No. of Migrant species (Non breeder)	12	19
No. of Residential species (Breeder)	16	24

**Table 2.** Mean Abundance of some migratory species at Bheemgoda Barrage and Missarpur Ghat in Ganga Valley after flood in Bheemgoda Barrage at Haridwar (Uttarakhand).

S. N.	Common Name of species	Mean Abundance before flood (2009)		Mean Abundance after flood (2011-15)		Mean Abundance during 2016-2018	
		Bheemgoda Barrage	Missarpur Ganga Ghat	Bheemgoda Barrage	Missarpur Ganga Ghat	Bheemgoda Barrage	Missarpur Ganga Ghat
1.	Ruddy Shelduck	60.50	25.55	12.5	60.18	20.5	65.55
2.	Pintail	14.63	20.15	10.00	35.73	7.17	36.14
3.	Mallard	7.87	3.75	7.39	13.69	6.15	12.5
4.	Red Crested Pochard	13.50	13.47	6.70	14.97	13.00	15.5
5.	Common Teal	22.97	14.00	13.33	17.23	12.5	14.5

**Table 3.** Avian species observed at natural and man-made wetlands in Haridwar (Uttarakhand)

Family	Common Name	Zoological Name	Sta- tus	Mis- sarpur (Natural wetland)	Bheemgo- da barrage (Man-made wetland)	IUCN Sta- tus
Accipitridae	Black Kite	<i>Milvus migrans</i>	R	+	+	LC
	Crested Serpent Eagle	<i>Spilornis cheela</i>	R	+	+	LC
	Bonelli's eagle	<i>Aquila fasciata</i>	R	+	+	LC
Alcedinidae	Pallas's fish eagle	<i>Haliaeetus leucoryphus</i>	WM	+	-	EN
	Blue-eared Kingfisher	<i>Alcedomeninting</i>	R	+	-	LC
	Pied Kingfisher	<i>Cerylerudis</i>	R	+	+	LC
Anatidae	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	R	+	+	LC
	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	R	+	+	LC
	Common Merganser	<i>Mergus merganser</i>	WM	+	+	LC
	Eurasian Teal	<i>Anas crecca</i>	WM	+	+	LC
	Gadwall	<i>Anas strepera</i>	WM	+	+	LC
	Mallard	<i>Anas platyrhynchos</i>	WM	+	-	LC
	Marbled Duck	<i>Marmaronetta angustirostris</i>	R	+	+	LC
	Northern Pintail	<i>Anas acuta</i>	WM	+	+	LC
	Red-crested Pochard	<i>Nettarufina</i>	WM	+	+	LC
	Ruddy Shelduck	<i>Tadorna ferruginea</i>	WM	+	+	LC
	Tufted Duck	<i>Aythya fuligula</i>	WM	-	+	LC
	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	R	+	-	LC
	Bar-headed Goose	<i>Anser indicus</i>	WM	+	-	LC
	Red-crested pochard	<i>Nettarufina</i>	WM	+	-	LC
	Ardeidae	Grey Heron	<i>Ardeacinerea</i>	R	+	+
Indian Pond Heron		<i>Ardeolagrayii</i>	R	+	+	LC
Great Egret		<i>Casmerodius albus</i>	R	+	+	LC
Western Cattle Egret		<i>Bubulcus ibis</i>	R	+	-	LC
Charadriidae	Red-wattled Lapwing	<i>Vanellus indicus</i>	R	+	-	LC
	River Lapwing	<i>Vanellus duvaucelii</i>	R	+	+	NT
Ciconiidae	Woolly-necked Stork	<i>Ciconia episcopus</i>	R	+	+	Vul
	Black-necked stork	<i>Ephippiorhynchus asiaticus</i>	WM	+	+	NT
	Black stork	<i>Ciconia nigra</i>	WM	-	+	LC
Laridae	Painted stork	<i>Mycteria leucocephala</i>	WM	-	+	NT
	Pallas's Gull	<i>Ichthyophaga ichthyaetus</i>	WM	+	-	LC
	Black-headed gull	<i>Chroicocephalus ridibundus</i>	WM	+	+	LC
	Steppe Gull	<i>Larus cachinnans</i>	WM	+	-	LC
	River tern	<i>Sterna aurantia</i>	WM	+	-	NT
Motacillidae	White Wagtail	<i>Motacilla alba</i>	R	+	-	LC
	Western yellow wagtail	<i>Motacilla flava</i>	WM	+	-	LC
Pandionidae	Western Osprey	<i>Pandion haliaetus</i>	WM	+	+	LC
Phalacrocoracidae	Little Cormorant	<i>Microcarboniger</i>	R	+	+	LC
	Great Cormorant	<i>Phalacrocorax carbo</i>	R	+	+	LC
Podicipedidae	Great Crested Grebe	<i>Podiceps cristatus</i>	WM	+	+	LC
	Little Grebe	<i>Tachybaptus ruficollis</i>	R	+	+	LC
Recurvirostridae	Black-winged stilt	<i>Himantopus himantopus</i>	R	+	-	LC
	Pied avocet	<i>Recurvirostra avosetta</i>	WM	+	-	LC
Scolopacidae	Common sandpiper	<i>Actitis hypoleucos</i>	R	+	+	LC
Threskiornithidae	Red-naped ibis	<i>Pseudibis papillosa</i>	R	+	+	LC
Muscicapidae	Black redstart	<i>Phoenicurus ochruros</i>	R	+	-	LC

R: Resident; WM: Winter Migratory; LC: Least Concern; NT: Near Threatened; Vul: Vulnerable

53.33% and 47.22% respectively. Bird survey indicated that there was a significant increase (p = 0.064, t-test) in the population of certain species such as Bhraminy Shelduck

(67%), Black Headed Gull (31%), Gadwall (7%), Northern Pintail (59%), Red Crested Pochard (10%) and Tufted Pochard (47%) in Missarpur Ganga Ghat as compared to Bheemgoda Barrage

(based on the average abundance of the species observed during study period). It may be pointed out that after flood and loss of vegetated island, there was significant decrease ( $p= 0.023$ , t-test) in the population of species such as Black necked stork (76%), Great crested grebe (56%), Pallas gull (47%) at Bheemgoda barrage, while some species such as Bar headed goose, Common pochard did not arrive in Bheemgoda barrage after the flood.

The habitat of the area like vegetation composition and cover are the important factors that are responsible for tandem selection of the habitat and distribution, diversity and richness of the water bird species. Rajpar *et al.* (2011) reported that vegetation composition influences the variety of food resources which increase the abundance of the waterbird species in the area. The deeper water supports the rich density of some species especially of ducks prefer deep open water body for foraging (Saikia and Bhattacharjee, 1993). It has been reported that the population of water residential and migrant birds have declined significantly. (Saini et al 2017). The study showed that among the water bird species, four species viz; River Tern (Fig. 2A) River Lapwing (Fig. 2B), Painted Stork (Fig. 2C) Black-necked stork (Fig. 2 D), are under near threaten category (IUCN) and one species viz Pallas's fish eagle (Fig. 2E) under endangered (IUCN) category at man-made and natural wetland respectively.

The presence of Bar-headed Goose (*Anser indicus*) (Fig. 2F) at Misserpur wetland arrived in winter season from central part of Asia, thereby, indicating that natural wetland favourable for water migratory birds. Ruddy Shelduck (Fig. 2G) and Northern Pintail (Fig. 2H) are the winter migrants in north region of Indian Subcontinent as reported earlier by Bhatt *et al.* (2014). The presence of near threatened species in wetlands of Haridwar indicates the need of conservation effort in this area for water bird species. The restoration practice of wetland sites will save the host variety of plant life, such as emergent vegetation, which can provide shelter for waterbirds. Earlier studies have also reported that both natural (Misserpur) and man-made wetlands (Bheemgoda) are good habitats for water birds and migratory species (Saini *et al.*, 2017).

## Conclusion

Present study suggests that the natural wetland (Misserpur Wetland) of the Haridwar district was more suitable for water bird species as compared to man-made wetland (Bheemgoda Wetland). The natural wetland provided a variety of food, shelter and roosting site for bird species. After the flood in the area of Bheemgoda Wetland, during 2010, most of the water birds shifted to natural wetland due to lack of shelter. The study will help in con-

servation and management of the distribution of water birds species in natural and man-made wetlands in the coming time.

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