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Research Article

Distribution and review of Water migratory bird species in riverine and water reservoir wetlands of district Haridwar in Uttarakhand, India

Kamal Kant Joshi[1], Anita Rawat[2] and Ashutosh Mishra[3]

[1]*Department of Environmental Sciences Graphic Era Hill University, Dehradun, Uttarakhand, India*
[2] *Uttarakhand Science Education and Research Centre, Dehradun, Uttarakhand, India*
[3] *Uttarakhand Council of Science and Technology, Dehradun, Uttarakhand , India*

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ABSTRACT

Indian Himalayan Region contributes a rich biodiversity zone in the world. The wetland ecosystems also play major role to enhance the avian diversity in the Uttarakhand. However, various factors influence the distribution, abundance, and diversity of waterbird species. The current study was performed to know the current status and distribution of waterbird species in riverine and water reservoir wetlands of Uttarakhand. Total 22 species along with 1 Vulnerable, 02 near threaten and 01 Endangered waterbird species recorded from the study sites. In our study about 10-30% water migratory bird species contributes to increase the local bird diversity in the wetland area and waterbird changing their habitat due to anthropogenic activity. The maximum waterbird species with their individual reported at manmade wetland. The presence of endangered and threatened species in these wetland emphases on the conservation programme and a regular monitoring requires understanding the waterbird species distribution pattern and influencing factors for waterbird species.

Key words: Wetland, Himalayan Region, Biodiversity, Waterbird, Uttarakhand

INTRODUCTION

The wetlands are classified on the basis of the ecological, hydrological, and geological condition of the area. These wetlands are unique ecosystem that highly supported by many aquatic creatures, including bird species. Wetlands are unique and one of the most productive ecosystems of our natural environment (Ghermandi *et al*., 2010). In India, many wetlands area are eminent to host the thousands of water migratory bird species that come from western and European countries in India. Out of these, Bharthpur wildlife sanctuary (Rajasthan), and coastal areas of Gujarat are well studied (Agarwal, 2011). It has been reported the land use pattern is being change very rapidly and similarly natural wetlands are converting in agricultural and residential colonies. The various human activities and water pollution in wetland area have been declined water migratory bird species (Gaston 1975; Hardy *et al*. 1987; Mckinney 2002). The significantly decline in the population of water residential and migrant bird species has been reported (Saikia & Bhattacharjee 1993).

The Indian Himalayan Region has been recognized for rich avian diversity and wetlands also play an important role to enhance the avian diversity. However, the wetlands of hill regions are less studies areas as compared to other regions. On the other hand, existing wetlands in the Himalayan region of Uttarakhand are suitable habitat for avian species. In Uttarakhand, about 310 water bird species including migratory species have been reported in different wetlands of Uttarakhand (Mohan *et al*., 2016). The available knowledge (Dhakate *et al*. 2008; Bhattacharjee & Bargali 2003; Narang, 1990; Gandhi & Singh, 1995; Tak *et al*., 1998; Tak & Sati, 2003; Kumar *et al*., 2005; Kaushik *et al*., 2013; Bhatt, *et al*., 2015) about waterbird species in Uttarakhand wetland is based on checklist. For that reason, it is required to know the status of waterbird species in riverine (nature) and water reservoir (manmade) wetland.

The current study attempted to explore and analysis of migratory waterbird species diversity and abundance in riverine and water reservoir wetland of District Haridwar, Uttarakhand, India.

MATERIAL AND METHODS

Study site

The current study was carried out from November 2021 to March 2023 in two different riverine and manmade wetlands of the Haridwar district in Uttarakhand.

Manmade water reservoir wetland

The waterbird survey was conducted at water reservoir (man-made) wetland of district Haridwar. It is known as Bheemgoda Barrage. Geographically, it is situated at 249.7m asl with N 29°58′; E 78°13′ (Figure 1). It covers about 2.5 km^2 area and filled with various aquatic vegetation structures. The dominant vegetation compositions are *Eichhornia crassipes*, *Potomageton pectinatus* and *Typha elephantine* along with *Dalbergia sissoo* tree species is commonly dominating around the wetland.

Riverine wetland at Ganga Ghats:

The riverine natural wetland habitat at Ganga ghat is

*Corresponding Author's E-mail: kamal_josi@yahoo.com

situated at 214 m asl with N 29°89′; E 78°14′ (**Figure 2**). This wetland is located downstream about 8 km from water reservoir (man-made) wetland. It covers about 1.5 km^2 areas and the vegetation of this area is .dominated by *Ipomea fistulosa, Potomageton pectinatus, Eichhornia crassipes* and *Typha elephantine*. In addition, the *Dalbergia sissoo* and mixed tree species is occupied this area.

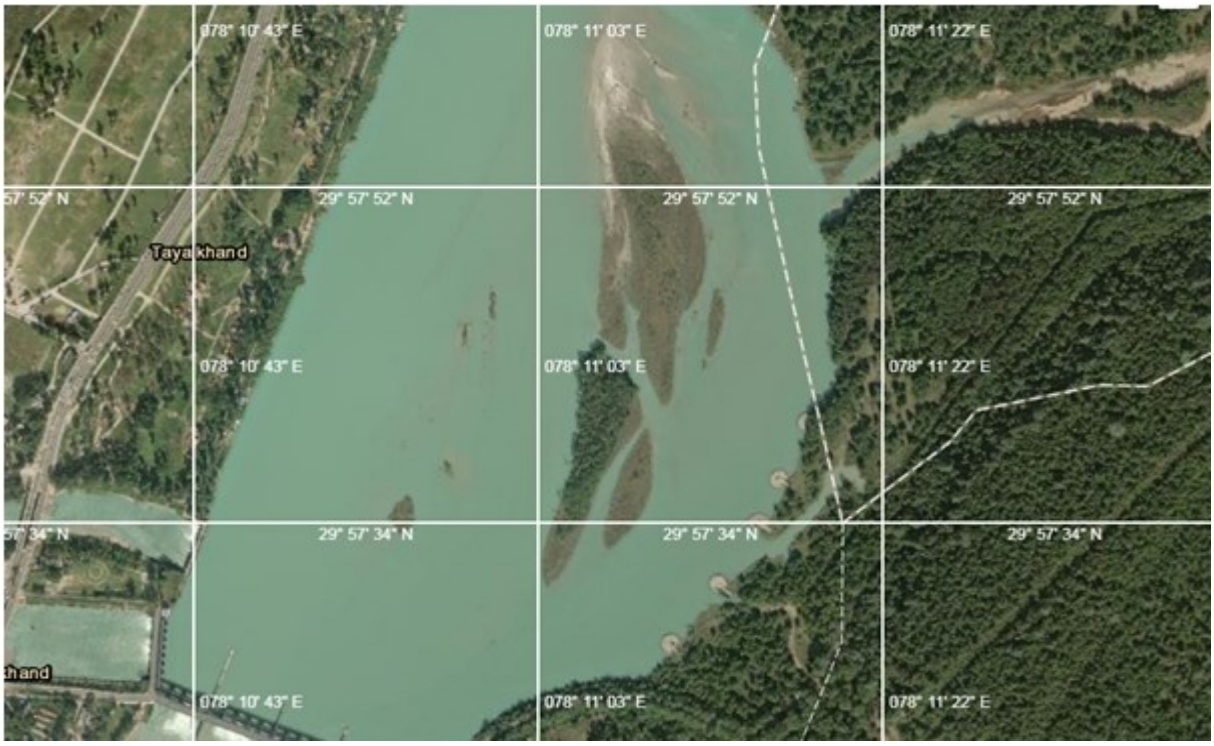

Figure 1. A Google map view and a pictorial view of manmade Bhimgoda wetland in Haridwar district of Uttarakhand

Figure 2. A Satellite image of riverine Misserpur wetland of Haridwar district in Uttarakhand

Waterbird surveys

The waterbird species surveys were carried out throughout the year (January 2021 to January 2023) and point count along with line transect (Bibby *et al.*, 2000) methods were used for waterbird assessment and same study points were revisited in the following year. Total 80 vantage points (2 wetland habitats X 40 points) were studied with the help of prismatic field binocular (10 x 50X). Each study points morning 8:30-11:30 am to 3:30 – 5:30 pm in evening (summer and winter seasons) were surveyed and 2 days in a week was used for waterbird data collection. During the survey, minimum of 10 and a maximum of 40 points were studied around the edge of each wetland site. Waterbird species were identified using field guide books (Grimmett *et al*., 2016). Waterbird species were captured (camera Sony DCR/ DVD803E) for references.

RESULTS AND DISCUSSION

Total 22 waterbird species belonging to ten families were reported. Out of these two near threatened (*Vanellus duvaucelii* and *Mycteria leucocephala*), one endangered (*Haliaeetus leucoryphus*), and one vulnerable (*Sterna aurantia*) waterbird species reported (Plate 1).

About 11 winter migratory (*Tadorna ferruginea, Aythya fuligula, Motacilla alba, Netta rufina, Anas platyrhynchos, Pandion haliaetus, Ichthyaetus ichthyaetus, Anser indicus, Ciconia nigra, Mareca strepera, and Podiceps cristatus*) waterbird species comes from the Central European region and follow the Central Asian Flyway to reach the wetlands of Uttarakhand. During the study an interesting findings recorded that a winter visitor bird *Tadorna ferruginea* species found throughout the years in the study area. The presence of water migratory bird species and IUCN categorized (threatened and endangered) species in the study area indicates the both the wetlands are suitable, rich in food resource and provide a harbor for the water bird species.

During the study, it was recorded the winter visitor waterbird species stay in these wetland for 3 to 4 days and move ahead to other wetlands. Only Ruddy Shelduck (*Tadorna ferruginea*) water species reported November to April Months. Most of the waterbird species reappear in the study sites when they return back at the end of March months and maximum species appear at mid month of January in both the Natural and manmade wetlands.

Plate1. Showing endanger (Pallas's Fish Eagle) and vulnerable (River Tern) species reported at riverine wetland area

In the present study, the diversity indices indicate maximum waterbird diversity and richness reported at manmade reservoir as compare to riverine water body. The nonparametric values too support the high diversity at manmade reservoir (Table 1). The maximum abundance of waterbird migratory species was reported at manmade reservoir. The analysis of variance analysis value indicates significantly ($d = 1; p > 0.02, F = 5.15$) high abundance of waterbird species was recorded at manmade wetland of the study area. The high abundance of migratory waterbird species at manmade reservoir wetland indicates the rich sources of food availability and less anthropogenic activities. Previous studies (Tavares *et al*., 2015; Brandolin and Blendinger, 2016; Borneman *et al*., 2016; Xie *et al*., 2020; Tamang *et al*., 2024) have been illustrated that anthropogenic activities disturbs the nesting and foraging of waterbird species and some time treat as species- specific trait. Mahar *et al*., 2023 also reported that distance to human settlement and distance to nearest road had profound effects on the abundance of waterbird species. However, during the study anthropogenic activities like collection of sand, bathing and the livestock grazing at bank of natural wetland were the accountable for the poor abundance of waterbird migratory species at natural wetland. Rarefaction curve between waterbird species and their individuals indicates maximum species with their individuals reported at manmade reservoir wetland (Figure 3).

Table 1. Waterbird species observation in different wetlands of Haridwar district of Uttarakhand

	Riverine wetland (Misserpur Gangaghat)	Manmade wetland (Bheemgoda water reservoir)
Elevation (m asl)	214 m asl	249.7 m asl
Latitude N	29°89′ N	29°58′ N
Longitude E	78°14′E	78°13′ E
Species Diversity	2.75	3.22
Species richness	8.6	11.66
No. of Species	16	22
No. of Individuals	346	423
Chao 1	15	20
Chao 2	17	21
Jackknife	18	24
Migratory bird species	5	6

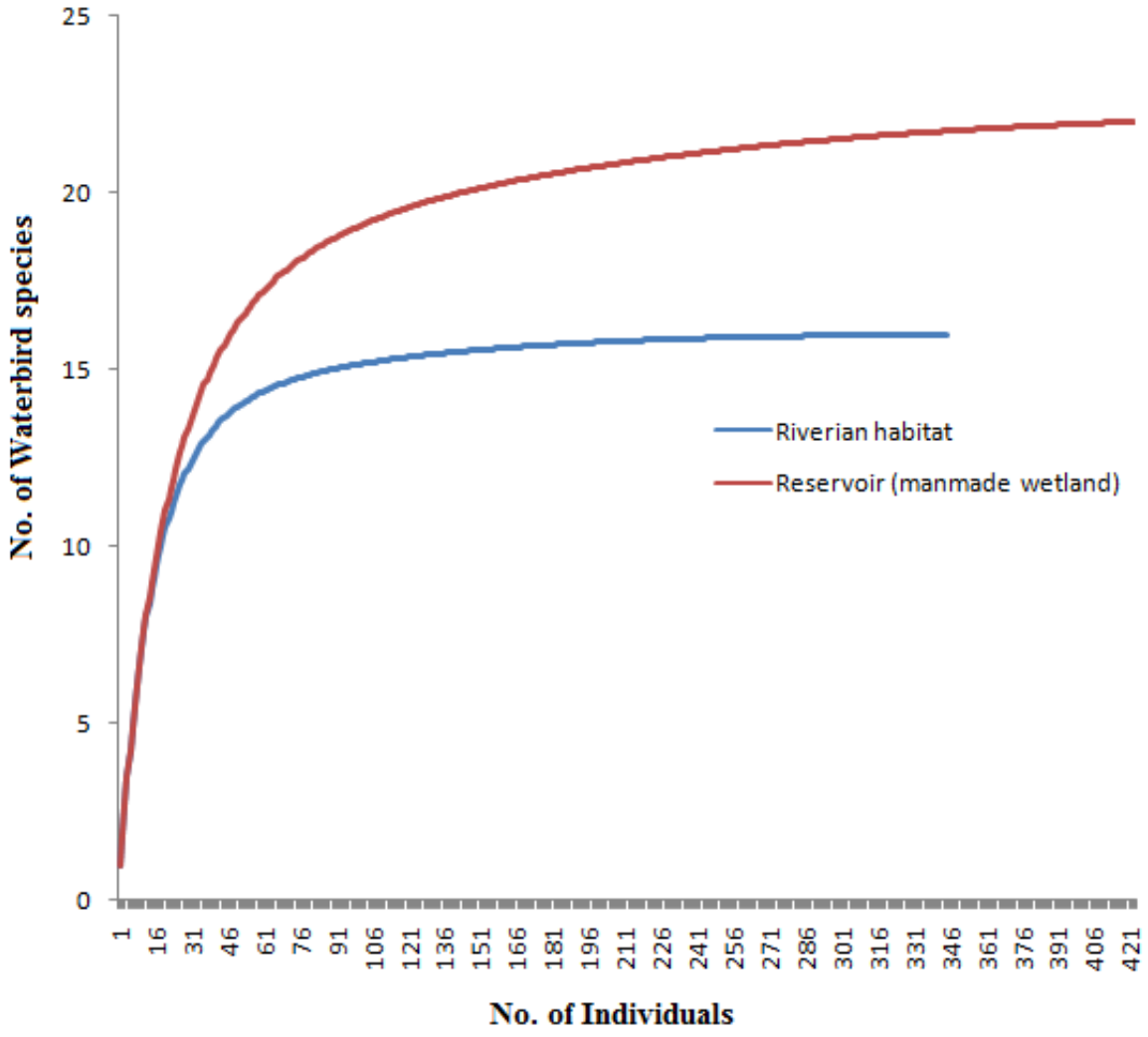

Figure 3. Showing the species distribution with individual species in riverine and manmade wetland of district Haridwar, Uttarakhand

The habitat variances between the wetland (riverine and reservoir) also influence the waterbird species. The Jacard's similarity index indicates that waterbird species have low similarity (0.475) in the manmade and natural habitat (**Figure 4**). The results, illustrated that rich abundance at manmade wetland is harbor for the waterbird species and consider as an alternate habitat. The artificial or manmade wetland supports to wide

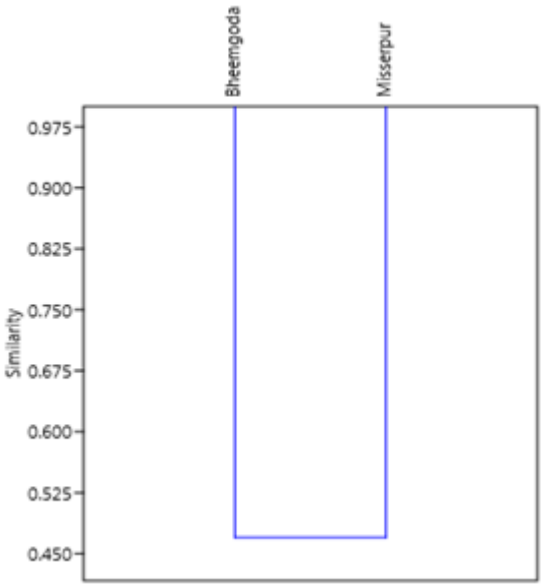

Figure 4. Jaccard's Similarity index showing the waterbird species maximum similarity between Reservoirs as compared to the river waterbird species

range of resident waterbird species than natural wetlands and provide an alternative habitat for the waterbird species (Giosa *et al*., 2018; Rajpar *et al*., 2022). In contrast, some previous studies (Strong & Sherry 2000; Kusler, 2004; Henning & Remsburg 2009; Juarez *et al*., 2019) natural wetlands such as near waterlogged areas and aquaculture ponds, agricultural fields and marsh swamps may also harbor for the diversity of waterbirds.

CONCLUSION

The wetlands are known one of the most diverse and valuable ecosystems due to their unique geographical and climatic conditions. In our study we found the waterbird species are changing their natural habitat and attracting to the manmade made wetlands due to less disturbance and food resources. In addition, manmade reservoirs (artificial wetlands) play an important role to provide the food and alternative habitat for the waterbird species and enhance the local avian diversity. Natural wetlands are vanishing due to anthropogenic activity a regular interval monitoring is required to understand the waterbird distribution and changing in wetlands composition. With this study it can be suggested that education awareness programs on wetlands introduce the birding sites and define the role of citizen science for the conservation of wetland by the forest departments.

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