

Study of winter avifauna diversity from a man-made reservoir in the West Bengal, India

Debayan Gayen^{1*}, Biswajit Mukherjee², Sanchari Sarkar³, Bappa Goswami⁴, Sagar Adhurya⁵ and Moitreyee Chakraborty⁶

¹Research Assistant, WBZA Sponsored Projects, Department of Zoology for UG and PG Studies, Serampore College, Serampore, Hooghly, Pin-712201, West Bengal, India; and Research scholar, PG Department of Conservation Biology, Durgapur Government College, J.N. Avenue, Durgapur- 713214, West Bengal, India

²Sonatore Para, P.O. and P.S. - Suri, Pin- 731101, Birbhum, West Bengal, India

³JRF, DST Sponsored Project and Research Scholar, PG Department of Conservation Biology, Durgapur Government College, J.N. Avenue, Durgapur- 713214, West Bengal, India

⁴District Officer, Minority Affairs, Berhampore, Murshidabad, West Bengal, India

⁵Durgapur Wildlife Information and Nature Guide Society, West Bengal, India

⁶Assistant Professor, PG Department of Conservation Biology, Durgapur Government College, J.N. Avenue, Durgapur- 713214, West Bengal, India

*Corresponding author✉: debayangayen123@gmail.com

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Abstract

The present study was conducted to determine the winter avifauna diversity of the Bakreswar Reservoir, Birbhum district, West Bengal from November 2017 to February 2021 using point count and opportunistic spotting. A total of 174 species of birds belonging to 18 orders, 47 families and 115 genera were noted during the study of which the family Anatidae was the most dominant family with 21 species, followed by the Accipitridae with 19 species, and the Motacillidae and Ardeidae with 10 species each. The Lesser whistling teal *Dendrocygna javanica*, Red-crested pochard *Netta rufina* and Bar-headed goose *Anser indicus* were the most abundant species during the winter months. Four Vulnerable species and five Near Threatened species were also recorded in the study area. Various diversity indices indicated that the species assemblage in 2019–2020 was more diverse than other years. Some species, such as the Common shelduck *Tadorna tadorna* (Linnaeus, 1758), Swinhoe's minivet *Pericrocotus cantonensis* Swinhoe, 1861, Eurasian sparrowhawk *Accipiter nisus* (Linnaeus, 1758), Pallas' gull *Ichthyaetus ichthyaeus* (Pallas, 1773), Black-headed gull *Chroicocephalus ridibundus* (Linnaeus, 1766), Hen harrier *Circus cyaneus* (Linnaeus, 1766) and Bonelli's eagle *Aquila fasciata* Vieillot, 1822, are recorded for the first time from this region. Various threats like habitat destruction, habitat degradation and hunting of migratory and threatened birds pose the major problems in the study location.

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Introduction

The study of diversity and distribution patterns of organisms and their function in the ecosystem are quite challenging. Birds are known to maintain the

balance of an ecosystem (Padmavati et al., 2010) by influencing the nutrient flow, and also playing a significant role in various food webs, mainly as pollinators and predators (Whelan et al., 2008). Specific bird species assemblages are also good

indicators of ecosystem integrity and function (Hossain and Aditya, 2016). Recently, it has been noted that the bird population is facing serious problems due to habitat destruction, various anthropogenic interventions and climate change (Rapoport, 1993; Crick, 2004; Ahola et al., 2007; Chen et al., 2011; Mengesha et al., 2014). Moreover, there has been great concerns about bird conservation all around the globe. Out of the 1341 birds found in the Indian subcontinent (Praveen et al., 2021), West Bengal State is home to about 868 species of birds (eBird, 2021 <https://www.ebird.org>). Studies of avifaunal diversity from different parts of India, encompassing different habitat types, are commonly recorded (Roy et al., 2011; Roy et al., 2012 a, b; Changder et al., 2015; Ghosh, 2016; Hossain and Aditya, 2016; Mukhopadhyay and Mazumder, 2017).

Birbhum district is located in the western part of the state of West Bengal and lies between 23°33' and 24°35' North latitude and 87°10' and 88°2' East latitude. It has an area of about 4545 sq. km and is bordered by Jharkhand on the northern and western side, Murshidabad and Bardhaman districts on the eastern side and by Paschim Bardhaman district on the southern side, which is demarcated by the Ajoy River. This region is characterized by warm and humid climate in the summer and dry and cool climate during the winter. The soil of this region is mostly red soils and the natural vegetation is dry deciduous type (Nandi et al., 2001). Birbhum district is considered one of the most important districts in the state of West Bengal in terms of the abundance of waterbirds. Various lakes and reservoirs of this district become home to a large number of migratory waterbirds during the winter months, of which the Ballavpur Wildlife Sanctuary, Tilpara Barrage, Bakreswar Reservoir and Hinglow Reservoir deserve special mention. Various papers on the water birds of the Birbhum district, including the Bakreswar Dam, were published in previous years (O'malley et al., 1910; Nandi et al., 2001; Mazumder et al., 2007; Sinha et al., 2011; Ganguly and Mukhopadhyay, 2014; Khan et al., 2016). Most of these studies included the wetland dependent birds and water birds, and so the present study was conducted to enlist all the avifauna available in the Bakreswar Dam of Birbhum district during the winter months for a period of four years and also to know more about their abundance and various threats that are prevailing in the area.

Material and Methods

Study area

The study was conducted at the Bakreswar Dam, Birbhum district, West Bengal State, India (Fig. 1). Situated about 5 km from Dubrajpur town and about 20 km from Suri town, this man-made reservoir was formed by damming the Bakreswar River, mainly to provide water to the Bakreswar Thermal Power Plant, in 1999 (Fig. 2). The dam is located at 23°50.519'N and

87°24.612'E. The total area of the dam is about 6.38 km². The maximum depth of the reservoir is about 36.8 m. The average temperature of the study area ranges between 27°C and 40°C (Sinha et al., 2011). This area is rich in aquatic macrophytes like the Sedge (*Scirpus* spp.), Reeds (*Fragmites* sp.), Ditch grasses (*Ruppia* spp.), Water Lettuce (*Pistia* sp., *Enteromorpha* sp.) and many others. Moreover, this reservoir is also home to various species of arthropods, molluscs and fishes (Sinha et al., 2011). Presently, because of the presence of numerous migratory water birds and its scenic beauty, it has become a popular destination for tourists, picnickers and wildlife photographers.

Methodology

The study was conducted from November 2017 to February 2021 for four months every year (November to February). The survey was done twice a month randomly in the morning (05.30 AM- 10.00 AM), noon (11.30 AM- 02.00 PM) and afternoon (03.00 PM- 04.00 PM). The bird survey was conducted using the point count method but various opportunistic spotting were also added to the list. Birds were observed using 8X40 magnification Olympus binoculars and identified using suitable field guides (Grewall et al., 2002; Grimett et al., 2012). Photographs were taken using DSLR (Nikon D3400) and Point and Shoot Cameras (Nikon Coolpix B700 and Nikon Coolpix P900). The family, common names and scientific names of the birds given in the checklist were according to Praveen et al. (2021). The IUCN Status of the birds is given following IUCN (2021) as Least Concern (LC), Near Threatened (NT) and Vulnerable (VU). The Wildlife Protection Act (WPA) schedule of the birds is given as per Praveen et al. (2020). The data collected was used to estimate the diversity of the avifauna species. Various diversity indices were estimated using PAST 4.05: Richness (S), Shannon Diversity Index (H) (Shannon, 1948), Pielou's Evenness Index (J) (Pielou, 1966), Margalef's Diversity Index (Margalef, 1968) and Berger-Parker Dominance (d) Index (Berger and Parker, 1970).

$$\text{Shannon's Diversity Index, } H = - \sum_{i=1}^s \frac{n_i}{N} \ln \frac{n_i}{N}$$

Here, n_i is the number of individuals of a particular species and N is the total number of individuals covering all species.

$$\text{Pielou's Evenness Index, } J = H / \ln S$$

$$\text{Margalef's Diversity Index} = S - 1 / \ln N$$

Here, S = Number of species and N = Total number of individuals.

$$\text{Berger - Parker's dominance, } d = \frac{N_{max}}{N}$$

Here, N_{max} is the number of individuals of a species having maximum count.

The species accumulation curve was prepared using MS Excel and the maps were prepared using Arc GIS software.

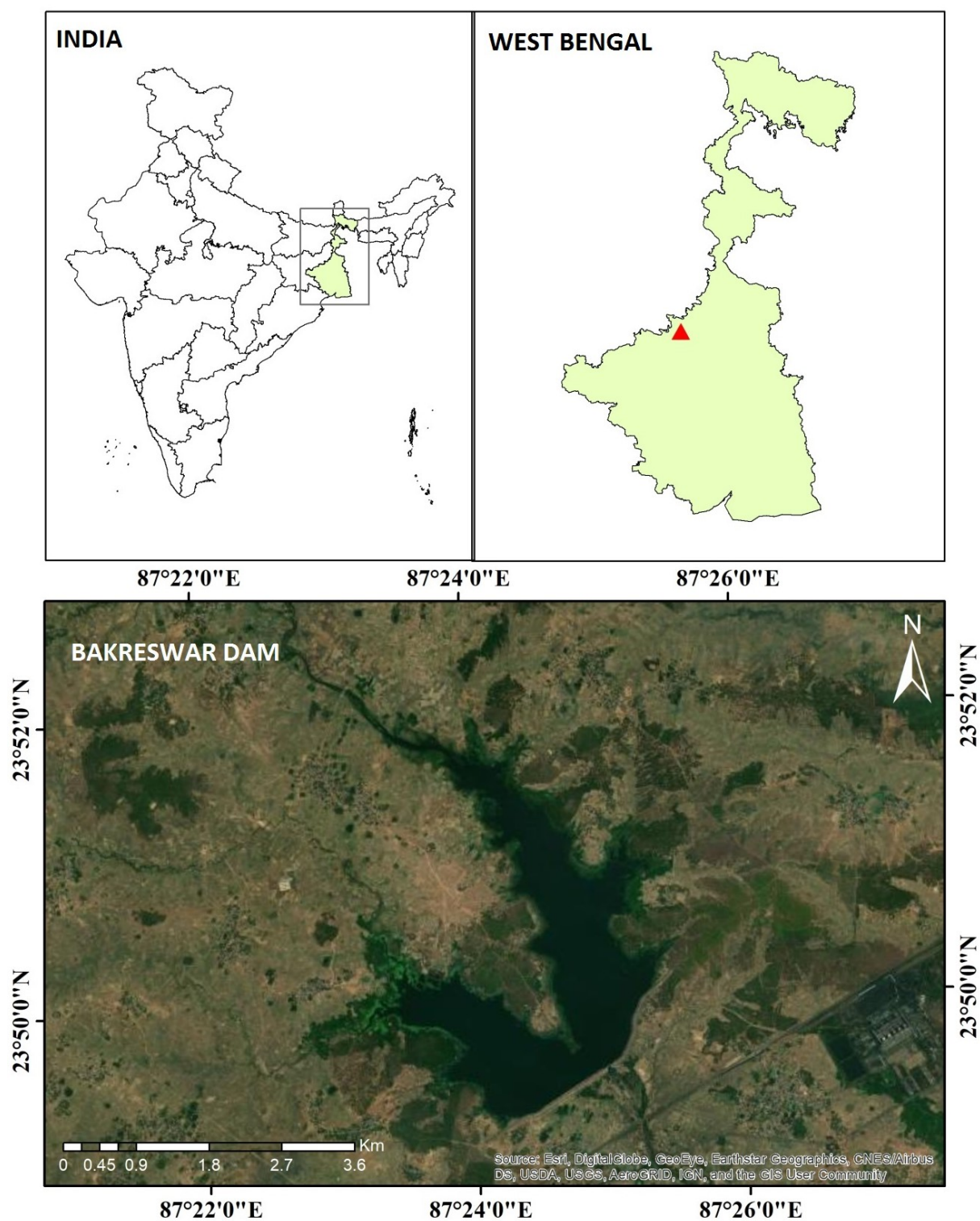


Figure 1: Location of the Bakreswar Dam, Birbhum in India (above left), in West Bengal (above right) and its satellite image (below). Map prepared using ArcGIS software.

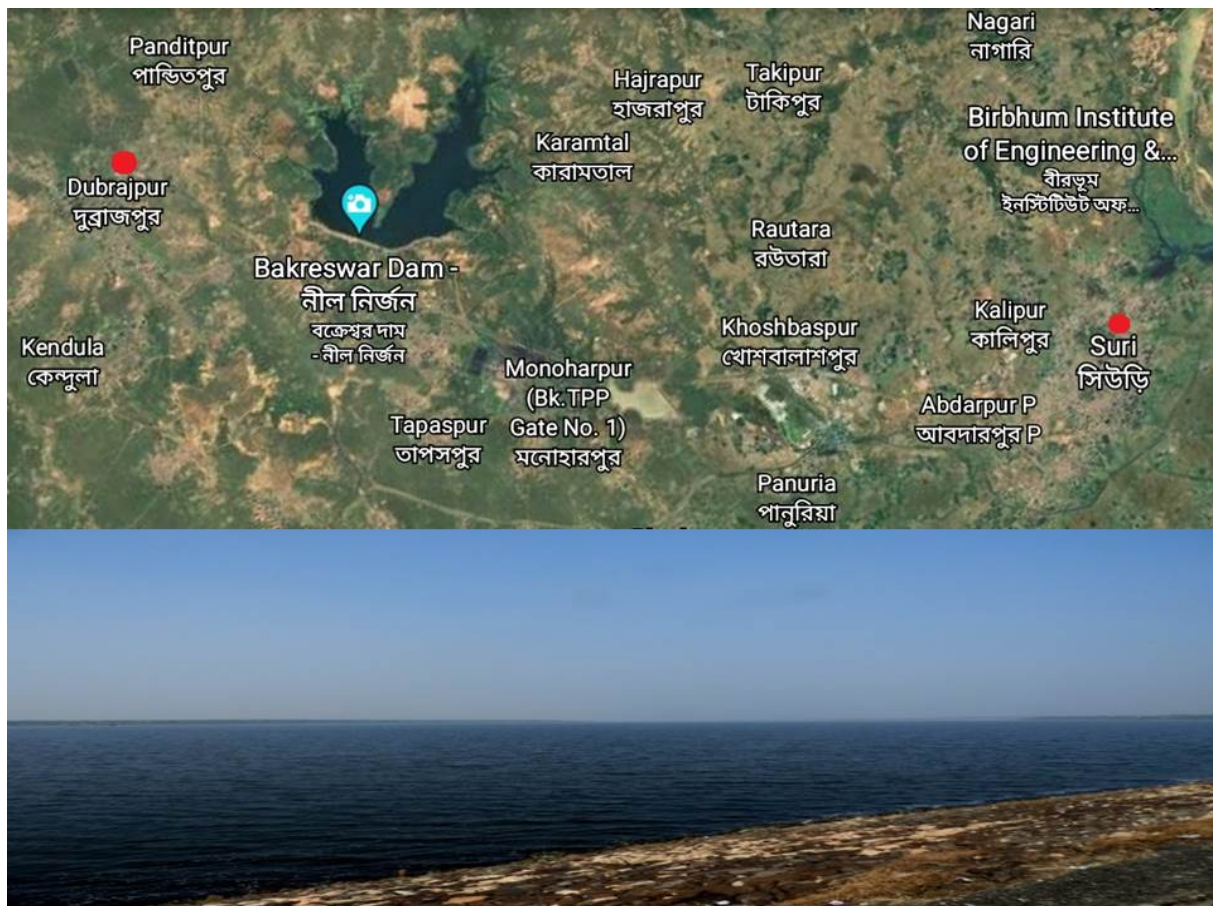


Figure 2: Showing the distance of Bakreswar Dam from the nearest towns Dubrajpur and Suri (red dots) of the district of Birbhum, West Bengal (above) and the scenic beauty of the study location (below).

Results and Discussion

A total of 174 species of birds belonging to 18 orders, 47 families and 115 genera were observed during the present study. Among the 47 families, Anatidae is the most dominant family with 21 species, followed by Accipitridae with 19 species, Motacillidae and Ardeidae with 10 species each, Muscicapidae with eight species and Scolopacidae with seven species. Of the remaining 41 families, one family was represented by six species, two families were represented by five species, seven families by four species, another seven families were represented by three species, 10 families with two species and 14 families were represented by one species each. The Lesser Whistling teal *Dendrocygna javanica* (Horsfield, 1821), Red-crested pochard *Netta rufina* (Pallas, 1773), and Bar-headed goose *Anser indicus* (Latham, 1790) were the most abundant species during the winter months. The Common pochard *Aythya ferina* (Linnaeus, 1758), Woolly-necked stork *Ciconia episcopus* (Boddaert, 1783), Lesser adjutant stork *Leptoptilos javanicus* (Horsfield, 1821) and Greater spotted eagle *Clanga clanga* (Pallas, 1811) were all recorded during the study and are considered as Vulnerable (VU) according to the IUCN Red List of Threatened Species (IUCN, 2022). Moreover, five

Near Threatened species (NT) like the Falcated duck *Mareca falcate* (Georgi, 1775), Ferruginous duck *Aythya nyroca* (Güldenstädt, 1770), Oriental darter *Anhinga melanogaster* Pennant, 1769, Black-headed ibis *Threskiornis melanocephalus* (Latham, 1790) and Red-necked falcon *Falco chicquera* Daudin, 1800 were also recorded during the study (IUCN, 2021). Among the observed species, 13.2% belong to Schedule I, 86.2% belong to Schedule IV and 0.6% belong to Schedule V of the WPA Schedule List (Praveen et al., 2020). The migratory status of the different birds of the present study are that, 71 species were migratory, 100 were residents, one local migrant and the remaining two were vagrant species. A detailed checklist of the birds, along with their scientific names and presence or absence per study year is given in Table 1 (see Appendix for photos).

The results of various calculated diversity indices for the different years of the present study are provided in Table 2. Shannon-Wiener is the overall general diversity index and its maximum value was observed during 2020–2021 (1.93) whereas the minimum was during 2017–2018 (1.70). According to Pielou's evenness index, it is seen that 2018–2019 and 2020–2021 (0.05) are the most evenly distributed years, followed by 2017–2018 and 2019–2020 (0.04).

Table 1: Winter avifaunal species recorded during the present study from the Bakreswar Dam, Birbhum, West Bengal, India. (Abbreviations used: M- Migratory, LM- Local Migrant, R- Resident, V- Vagrant to the study area, P- Present, A- Absent, LC- Least Concern, NT- Near Threatened, VU- Vulnerable.

S. No.	Family	Common name	Scientific name	IUCN Status	Migratory Status	Presence/ Absence yearly			
						Nov. 2017- Feb. 2018	Nov. 2018- Feb. 2019	Nov. 2019- Feb. 2020	Nov. 2020- Feb. 2021
1	Anatidae	Fulvous whistling duck	<i>Dendrocygna bicolor</i> (Vieillot, 1816)	LC	M	A	P	A	A
2	Anatidae	Lesser whistling duck	<i>Dendrocygna javanica</i> (Horsfield, 1821)	LC	LM	P	P	P	P
3	Anatidae	Bar-headed goose	<i>Anser indicus</i> (Latham, 1790)	LC	M	P	P	P	P
4	Anatidae	Greylag goose	<i>Anser anser</i> (Linnaeus, 1758)	LC	M	A	P	P	P
5	Anatidae	Greater white-fronted goose	<i>Anser albifrons</i> (Scopoli, 1769)	LC	M	A	A	A	P
6	Anatidae	Knob-billed duck	<i>Sarkidiornis melanotos</i> (Pennant, 1769)	LC	M	A	P	P	A
7	Anatidae	Ruddy shelduck	<i>Tadorna ferruginea</i> (Pallas, 1764)	LC	M	P	P	P	P
8	Anatidae	Common shelduck	<i>Tadorna tadorna</i> (Linnaeus, 1758)	LC	M	A	P	A	A
9	Anatidae	Cotton teal	<i>Nettapus coromandelianus</i> J.F. Gmelin, 1789	LC	R	P	P	P	P
10	Anatidae	Garganey	<i>Spatula querquedula</i> (Linnaeus, 1758)	LC	M	P	P	P	P
11	Anatidae	Northern shoveler	<i>Spatula clypeata</i> (Linnaeus, 1758)	LC	M	P	P	P	P
12	Anatidae	Gadwall	<i>Mareca strepera</i> (Linnaeus, 1758)	LC	M	P	P	P	P
13	Anatidae	Falcated duck	<i>Mareca falcate</i> (Georgi, 1775)	NT	M	A	P	P	P
14	Anatidae	Eurasian wigeon	<i>Mareca penelope</i> (Linnaeus, 1758)	LC	M	P	P	P	P
15	Anatidae	Mallard	<i>Anas platyrhynchos</i> Linnaeus, 1758	LC	M	A	P	P	P
16	Anatidae	Northern pintail	<i>Anas acuta</i> Linnaeus, 1758	LC	M	P	P	P	P
17	Anatidae	Common teal	<i>Anas crecca</i> Linnaeus, 1758	LC	M	P	P	P	P
18	Anatidae	Red-crested pochard	<i>Netta rufina</i> (Pallas, 1773)	LC	M	P	P	P	P
19	Anatidae	Common pochard	<i>Aythya ferina</i> (Linnaeus, 1758)	Vu	M	P	P	P	P
20	Anatidae	Ferruginous duck	<i>Aythya nyroca</i> (Güldenstädt, 1770)	NT	M	P	P	P	P
21	Anatidae	Tufted duck	<i>Aythya fuligula</i> (Linnaeus, 1758)	LC	M	P	P	P	P
22	Podicipedidae	Little grebe	<i>Tachybaptus ruficollis</i> (Pallas, 1764)	LC	R	P	P	P	P
23	Podicipedidae	Great crested grebe	<i>Podiceps cristatus</i> (Linnaeus, 1758)	LC	M	P	P	P	P
24	Phasianidae	Grey francolin	<i>Francolinus pondicerianus</i> (J.F. Gmelin, 1789)	LC	R	P	P	P	P
25	Columbidae	Rock pigeon	<i>Columba livia</i> J.F. Gmelin, 1789	LC	R	P	P	P	P
26	Columbidae	Oriental turtle dove	<i>Streptopelia orientalis</i> (Latham, 1790)	LC	V	A	A	A	P
27	Columbidae	Eurasian collared dove	<i>Streptopelia decaocto</i> (Fridvaldszky, 1838)	LC	R	P	P	P	P
28	Columbidae	Spotted dove	<i>Streptopelia chinensis</i> (Scopoli, 1786)	LC	R	P	P	P	P
29	Columbidae	Yellow-footed green pigeon	<i>Treron phoenicopterus</i> (Latham, 1790)	LC	R	P	P	P	P
30	Cuculidae	Greater coucal	<i>Centropus sinensis</i> (Stephens, 1815)	LC	R	P	P	P	P
31	Cuculidae	Asian koel	<i>Eudynamis scolopaceus</i> (Linnaeus, 1758)	LC	R	P	P	P	P
32	Cuculidae	Plaintive cuckoo	<i>Cacomantis merulinus</i> (Scopoli, 1786)	LC	R	A	A	P	P
33	Cuculidae	Common hawk cuckoo	<i>Hierococcyx varius</i> (Vahl, 1797)	LC	R	P	P	P	P
34	Caprimulgidae	Indian nightjar	<i>Caprimulgus asiaticus</i> Latham, 1790	LC	R	P	P	P	P
35	Apodidae	Indian house swift	<i>Apus affinis</i> (J.E. Gray, 1830)	LC	R	P	P	P	P
36	Apodidae	Asian palm swift	<i>Cypsiurus balasiensis</i> (J.E. Gray, 1829)	LC	R	P	P	P	P

Table 1: (Continued)

S. No.	Family	Common name	Scientific name	IUCN Status	Migratory Status	Presence/ Absence yearly			
						Nov. 2017- Feb. 2018	Nov. 2018- Feb. 2019	Nov. 2019- Feb. 2020	Nov. 2020- Feb. 2021
37	Rallidae	Common moorhen	<i>Gallinula chloropus</i> (Linnaeus, 1758)	LC	R	P	P	P	P
38	Rallidae	Common coot	<i>Fulica atra</i> Linnaeus, 1758	LC	R	P	P	P	P
39	Rallidae	Grey-headed swamphen	<i>Porphyrio poliocephalus</i> (Latham, 1801)	LC	R	P	P	P	P
40	Rallidae	White-breasted waterhen	<i>Amaurornis phoenicurus</i> (Pennant, 1769)	LC	R	P	P	P	P
41	Burhinidae	Indian thick-knee	<i>Burhinus indicus</i> (Salvadori, 1865)	LC	R	A	A	P	A
42	Charadriidae	Yellow-wattled lapwing	<i>Vanellus malabaricus</i> (Boddaert, 1783)	LC	R	A	P	P	P
43	Charadriidae	Grey-headed lapwing	<i>Vanellus cinereus</i> (Blyth, 1842)	LC	M	P	P	P	P
44	Charadriidae	Red-wattled lapwing	<i>Vanellus indicus</i> (Boddaert, 1783)	LC	R	P	P	P	P
45	Charadriidae	Kentish plover	<i>Charadrius alexandrinus</i> Linnaeus, 1758	LC	M	P	A	A	A
46	Charadriidae	Little ringed plover	<i>Charadrius dubius</i> Scopoli, 1786	LC	R	P	A	A	A
47	Jacanidae	Pheasant-tailed jacana	<i>Hydrophasianus chirurgus</i> (Scopoli, 1786)	LC	R	P	P	P	P
48	Jacanidae	Bronze-winged jacana	<i>Metopidius indicus</i> (Latham, 1790)	LC	R	P	P	P	P
49	Scolopacidae	Temminck's stint	<i>Calidris temminckii</i> (Leisler, 1812)	LC	M	P	P	A	A
50	Scolopacidae	Common snipe	<i>Gallinago gallinago</i> (Linnaeus, 1758)	LC	M	P	P	P	P
51	Scolopacidae	Pintail snipe	<i>Gallinago stenura</i> (Bonaparte, 1831)	LC	M	P	P	P	P
52	Scolopacidae	Common sandpiper	<i>Actitis hypoleucos</i> (Linnaeus, 1758)	LC	M	P	P	P	P
53	Scolopacidae	Green sandpiper	<i>Tringa ochropus</i> Linnaeus, 1758	LC	M	P	A	A	A
54	Scolopacidae	Spotted redshank	<i>Tringa erythropus</i> (Pallas, 1764)	LC	M	A	A	P	A
55	Scolopacidae	Common greenshank	<i>Tringa nebularia</i> (Gunnerus, 1767)	LC	M	A	A	P	A
56	Tumidae	Barred buttonquail	<i>Turnix suscitator</i> (J.F. Gmelin, 1789)	LC	R	P	P	P	P
57	Laridae	Black-headed gull	<i>Chroicocephalus ridibundus</i> (Linnaeus, 1766)	LC	M	P	A	P	A
58	Laridae	Pallas's gull	<i>Ichthyaetus ichthyaetus</i> (Pallas, 1773)	LC	M	A	A	P	A
59	Ciconiidae	Asian openbill	<i>Anastomus oscitans</i> (Boddaert, 1783)	LC	R	P	P	P	P
60	Ciconiidae	Woolly-necked stork	<i>Ciconia episcopus</i> (Boddaert, 1783)	Vu	R	A	P	P	P
61	Ciconiidae	Lesser adjutant	<i>Leptoptilos javanicus</i> (Horsfield, 1821)	Vu	R	A	A	P	A
62	Anhingidae	Oriental darter	<i>Anhinga melanogaster</i> Pennant, 1769	NT	R	P	A	A	A
63	Phalacrocoracidae	Little cormorant	<i>Microcarbo niger</i> (Vieillot, 1817)	LC	R	P	P	P	P
64	Phalacrocoracidae	Great cormorant	<i>Phalacrocorax carbo</i> (Linnaeus, 1758)	LC	M	P	P	P	P
65	Phalacrocoracidae	Indian cormorant	<i>Phalacrocorax fuscicollis</i> Stephens, 1826	LC	R	P	P	P	P
66	Ardeidae	Yellow bittern	<i>Ixobrychus sinensis</i> (J.F. Gmelin, 1789)	LC	R	A	P	A	A
67	Ardeidae	Cinnamon bittern	<i>Ixobrychus cinnamomeus</i> (J.F. Gmelin, 1789)	LC	R	A	P	A	A
68	Ardeidae	Grey heron	<i>Ardea cinerea</i> Linnaeus, 1758	LC	R	P	P	P	P
69	Ardeidae	Purple heron	<i>Ardea purpurea</i> Linnaeus, 1766	LC	R	P	P	P	P
70	Ardeidae	Great egret	<i>Ardea alba</i> Linnaeus, 1758	LC	R	P	P	P	P
71	Ardeidae	Intermediate egret	<i>Ardea intermedia</i> Wagler, 1829	LC	R	P	P	P	P
72	Ardeidae	Little egret	<i>Egretta garzetta</i> (Linnaeus, 1766)	LC	R	P	P	P	P
73	Ardeidae	Cattle egret	<i>Bubulcus ibis</i> (Linnaeus, 1758)	LC	R	P	P	P	P

Table 1: (Continued)

S. No.	Family	Common name	Scientific name	IUCN Status	Migratory Status	Presence/ Absence yearly			
						Nov. 2017-Feb. 2018	Nov. 2018-Feb. 2019	Nov. 2019-Feb. 2020	Nov. 2020-Feb. 2021
74	Ardeidae	Indian pond heron	<i>Ardeola grayii</i> (Sykes, 1832)	LC	R	P	P	P	P
75	Ardeidae	Black-crowned night heron	<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	LC	R	P	P	P	P
76	Threskiornithidae	Black-headed ibis	<i>Threskiornis melanocephalus</i> (Latham, 1790)	NT	R	P	P	A	A
77	Pandionidae	Osprey	<i>Pandion haliaetus</i> (Linnaeus, 1758)	LC	M	P	P	P	P
78	Accipitridae	Black-winged kite	<i>Elanus caeruleus</i> (Desfontaines, 1789)	LC	R	P	P	P	P
79	Accipitridae	Oriental honey buzzard	<i>Pernis ptilorhynchus</i> (Temminck, 1821)	LC	R	P	P	P	P
80	Accipitridae	Crested serpent eagle	<i>Spilornis cheela</i> (Latham, 1790)	LC	R	P	A	P	P
81	Accipitridae	Short-toed snake eagle	<i>Circaetus gallicus</i> (J.F. Gmelin, 1788)	LC	R	P	P	P	P
82	Accipitridae	Greater spotted eagle	<i>Clanga clanga</i> (Pallas, 1811)	Vu	M	P	P	P	P
83	Accipitridae	Booted eagle	<i>Hieraetus pennatus</i> (J.F. Gmelin, 1788)	LC	M	P	P	P	P
84	Accipitridae	Bonelli's eagle	<i>Aquila fasciata</i> Vieillot, 1822	LC	M	A	A	A	P
85	Accipitridae	White-eyed buzzard	<i>Butastur teesa</i> (Franklin, 1831)	LC	R	P	P	P	P
86	Accipitridae	Western marsh harrier	<i>Circus aeruginosus</i> (Linnaeus, 1758)	LC	M	P	P	P	P
87	Accipitridae	Eastern marsh harrier	<i>Circus spilonotus</i> Kaup, 1847	LC	M	P	A	P	A
88	Accipitridae	Hen harrier	<i>Circus cyaneus</i> (Linnaeus, 1766)	LC	M	P	A	A	A
89	Accipitridae	Pied harrier	<i>Circus melanoleucos</i> (Pennant, 1769)	LC	M	P	P	P	P
90	Accipitridae	Shikra	<i>Accipiter badius</i> (J.F. Gmelin, 1788)	LC	R	P	P	P	P
91	Accipitridae	Eurasian sparrowhawk	<i>Accipiter nisus</i> (Linnaeus, 1758)	LC	M	A	P	A	A
92	Accipitridae	Black kite	<i>Milvus migrans</i> (Boddaert, 1783)	LC	R	P	P	P	P
93	Accipitridae	Brahminy kite	<i>Haliastur indus</i> (Boddaert, 1783)	LC	R	A	A	P	A
94	Accipitridae	Common buzzard	<i>Buteo buteo</i> (Linnaeus, 1758)	LC	M	A	A	P	P
95	Accipitridae	Himalayan buzzard	<i>Buteo refectus</i> Portenko, 1935	LC	M	A	P	P	A
96	Accipitridae	Long-legged buzzard	<i>Buteo rufinus</i> (Cretzschmar, 1829)	LC	R	P	P	P	P
97	Upupidae	Common hoopoe	<i>Upupa epops</i> Linnaeus, 1758	LC	R	P	P	P	P
98	Alcedinidae	Common kingfisher	<i>Alcedo atthis</i> (Linnaeus, 1758)	LC	R	P	P	P	P
99	Alcedinidae	Stork-billed kingfisher	<i>Pelargopsis capensis</i> (Linnaeus, 1766)	LC	R	P	P	P	P
100	Alcedinidae	White-throated kingfisher	<i>Halcyon smyrnensis</i> (Linnaeus, 1758)	LC	R	P	P	P	P
101	Alcedinidae	Pied kingfisher	<i>Ceryle rudis</i> (Linnaeus, 1758)	LC	R	P	P	P	P
102	Meropidae	Green bee-eater	<i>Merops orientalis</i> Latham, 1801	LC	R	P	P	P	P
103	Picidae	Eurasian wryneck	<i>Jynx torquilla</i> Linnaeus, 1758	LC	R	P	P	P	P
104	Picidae	Black-rumped flameback	<i>Dinopium benghalense</i> (Linnaeus, 1758)	LC	R	P	P	P	P
105	Falconidae	Common kestrel	<i>Falco tinnunculus</i> Linnaeus, 1758	LC	M	P	P	P	P
106	Falconidae	Red-necked falcon	<i>Falco chicquera</i> Daudin, 1800	NT	R	P	A	A	A
107	Falconidae	Peregrine falcon	<i>Falco peregrinus</i> Tunstall, 1771	LC	M	A	P	A	P
108	Psittaculidae	Rose-ringed parakeet	<i>Psittacula krameri</i> (Scopoli, 1769)	LC	R	P	P	P	P
109	Campephagidae	Small minivet	<i>Pericrocotus cinnamomeus</i> (Linnaeus, 1766)	LC	R	P	P	P	P
110	Campephagidae	Swinhoe's minivet	<i>Pericrocotus cantonensis</i> Swinhoe, 1861	LC	V	A	P	A	A

Table 1: (Continued)

S. No.	Family	Common name	Scientific name	IUCN Status	Migratory Status	Presence/ Absence yearly			
						Nov. 2017- Feb. 2018	Nov. 2018- Feb. 2019	Nov. 2019- Feb. 2020	Nov. 2020- Feb. 2021
111	Campephagidae	Black-winged cuckooshrike	<i>Lalage melaschistos</i> (Hodgson, 1836)	LC	M	A	P	P	A
112	Campephagidae	Black-headed cuckooshrike	<i>Lalage melanoptera</i> (Rüppell, 1839)	LC	R	A	P	P	A
113	Oriolidae	Indian golden oriole	<i>Oriolus kundoo</i> Sykes, 1832	LC	R	A	P	A	P
114	Oriolidae	Black-hooded oriole	<i>Oriolus xanthornus</i> (Linnaeus, 1758)	LC	R	P	P	P	P
115	Aegithinidae	Common iora	<i>Aegithina tiphia</i> (Linnaeus, 1758)	LC	R	P	P	P	P
116	Dicruridae	Black drongo	<i>Dicrurus macrocercus</i> Vieillot, 1817	LC	R	P	P	P	P
117	Dicruridae	Ashy drongo	<i>Dicrurus leucophaeus</i> Vieillot, 1817	LC	R	A	A	P	P
118	Monarchidae	Indian paradise-flycatcher	<i>Terpsiphone paradise</i> (Linnaeus, 1758)	LC	M	A	A	P	A
119	Laniidae	Brown shrike	<i>Lanius cristatus</i> Linnaeus, 1758	LC	M	P	P	P	P
120	Laniidae	Long-tailed shrike	<i>Lanius schach</i> Linnaeus, 1758	LC	M	P	P	P	P
121	Corvidae	Rufous treepie	<i>Dendrocitta vagabunda</i> (Latham, 1790)	LC	R	P	P	P	P
122	Corvidae	House crow	<i>Corvus splendens</i> Vieillot, 1817	LC	R	P	P	P	P
123	Alaudidae	Ashy-crowned sparrow lark	<i>Eremopterix griseus</i> (Scopoli, 1786)	LC	R	P	P	P	P
124	Alaudidae	Bengal bushlark	<i>Mirafra assamica</i> Horsfield, 1840	LC	R	P	P	P	P
125	Alaudidae	Indian bushlark	<i>Mirafra erythroptera</i> Blyth, 1845	LC	R	A	P	P	P
126	Cisticolidae	Common tailorbird	<i>Orthotomus sutorius</i> (Pennant, 1769)	LC	R	P	P	P	P
127	Cisticolidae	Grey-breasted prinia	<i>Prinia hodgsonii</i> Blyth, 1844	LC	R	P	P	P	P
128	Cisticolidae	Jungle prinia	<i>Prinia sylvatica</i> Jerdon, 1840	LC	R	A	A	P	P
129	Cisticolidae	Ashy prinia	<i>Prinia socialis</i> Sykes, 1832	LC	R	P	P	P	P
130	Cisticolidae	Plain prinia	<i>Prinia inornata</i> Sykes, 1832	LC	R	P	P	P	P
131	Cisticolidae	Zitting cisticola	<i>Cisticola juncidis</i> (Rafinesque, 1810)	LC	R	P	P	P	P
132	Acrocephalidae	Thick-billed warbler	<i>Arundinax aedon</i> (Pallas, 1776)	LC	M	A	A	P	A
133	Acrocephalidae	Paddyfield warbler	<i>Acrocephalus agricola</i> (Jerdon, 1845)	LC	M	A	A	P	A
134	Acrocephalidae	Blyth's reed warbler	<i>Acrocephalus dumetorum</i> Blyth, 1849	LC	M	P	P	P	P
135	Acrocephalidae	Clamorous reed warbler	<i>Acrocephalus stentoreus</i> (Hemprich and Ehrenberg, 1833)	LC	M	P	A	A	A
136	Hirundinidae	Barn swallow	<i>Hirundo rustica</i> Linnaeus, 1758	LC	M	P	P	P	P
137	Hirundinidae	Wire-tailed swallow	<i>Hirundo smithii</i> Leach, 1818	LC	R	P	P	P	P
138	Hirundinidae	Red-rumped swallow	<i>Cecropis daurica</i> (Laxmann, 1769)	LC	R	A	P	P	A
139	Hirundinidae	Streak-throated swallow	<i>Petrochelidon fluviicola</i> (Blyth, 1855)	LC	R	P	P	P	A
140	Phylloscopidae	Tickell's leaf warbler	<i>Phylloscopus affinis</i> (Tickell, 1833)	LC	M	P	P	P	P
141	Phylloscopidae	Dusky warbler	<i>Phylloscopus fuscatus</i> (Blyth, 1842)	LC	M	P	P	P	P
142	Phylloscopidae	Common chiffchaff	<i>Phylloscopus collybita</i> (Vieillot, 1817)	LC	M	A	P	P	P
143	Phylloscopidae	Greenish warbler	<i>Phylloscopus trochiloides</i> (Sundevall, 1837)	LC	M	P	P	P	P
144	Paradoxornithidae	Yellow-eyed babbler	<i>Chrysomma sinense</i> (J.F. Gmelin, 1789)	LC	R	P	P	P	P
145	Leiothrichidae	Jungle babbler	<i>Argya striata</i> (Dumont, 1823)	LC	R	P	P	P	P
146	Leiothrichidae	Common babbler	<i>Argya caudate</i> (Dumont, 1823)	LC	R	P	P	P	P
147	Leiothrichidae	Striated babbler	<i>Argya earlei</i> (Blyth, 1844)	LC	R	A	P	P	A

Table 1: (Continued)

S. No.	Family	Common name	Scientific name	IUCN Status	Migratory Status	Presence/ Absence yearly			
						Nov. 2017- Feb. 2018	Nov. 2018- Feb. 2019	Nov. 2019- Feb. 2020	Nov. 2020- Feb. 2021
148	Sturnidae	Asian pied starling	<i>Gracupica contra</i> (Linnaeus, 1758)	LC	R	P	P	P	P
149	Sturnidae	Chestnut-tailed starling	<i>Sturnia malabarica</i> (J.F. Gmelin, 1789)	LC	R	P	P	P	P
150	Sturnidae	Common myna	<i>Acridotheres tristis</i> (Linnaeus, 1766)	LC	R	P	P	P	P
151	Muscicapidae	Indian robin	<i>Copsychus fulicatus</i> (Linnaeus, 1766)	LC	R	P	P	P	P
152	Muscicapidae	Oriental magpie robin	<i>Copsychus saularis</i> (Linnaeus, 1758)	LC	R	P	P	P	P
153	Muscicapidae	Verditer flycatcher	<i>Eumyias thalassinus</i> (Swainson, 1838)	LC	R	A	P	P	A
154	Muscicapidae	Bluethroat	<i>Luscinia svecica</i> (Linnaeus, 1758)	LC	M	A	P	P	P
155	Muscicapidae	Siberian rubythroat	<i>Calliope calliope</i> (Pallas, 1776)	LC	M	A	P	P	P
156	Muscicapidae	Taiga flycatcher	<i>Ficedula albicilla</i> (Pallas, 1811)	LC	M	P	P	P	P
157	Muscicapidae	Siberian stonechat	<i>Saxicola maurus</i> (Pallas, 1773)	LC	M	P	P	P	P
158	Muscicapidae	Pied bushchat	<i>Saxicola caprata</i> (Linnaeus, 1766)	LC	M	P	A	A	A
159	Nectariniidae	Purple-rumped sunbird	<i>Leptocoma zeylonica</i> (Linnaeus, 1766)	LC	R	P	P	P	P
160	Nectariniidae	Purple sunbird	<i>Cinnyris asiaticus</i> (Latham, 1790)	LC	R	P	P	P	P
161	Ploceidae	Baya weaver	<i>Ploceus philippinus</i> (Linnaeus, 1766)	LC	R	A	P	P	A
162	Estrildidae	Red munia	<i>Amandava amandava</i> (Linnaeus, 1758)	LC	R	P	P	P	P
163	Estrildidae	Indian silverbill	<i>Euodice malabarica</i> (Linnaeus, 1758)	LC	R	P	P	P	P
164	Estrildidae	Scaly-breasted munia	<i>Lonchura punctulata</i> (Linnaeus, 1758)	LC	R	P	P	P	P
165	Motacillidae	Grey wagtail	<i>Motacilla cinerea</i> Tunstall, 1771	LC	M	P	P	A	A
166	Motacillidae	Eastern yellow wagtail	<i>Motacilla tschutschensis</i> J.F. Gmelin, 1789	LC	M	P	P	P	P
167	Motacillidae	Citrine wagtail	<i>Motacilla citreola</i> Pallas, 1776	LC	M	A	P	P	A
168	Motacillidae	White-browed wagtail	<i>Motacilla maderaspatensis</i> J.F. Gmelin, 1789	LC	R	P	P	P	A
169	Motacillidae	White wagtail	<i>Motacilla alba</i> Linnaeus, 1758	LC	M	P	P	P	P
170	Motacillidae	Richard's pipit	<i>Anthus richardi</i> Vieillot, 1818	LC	M	A	P	P	P
171	Motacillidae	Paddyfield pipit	<i>Anthus rufulus</i> Vieillot, 1818	LC	R	P	P	P	P
172	Motacillidae	Blyth's pipit	<i>Anthus godlewskii</i> (Taczanowski, 1876)	LC	M	A	A	P	A
173	Motacillidae	Tree pipit	<i>Anthus trivialis</i> (Linnaeus, 1758)	LC	M	A	A	P	P
174	Motacillidae	Olive-backed pipit	<i>Anthus hodgsoni</i> Richmond, 1907	LC	M	P	P	P	P

Table 2: Diversity Indices for different years (2017–2021) for the waterbirds of Bakreswar Dam, Birbhum, West Bengal, India.

Diversity index	Nov. 2017-Feb. 2018	Nov. 2018-Feb. 2019	Nov. 2019-Feb. 2020	Nov. 2020-Feb. 2021
No. of species	130	144	153	133
No. of individuals	7265	7163	7745	6837
Shannon	1.70	1.91	1.83	1.93
Evenness	0.04	0.05	0.04	0.05
Margalef	14.51	16.11	16.97	14.95
Berger-Parker	0.70	0.67	0.68	0.66

Margalef's index is generally concerned with species richness and both indices have the highest values during the year 2019–20 and the lowest values during 2017–18. The Berger Parker index shows a maximum value during 2017–2018 (0.70) and minimum value during 2020–2021 (0.66) (Table 2).

Nandi et al. (2001) studied the waterbirds and water-associated birds from Birbhum district including the Bakreswar Reservoir where they documented only five species from the present study site. In later years, Mazumder et al. (2007) and Ganguly and Mukhopadhyay (2014) published their reports, where they reported 21 species and 33 species, respectively, of waterbirds and wetland-dependent birds from the Bakreswar Reservoir. Khan et al. (2016) documented the waterbirds only and their results showed 23 species of waterbirds from the Bakreswar Dam. As all the previous works on the birds of Bakreswar Reservoir mainly included the waterbirds and wetland-dependent birds, it is difficult to compare the present work with them. The present study is, therefore, the first of its kind from the study location, which includes all the winter avifauna diversity present in the study location. Mazumder et al. (2007) and Ganguly and Mukhopadhyay (2015) mentioned the presence of the Falcated duck *Mareca falcata* (Georgi, 1775), Knob-billed duck *Sarkidiornis melanotos* (Pennant, 1769), Indian cormorant *Phalacrocorax fuscicollis* Stephens, 1826 and Mallard *Anas platyrhynchos* Linnaeus, 1758, which were also observed during the present study but quite rarely, or in small numbers. The Brown-headed gull *Chroicocephalus brunnicephalus* (Jerdon, 1840), as documented by Ganguly and Mukhopadhyay (2015) and the Wood sandpiper *Tringa glareola* Linnaeus, 1758 reported by Khan et al. (2016) have not been recorded during the present study. Either we overlooked the species in spite of the long field surveys or these species may have stopped coming to the present study location. Three species of waterbirds, the Black-headed gull *Chroicocephalus ridibundus* (Linnaeus, 1766), Pallas' gull *Ichthyiaetus ichthyiaetus* (Pallas, 1773) and the Common shelduck *Tadorna tadorna* (Linnaeus, 1758) were not reported by any of the previous studies and so are probably the first report from this locality. Moreover, sightings of a few birds, like the Eurasian sparrowhawk *Accipiter nisus* (Linnaeus, 1758), Bonelli's eagle

Aquila fasciata Vieillot, 1822, Swinhoe's minivet *Pericrocotus cantonensis* Swinhoe, 1861 and Hen harrier *Circus cyaneus* (Linnaeus, 1766) are worth mentioning and may well be the first records from the district also.

The number of winter avifauna species in the Bakreswar Reservoir is increasing over time owing to the increasing involvement of researchers and extensive exploration. At the end of 2017–18, 2018–19, 2019–20 and 2020–21, the number of avifauna species was 130, 156, 171 and 174, respectively (Fig. 3). Of the 174 observed species, 13 species of birds, like the Fulvous whistling duck *Dendrocygna bicolor* (Vieillot, 1816), Greater white-fronted goose *Anser albifrons* (Scopoli, 1769), Oriental turtle dove *Streptopelia orientalis* (Latham, 1790), Red-necked falcon *Falco chicquera* Daudin, 1800, and Swinhoe's minivet *Chroicocephalus ridibundus* Swinhoe, 1861, are recorded only once during the present study. Ten species of birds, which include Temminck's stint *Calidris temminckii* (Leisler, 1812), Clamorous reed warbler *Acrocephalus stentoreus* (Hemprich and Ehrenberg, 1833), Oriental darter *Anhinga melanogaster* Pennant, 1769, Black-headed ibis *Threskiornis melanocephalus* (Latham, 1790), Green sandpiper *Tringa ochropus* Linnaeus, 1758, Pied bushchat *Saxicola caprata* (Linnaeus, 1766) and two varieties each of bitterns *Ixobrychus* spp. and plovers *Charadrius* spp., were recorded only during the first two years of the study (2017–18 and 2018–19) but not recorded in the consecutive years. Moreover, 10 species of birds, like the Jungle prinia *Prinia sylvatica* Jerdon, 1840, Tree pipit *Anthus trivialis* (Linnaeus, 1758), Ashy drongo *Dicrurus leucophaeus* Vieillot, 1817, and Common buzzard *Buteo buteo* (Linnaeus, 1758) were not recorded during the first two years of the study but were observed from the third year onwards.

Various anthropogenic threats were recorded in the surrounding areas of the Bakreswar Dam of the district of Birbhum in West Bengal. Habitat destruction and habitat degradation pose the major threats to the avifauna diversity of this region. Moreover, various other anthropogenic activities are also affecting the avifaunal species of the Bakreswar Dam. Hunting of various migratory water birds and threatened species is a growing concern in recent times (Madsen and Fox, 1995). There is further scope for research on the site-specific occurrence of the birds in the present study giving special emphasis to the water birds.

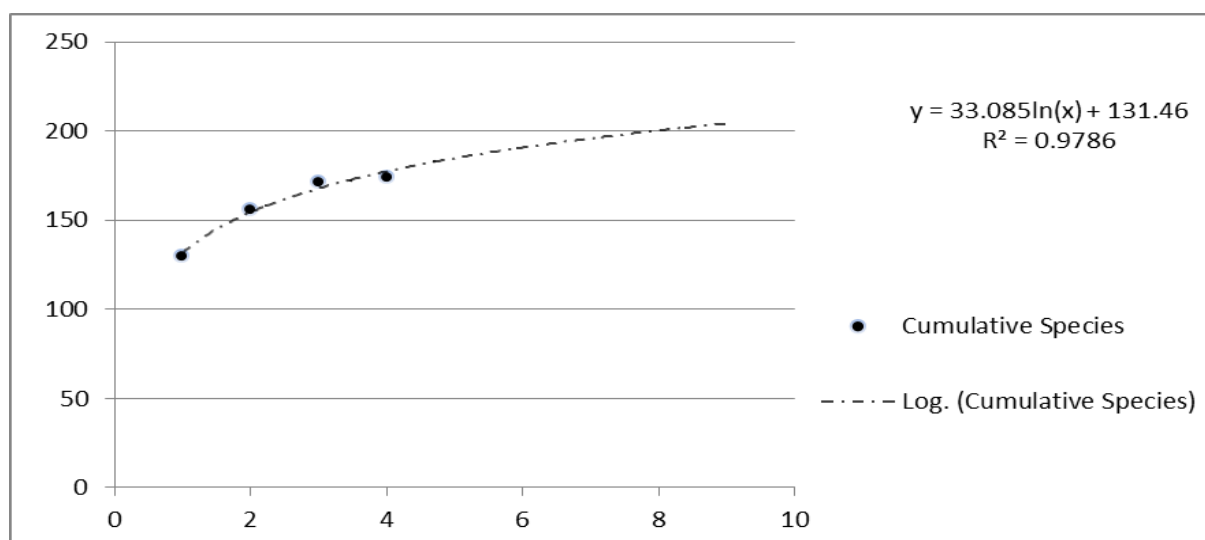


Figure 3: Species Accumulation Curve with a forecast using Log regression fit. [In the Curve, Year 1= 2017–18 and as follows].

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Conflict of interest

All the authors declare that there are no conflicting issues related to this research article.

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Appendix: Some waterbirds of the Bakreswar Dam, Birbhum, West Bengal, India.

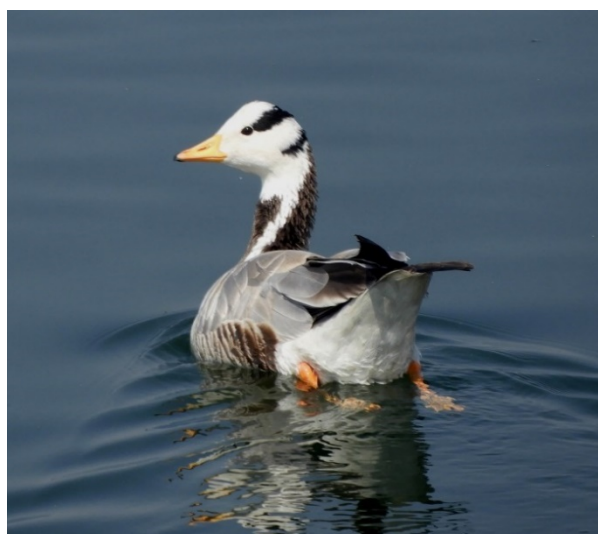


Figure 4: *Anser indicus* (Photo by Debayan Gayen)

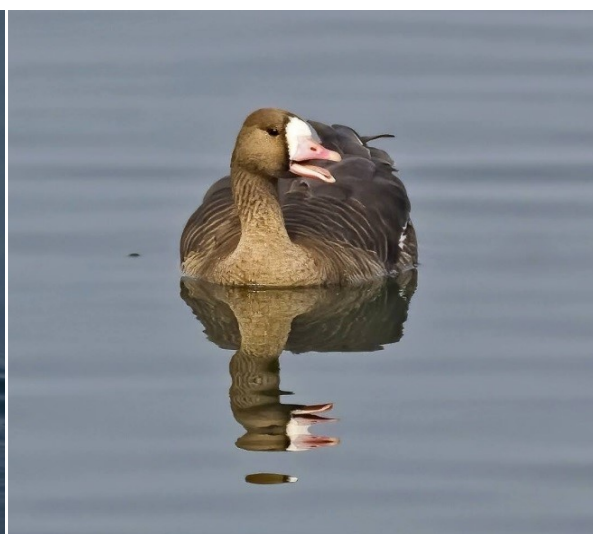


Figure 5: *Anser albifrons* (Photo by Biswajit Mukherjee)

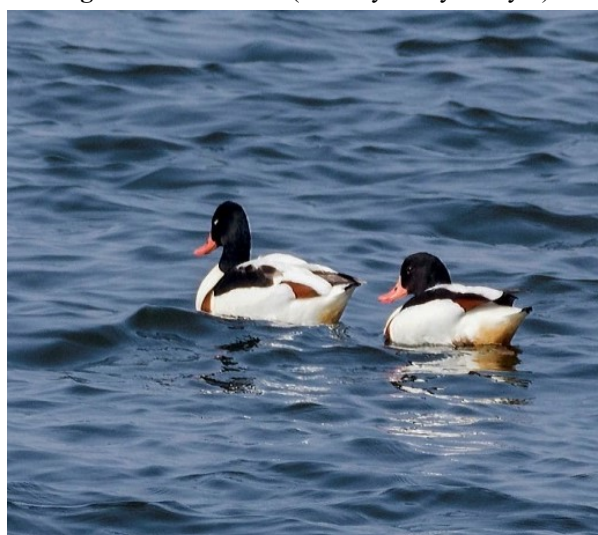


Figure 6: *Tadorna tadorna* (Photo by Biswajit Mukherjee)

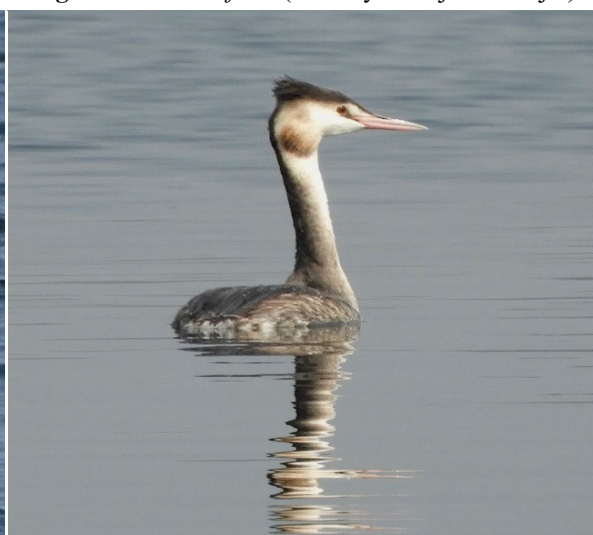


Figure 7: *Podiceps cristatus* (Photo by Debayan Gayen)

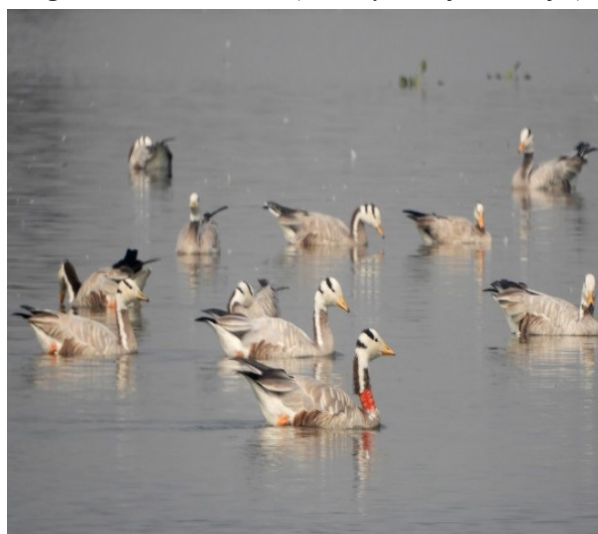


Figure 8: Tagged *Anser indicus* (H83) on 23.1.2019
(Photo by Debayan Gayen)

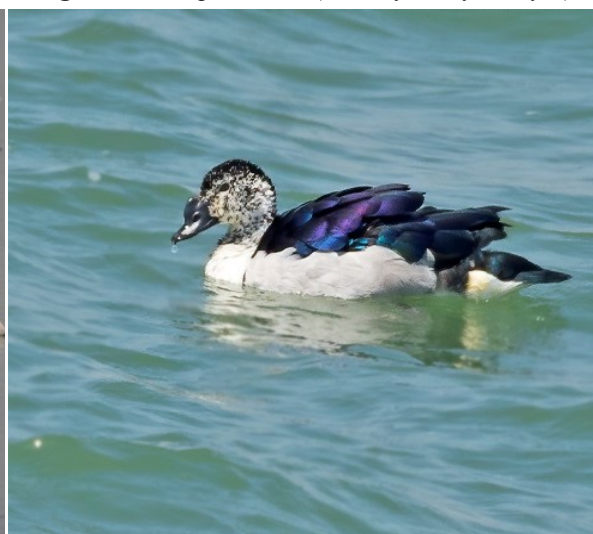


Figure 9: *Sarkidiornis melanotos*
(Photo by Biswajit Mukherjee)



Figure 10: *Anas platyrhynchos* (male and female)
(Photo by Biswajit Mukherjee)



Figure 11: *Aythya ferina*
(Photo by Debayan Gayen)

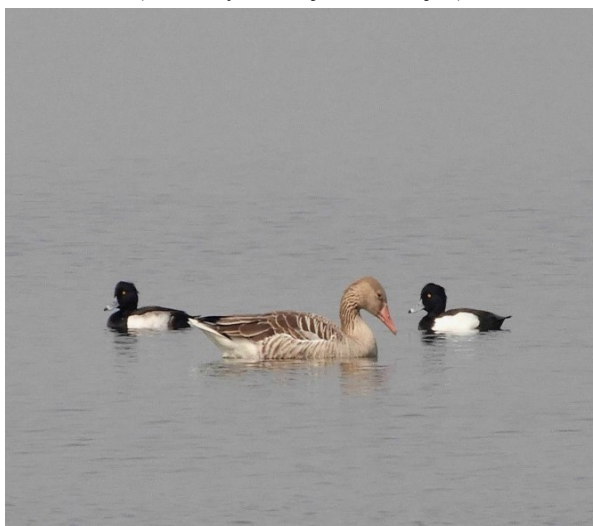


Figure 12: *Anser anser* and *Aythya fuligula* (male)
(Photo by Debayan Gayen)



Figure 13: *Spatula querquedula*
(Photo by Debayan Gayen)



Figure 14: *Accipiter nisus* (Photo by Biswajit Mukherjee)

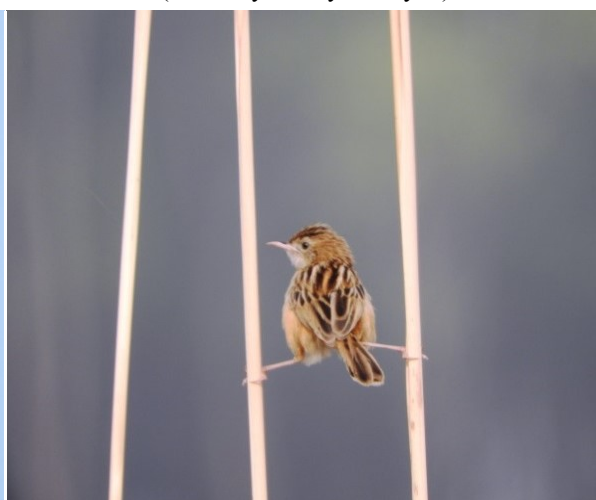


Figure 15: *Cisticola juncidis* (Photo by Debayan Gayen)

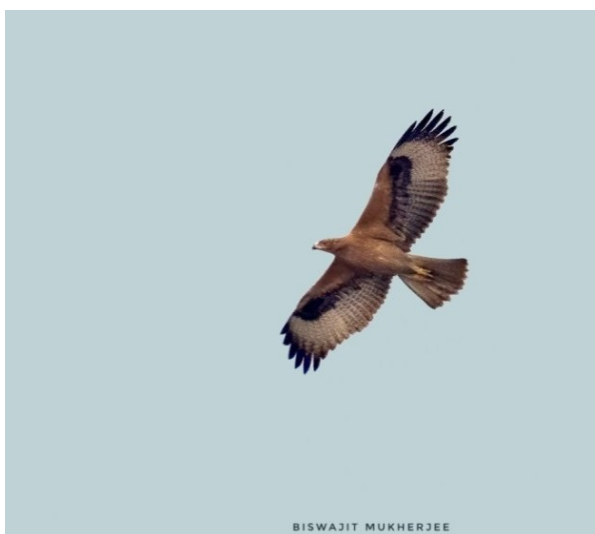


Figure 16: *Aquila fasciata*
(Photo by Biswajit Mukherjee)



Figure 17: *Pericrocotus cantonensis*
(Photo by Biswajit Mukherjee)

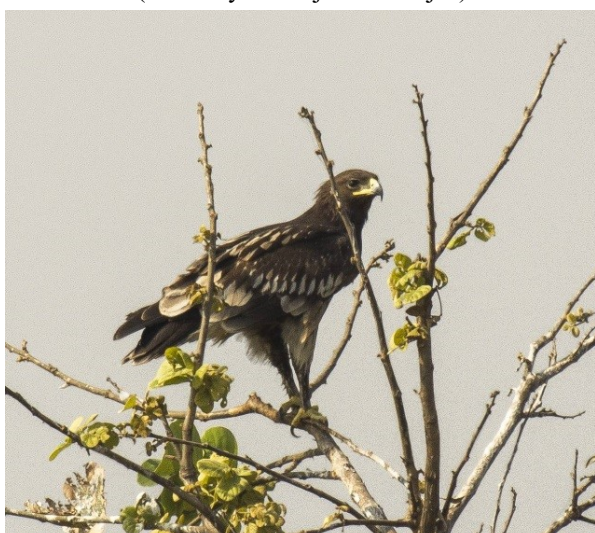


Figure 18: *Clanga clanga* (Photo by Sagar Adhurya)

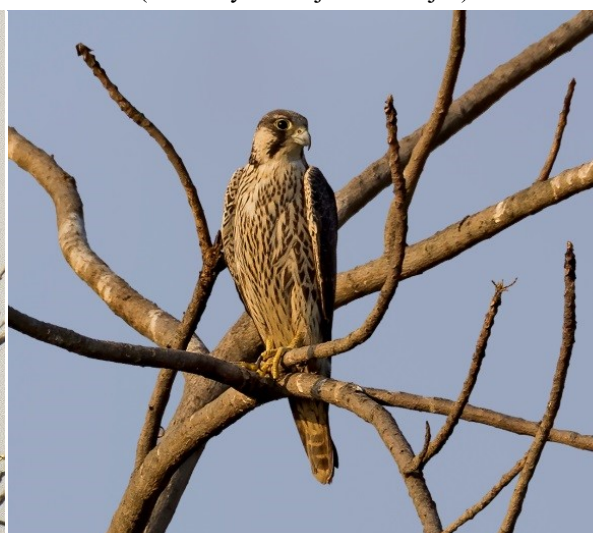


Figure 19: *Falco peregrinus* (Photo by Biswajit Mukherjee)



Figure 20: *Haliastur indus* (Photo by Bappa Goswami)



Figure 21: *Anthus trivialis* (Photo by Debayan Gayen)

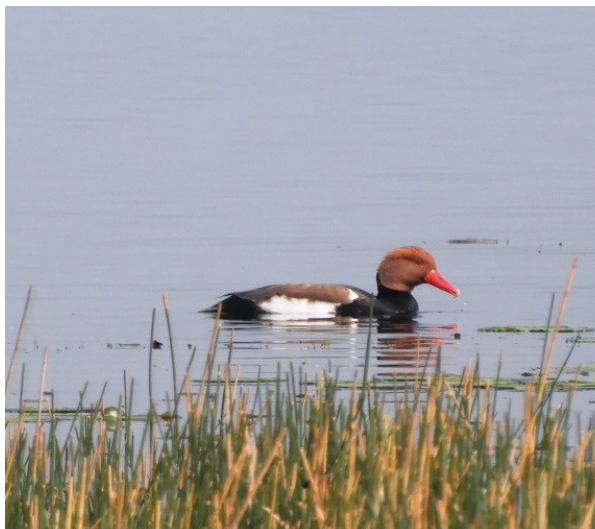


Figure 22: *Netta rufina* (male) (Photo by Debayan Gayen)



Figure 23: *Buteo buteo* (Photo by Debjit Mukherjee)



Figure 24: *Tadorna ferruginea* (male)
(Photo by Debayan Gayen)



Figure 25: *Prinia inornata*
(Photo by Debayan Gayen)



Figure 26: View of the study area
(Photo by Debayan Gayen)



Figure 27: Habitat degradation during the winter months
(Photo credit: Debayan Gayen)