

Short Communication:

Waterbird species distribution between natural and manmade wetland in Himalayan foothills of Uttarakhand, India

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Abstract. Saini V, Joshi K, Bhatt D, Singh A, Joshi R. 2017. Short Communication: Waterbird species distribution between natural and manmade wetland in Himalayan foothills of Uttarakhand, India. *Biodiversitas* 18: 334-340. A comparative study on waterbird diversity and abundance was conducted at natural and man-made wetland of District Hardwar from 2010 to 2013. A total of 37 waterbirds belonging to 11 families were recorded of which 14 species were winter migrant in the wetlands of the study area. Among these waterbird species, two species viz. Black-necked Stork, *Ephippiorhynchus asiaticus*; River Lapwing, *Vanellus duvaucelii* were near threatened (IUCN status Ver. 2013.1.) and two species namely Woolly-necked Stork, *Ciconia episcopus*; and Marbled Duck, *Marmaronetta angustirostris* were Vulnerable (IUCN status). The avian species diversity and abundance were recorded significantly high ($t = 4.16$, $p < 0.01$) at natural wetland site. It is also observed that vegetation variety and food availability is the responsible causes of waterbird species variation in the natural and manmade wetland. The results of this study suggest that freshwater natural wetland site is more suitable habitat for short and long-distance water migratory birds. This natural wetland should be protected to enhance the abundance and diversity of water migrant community.

Keywords: Diversity, man-made wetland, migratory species, natural wetland

INTRODUCTION

Globally, natural wetlands are under heavy pressure with increases of human activities and environmental changes (Turner et al. 2000; Froneman et al. 2001). Around the world, some natural wetlands disappeared completely due to the reclamation of wetlands for agriculture and expansion of township. Similarly, some have changed in aquaculture, reservoirs and irrigation canals (Lu et al. 1998). It is well known that the waterbird species are highly dependent on natural marsh habitat (Zakaria et al. 2013). Unfortunately, these natural wetlands are converts to other land uses. Pollution and anthropogenic activities in wetland area have declined the population of water migratory birds (Gaston 1975; Hardy et al. 1987; McKinney 2002). The natural and manmade wetlands support or attract several residents and migrant waterbird (Cowardin et al. 1979; Amezaga et al. 2002; Ismail et al. 2012). Birds utilize wetlands for nesting, breeding, roosting, and rearing young ones and for feeding, resting, shelter and social interaction (Stewart 2001).

The Indian Himalayan range is well recognized for its biological diversity and ecological values (Bhattacharya et al. 2007). About 1313 species (13%) of the world avian species are reported in India and the Indian subcontinent (Grimmett et al. 2011). The western part of Indian Himalayan Region is an important area of regional endemism and has been designated by BirdLife International as Endemic Bird Area (EBA 128). It also

contains 27 Important Bird Areas (IBAs) (Islam et al. 2004). The wetland bird studies in India have shown bird diversity in natural habitat (Rajashekara et al. 2011; Bhadja et al. 2013; Patel et al. 2015) or artificial wetland habitat (Tak et al. 2002; Urfi 2003, Mazumdar et al. 2006). The foothills of western Himalaya supports the natural and manmade wetlands in Dehradun, Haridwar and Ramnagar Districts of Uttarakhand, which provide suitable habitat not only for a short-distance migratory bird species but also a long-distance water migrant community. Many researchers have surveyed on waterbird species in Uttarakhand wetlands, such as Dhakate et al. (2008); Bhattacharjee and Bargali (2003) surveyed in Corbet National park wetland of district Ramnagar. Narang (1990); Gandhi and Singh, (1995); Tak et al. (1998); Tak and Sati (2003); Kumar et al. (2005); Kaushik et al. (2013) studied at Assan Barrage wetland at Dehradun. However, very few studies (Bhatt, et al. 2015) have been conducted on migrant waterbird at Bheemgoda Barrage of Haridwar district, and all the studies are based on checklist. However, comparative studies between natural and man-made wetland have not been conducted in Uttarakhand.

It has been reported that the population of water residential and migrant birds has declined significantly (Saikia and Bhattacharjee 1993; Wetlands International 2006). Therefore, it is necessary to understand the status of waterbird species in natural and manmade wetlands along with find out the causes of waterbird decline. In the present study an attempt was made to understand and compare the

waterbirds diversity between Bheemgoda Barrage (man-made wetland) and Misserpur (or Missarpur) wetland (natural wetland) of District Haridwar, Uttarakhand, India.

MATERIALS AND METHODS

Study area

The study was conducted from 2010 to 2013 year, in the foothills of Western Himalaya District Haridwar at manmade wetland. Indian wetlands were biogeographically categorized by Hussain and Roy (1993). The Bheemgoda Barrage geographically, situated (29°58' N, 78°13' E; 249.7m asl) between the Neeldhara and the tributaries of the Ganga river. It is type 17 (water-storage) barrage and comes biogeographic province 4.8.4 (Indo-Gangatic Monsoon forest). It covers about 2.5 km² area with different aquatic vegetation structure viz. *Eichhornia*

crassipes, *Potamogeton pectinatus* and *Typha elephantine* along with dominant tree *Dalbergia sissoo* is common around this wetland. On the other hand Misserpur is a natural (water-storage) wetland habitat above about 8 km from Bheemgoda Barrage. It is situated at 29°89' N, 78°14' E, at 214 m asl. and about 1.5 km² area (Figure 1). However, Misserpur site also comes biogeographic province 4.8.4 (Indo-Gangatic Monsoon forest). The aquatic vegetation of this area is dominated by *Typha elephantine*, *Eichhornia crassipes*, *Potamogeton pectinatus* and *Ipomea fistulosa*. Besides these, this area is occupied by *Dalbergia sissoo* and mixed tree species.

Climate: The climate of Haridwar is semi-arid and three prominent seasons like winter season (October to March), summer season (April to June) and rainy season (July to September). The temperature varies from 4 °C in winter to 44 °C in summer months. However, average rainfall (2000 mm) receives during the monsoon period.



Figure 1. Showing the study area in Himalayan foothills of District Haridwar, Uttarakhand, India. A. Bheemgoda barrage, and B. Misserpur Natural Wetland in the Ganga River, India

Field data collection

The waterbird species survey was conducted from January 2010 to December 2013 at wetland habitat of District Haridwar, Uttarakhand. These habitats were identified as natural (Bheemgoda barrage) and manmade (Misserpur) wetlands. Avian surveys were carried out in the morning (06.30 - 11.00) and evening (15.30 - 17.00) from October to March. The point count method (Bibby et al. 2000) was used during avian data collection. During each survey, we walked around the wetland and select vantage points with 20 - 30-meter intervals. Actual head counts were done for bird species that were small in numbers. Total 120 vantage points (60 points X 2 wetland habitats) were studied during the study period, and each point was revisited following years with the help of 10x50 prismatic field binocular. Regular field surveys were made through the study period with three days intervals, and survey was avoided during foggy weather and rainy days. Field guide books (Kazmierczak et al. 2003; Grimmett et al. 2011) were used for bird species identification and species photographed (camera Sony DCR/DVD803E) was taken for references. Along with the available vegetation at wetlands were also recorded with photographs and identified with the taxonomist. In addition, avian status and anthropogenic activities information also collected from adjoining residential area of the wetlands.

Data analysis

We pooled the field data, and mean value was used for analysis. The species diversity indices were calculated by using Shannon- Weavers formula [$H' = - \sum p_i (\ln p_i)$] (Shannon and Weaver 1949) and species richness were estimated by using Margalef's formula [$SR = (S-1)/\log N$] (Margalef 1951) in the wetland of Haridwar. We applied t-test and Confidence interval (CI) test to estimate the abundance of avian species between natural and manmade wetland habitats. We compared species richness between natural and manmade habitats using individual-based rarefaction curves (Colwell et al. 2004). Software such as PAST was used for statistical analysis.

RESULTS AND DISCUSSION

Thirty-seven avian species (12,679 individuals) belonging to 13 families (Table S.1) were recorded at manmade (Bheemgoda Barrage) and natural (Misserpur) wetland of Haridwar District. Out of 37 waterbird species, twenty three (62.1%) species were residential bird species and fourteen (37.8%) were reported as winter visitors (See Annexure 1). Among the waterbird species, two species which are under near threaten category (IUCN) (Black-necked Stork, *Ephippiorhynchus asiaticus* and River Lapwing *Vanellus duvaucelii*) were reported at man-made and natural wetland respectively (Figure 2). Of these 14 winter visitors, Bar-headed Goose, *Anser indicus* species was reported at natural wetland (Misserpur) after long time after 7 years. This information is based on the observation

of the population residing in the adjoining area of these wetlands.

A comparison of avian diversity indices between natural and manmade wetland habitat shows maximum diversity values were present in natural wetland (Table 1). Analysis of species abundance (t-test) revealed that avian community were more diverse and significantly high ($df = 35, t = 4.16, p < 0.01$) at natural wetland as compared to manmade wetland. The rarefaction curve also indicates the maximum species in terms of individuals reported at natural wetland as compared to manmade wetland habitat (Figure 3). Thus, these results support that natural wetlands are better habitats for waterbird species than the artificial wetlands as reported by Zhijun, et al. 2004 in China. Similarly, rich abundance of avian species, community composition, and species richness was reported maximum at natural marshes as compared to the rice field in southern France (Tourenq et al. 2001). The high abundance of avian species in the natural wetland is may be due to the availability of food variety, shelter and vegetation diversity. It is believed that the food resources are responsible for the habitat selection of waterbirds (Cody 1985). Recently, it has been reported that the aquatic vegetation composition and food resources influence the waterbirds diversity and density in wetlands (Colwell and Taft 2000; Patel et al. 2015).

Out of fourteen winter visitor species, eleven shared both wetlands. However, six species namely (Eurasian teal; *Anas crecca*, Gadwal, *Anas strepera*; Northern Pintail, *Anas acuta*; Pallas's Gull, *Ichthyaetus ichthyaeus*; Red-crested Pochard, *Netta rufina*; Tufted Duck, *Aythya fuligula*) were found significantly (95%) high in abundant at the natural wetland. However, one avian species (Black-headed Gull, *Chroicocephalus ridibundus*) were found significant high at manmade wetland of the study area (Table 2) and remaining two species (Black-necked Stork, *Ephippiorhynchus asiaticus*; Great Crested Grebe, *Podiceps cristatus*) abundance was about same in both wetlands.

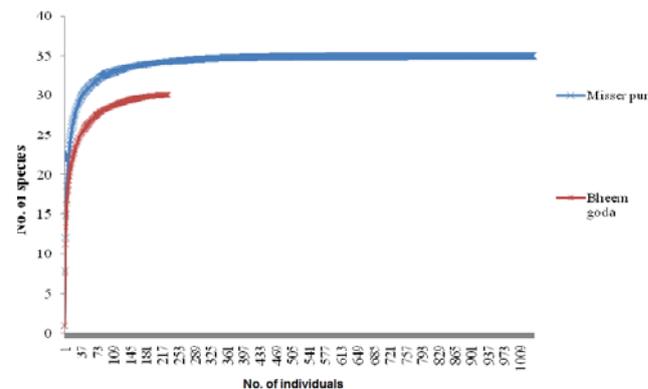


Figure 3. Rarefaction curve between number of species and individuals of species reported at Natural (Misserpur) and Manmade wetland (Bheemgoda barrage)



Figure 2: Photographic records of water birds at natural and man-made wetland of Haridwar District, Uttarakhand, India. A. Bar headed Geese (*Anser indicus*); Near threaten species declared by IUCN Version 2013.1., B. Black-necked stork (*Ephippiorhynchus asiaticus*); Near threaten species declared by IUCN, C. Black-winged stilt (*Himantopus himantopus*), D. River lapwing (*Vanellus duvaucelii*)

Table 1. Comparison of diversity indices between manmade and natural wetland habitat in Haridwar, Uttarakhand, India

Parameters	Bheem Goda Barrage (Manmade wetland)	Misserpur (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')	2.35	2.81
Margalef's Richness (R1)	10.81	11.23
No. of Individual	2285	10394
No. of Migrant species (Non breeder)	11	13
No. of Residential species (Breeder)	17	23

Table 2. The mean abundance of water migratory birds at 95% (confidence Interval value) level in both wetland areas in Haridwar, Uttarakhand, India

Common name	Zoological name	2010		2011		2012		2013	
		Bheem goda	Misserpur						
Black necked stork	<i>Ephippiorhynchus asiaticus</i>	0.01	0.03	0.03	0.02	0.01	0.01	0.03	0.03
Common teal	<i>Anes crecca</i>	0.02	0.23	0.14	0.10	0.07	0.16	0.02	0.28
Great crested grebe	<i>Podiceps cristatus</i>	0.02	0.05	0.16	0.18	0.01	0.10	0.02	0.03
Nothern pintail	<i>Anas acuta</i>	0.03	0.65	0.05	0.02	0.01	0.40	0.03	0.20
Red-crested pochard	<i>Rhodonessa rufina</i>	0.02	0.27	0.09	0.12	0.01	0.10	0.05	0.23
Gadwall	<i>Anas strepera</i>	0.02	0.27	0.01	0.49	0.07	0.13	0.10	0.12
Black headed gull	<i>Larus ridibundus</i>	0.10	0.05	0.08	0.09	0.10	0.14	0.19	0.10
Pallas's gull	<i>Larus ichthyaetus</i>	0.10	0.05	0.10	0.26	0.07	0.03	0.08	0.13
Tufted pochard	<i>Aythya filigula</i>	0.02	0.25	0.04	0.12	0.07	0.14	0.05	0.29

In the present study, we observed that the variety of vegetation structure (*Typha elephantine*, *Eichornia crassipes*, *Potamogeton pectinatus*, *Ceratophyllum demersum*, *Ipomea fistulosa*, *Zizyphus mauritiana* and *Lantana camera*) at natural wetland (Misserpur) and human encroachment at man-made wetland (Bheemgoda barrage) are the responsible causes of waterbirds variation in the study site wetlands. Along with, the effluent of a sewage treatment plant is released above the Misserpur

wetland site which stimulates the growth of aquatic plants at natural wetland (Misserpur). The variety of aquatic plants may be the cause which influences the bird species in both wetland habitats. Gucl et al. (2012) found that vegetation composition of natural and manmade wetland sites influence the bird species diversity and abundance. The habitat feature such as vegetation composition and cover is a key factor that affects the habitat selection and distribution, diversity and richness of waterbird species

(Rajpar et al. 2014). It has been reported (Lee and Rotteberry 2005; Augenfeld et al. 2008) vegetation composition influence the variety of food resources which increase the abundance the waterbird species.

The high abundance of Tufted ducks at natural wetland (Misserpur) indicates good depth at Misserpur wetland than the manmade wetland and supports the rich submerged vegetation in the natural wetland. It has been reported that deeper water supports the rich density of waterbird especially ducks and ducks prefer deep open water body for foraging (Hattori et al. 2001; Rajpar et al. 2011). The presences of near threaten species in wetlands of District Haridwar emphasis to make conservation effort in this area for waterbird species. The appearance of Bar-headed Goose, *Anser indicus* at Misserpur wetland which is a long-distance migrant species, arrived in winter season from central Asia. It indicates that natural wetland is also suitable wetland for water migratory birds in Haridwar District of Uttarakhand.

In conclusion, some previous studies (Zhijun et al. 2013; Zakaria et al. 2014) have reported that natural and man-made wetlands are good habitat for waterbird and migrant bird species. However, the results of present study are in favor of natural wetland and suggest that the natural wetland is more suitable for waterbird species. The natural wetlands provide a variety of food, shelter and roosting sites for wetland birds. However, most of the waterbird have changed their natural wetland habitat or have disappeared from the natural wetland due to lack of food resources, human activities and water pollution. Hence, the artificial wetlands are alternative habitat for natural wetland birds (Zhijun et al. 2013). With this study, we support that the natural wetland is more suitable for waterbird species. The presence of threatened species at natural wetland indicates that more concern is required for the conservation of natural wetland. However, in the present short-term (3 years) study we have not found decline in waterbird population in this area. Thus, further, a long term study is required to understand the climatic effects on water migrant bird species distribution in natural and man-made wetlands.

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Table S.1. Avian species observed at natural and man-made wetlands in Haridwar, Uttarakhand, India

Family	Common name	Zoological name	Status	Misserpur (Natural wetland)	Bheem goda barrage (Man-made wetland)	IUCN status
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	Blue-eared Kingfisher	<i>Alcedo meninting</i>	R	+	-	LC
	Pied Kingfisher	<i>Ceryle rudis</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
Ardeidae	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	+	+	Vul.
	Northern Pintail	<i>Anas acuta</i>	WM	+	+	LC
	Red-crested Pochard	<i>Netta rufina</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
	Grey Heron	<i>Ardea cinerea</i>	R	+	+	LC
	Indian Pond Heron	<i>Ardeola grayii</i>	R	+	+	LC
	Great Egret	<i>Casmerodius albus</i>	R	+	+	LC
	Little Egret	<i>Egretta garzetta</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
Laridae	Pallas's Gull	<i>Ichthyaeetus ichthyaeetus</i>	WM	+	-	LC
	Black-headed gull	<i>Chroicocephalus ridibundus</i>	WM	+	+	LC
Motacillidae	White Wagtail	<i>Motacilla alba</i>	R	+	-	LC
Pandionidae	Western Osprey	<i>Pandion haliaetus</i>	WM	+	+	LC
Phalacrocoracidae	Little Cormorant	<i>Microcarbo niger</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
Scolopacidae	Common sandpiper	<i>Actitis hypoleucos</i>	R	+	+	LC

Note: WM: Winter visitor species; R: Resident species; IUCN Status Version 2013.1: LC = Least concern, Vul. = Vulnerable, NT = Near threatened