

Status, diversity and species composition of wetland birds in Vaduvloor Bird Sanctuary, Tiruvarur district, Tamil Nadu, India

Abstract

Birds serve as the best indicators of wetland function and as measures of success in wetland management, restoration, and creation. This study was conducted from 2022 to 2024 in the Vaduvloor Bird Sanctuary of Tiruvarur district, employing the total count method to estimate the population of wetland birds. Year-wise species diversity, richness, relative diversity, evenness, density, and relative abundance were calculated. A total of 147 bird species belonging to 48 families and 18 orders were recorded. The maximum diversity and evenness were observed in 2024 (3.05 and 0.37), while the minimum values were recorded in 2023 (2.11 and 0.21). The total density was highest in 2023 (162.68/ha) and lowest in 2024 (27.82/ha), and species richness peaked in 2022 (117) and was lowest in 2024 (84). This sanctuary complex supports three IUCN Red-listed, four Near Threatened species: Curlew Sandpiper (*Calidris ferruginea*), Spot-billed Pelican (*Pelecanus philippensis*), Black-headed Ibis (*Threskiornis melanosephalus*), and Oriental Darter (*Anhinga melanogaster*), two vulnerable species: Yellow-throated Bulbul (*Pycnonotus xantholaemus*) and River Tern (*Sterna hirundo*), and one Endangered species – Lesser Sand Plover (*Charadrius mongolus*). This paper provides an overview of the current status and the IUCN status of wetland birds within the study area.

Keywords: - Wetland, Water birds, Vaduvloor Bird Sanctuary, Year-wise variations

Introduction

Birds are a diverse group of warm-blooded vertebrates known for their feathers, beaks, ability to lay hard-shelled eggs, and, in many cases, their capacity for flight. They inhabit a wide range of ecosystems worldwide, including forests, grasslands, deserts, oceans, woodlands, gardens, swamps, Lakes and Rivers (McWilliams *et al.*, 2021; Idahoret *al.*, 2021). With a greater number of species spread across nearly the entire Earth than any other class of vertebrates (Darlington, 1948), birds exhibit a remarkable variety of sizes, from tiny hummingbirds to towering ostriches. Their physical characteristics also vary greatly, including colours, patterns, and specialized adaptations for different lifestyles. Birds are widely acknowledged as essential for biodiversity conservation (Begon and Townsend, 2021).

Their diversity within an area fulfils crucial ecological functions such as pollination, seed dispersal, and pest control. Additionally, birds are valuable indicators of biodiversity shifts and ecosystem health, serving as bioindicators (Jones *et al.*, 2009). Recognizing the importance of each bird species is vital for maintaining ecological balance and a healthy environment (Krishnamoorthi *et al.*, 2020; Baranidharan *et al.*, 2018).

The Indian subcontinent is home to approximately 1,340 bird species, constituting over 13% of the global avian diversity (Sivaperuman *et al.*, 2022). “Among the 1340 bird species found in India, 302 are water birds, 57 are endemic to the region, 3 are breeding endemics, and 85 are classified as threatened” (Birdlife International, 2019). The birds that are ecologically dependent on wetlands are called waterfowl or aquatic birds according to Ramsar Convention (1975). Wetland is an “Area of marsh, fen, peatland or water whether natural or artificial, permanent or temporary with water, that is static or flowing, fresh, brackish or salt including areas of marine water, the depth of which does not exceed 6 meters” (Ramsar convention, 2004; Gupta *et al.*, 2011). Wetlands, thesecond most productive ecosystems after tropical rainforests (Ekhande *et al.*, 2012), nurture migratory aquatic avian and resident avian species, enhancing wetland richness and productivity (Gibbs, 1993; Paracuellos, 2006). “Conserving wetlands is paramount to safeguard threatened and endangered species” (Abire *et al.*, 2014). The discharge of sewage and agricultural runoff constitutes significant factors introducing various nutrients into wetland ecosystems, leading to their degradation and potential demise (Koiri *et al.*, 2024; Sudhira and Kumar, 2000). The Vaduvor Bird Sanctuary serves as a crucial habitat for numerous wetland birds. Despite its importance, there has been a notable absence of systematic studies focusing on wetland birds in terms of seasonal patterns, diversity, evenness, richness, and density. **The Vaduvor Bird Sanctuary holds significance as one of the Ramsar sites, highlighting the importance of wetland conservation. Preserving these wetlands not only aids in conservation efforts but also has the potential to boost tourism for the sanctuary.** Therefore, this study was undertaken with the primary objective of conducting an inventory of wetland birds within the Vaduvor Bird Sanctuary.

Materials and Methods

Study Area

Vaduvor bird sanctuary (SriKodandaramaswamieri) is located between 10°42'9.39"N latitude and 79°19'4.94"E longitude and covers an area of over 128.10 ha

(1.28 sq.km) in Vaduvor Agraharam village of Mannargudi Taluk of Tiruvarur District in Tamil Nadu. "It is comprised of small man-made reservoirs connected by an ancient network of canals and these reservoirs are fed by the Mettur reservoir and are situated in the semi-arid district of Thiruvarur was created in 1999. The tank water is extensively **utilized** by the villagers for agriculture. As the sanctuary is basically an irrigation tank, there is no forest vegetation within the sanctuary. *Acacia nilotica* plantations raised by Social Forestry Wing stand on the western boundary of the sanctuary. Other species present in the sanctuary include *Azadiracta indica*, *Melia azadirach*, *Pongamia pinnata*, Coconut, Palmyrah, etc. A variety of medicinal plants, mostly in the form of shrubs and climbers, come up annually on the sanctuary bunds. A large portion of the tank on the northern side, close to the steel watch tower, has been encroached by Water hyacinth and Ipomoea. **Likewise, the aquatic submerged and terrestrial vegetation present in and around the wetland serve as essential foraging and breeding grounds for the birds. The interconnected wetland system plays a crucial role as a protective barrier against flooding and also serves as a water source during periods of drought. However, the Sanctuary faces mounting anthropogenic pressures stemming from urbanization, water extraction, unsustainable fishing practices, invasive species, and climate change. Consequently, it has been designated as an area of national significance by the government. To address these challenges, the Tiruvarur Forest Division implemented a management plan spanning from 2016 to 2021"** (Ramsar Sites Information Service, 2024).

Methodology

The field survey was conducted last three years from 2022 to 2024 using the total count method. Wherever possible, researchers walked in and around the wetlands or selected specific vantage points to count all the birds **(only seen) and the same pathway was used for whole survey** (Gupta *et al.*, 2011). The survey was carried out during dusk and dawn times, from 6:30 am to 10:00 am in the morning and 4:00 pm to 6:30 pm in the evening. Observations were made using binoculars (Nikon 7x50), and photographs of birds were taken using a camera (Nikon P900). Bird identification was confirmed using reference books such as "Birds of the Indian Subcontinent" (Grimmett *et al.*, 1999) and "The Book of Indian Birds" by Salim Ali (1996).

Data Analysis

Shannon-Weiner index of diversity (Shannon and Wiener, 1963) was used to assess the bird species diversity in Vaduvloor Bird Sanctuary.

The formula for calculating the Shannon diversity index is

$$H' = - \sum P_i \ln P_i$$

Where H' = Shannon index of diversity, P_i = the proportion of the i th species in the landscape element, $\ln P_i$ = Natural logarithm of the proportion of each species.

Richness was calculated by counting the number of species observed in a particular season and particular place (Harisha and Hosetti, 2009).

$$\text{Species richness} = \text{Number of species recorded}$$

Pielou's evenness index was utilized to estimate the species evenness within the Vaduvloor Bird Sanctuary. This index provides a measure of how evenly distributed the individuals are among different species, indicating the level of evenness in the community (Ekhande *et al.*, 2012).

$$\text{Evenness/Equitability} = H'/H'_{\text{max}}$$

Where, H' = Value recorded from Shannon-Weiner diversity index and H'_{max} = Maximum possible value of H' .

The Relative Abundance (Anjos, 2004 and Ayenalem & Bekele, 2008) was analyzed from the collected data during the study period using the following formula:

$$\text{Relative Abundance} = \frac{\text{Number of individual of species}}{\text{Number of individuals of all species}} \times 100$$

Density indicates the number of individuals of a species in a specific area. It's calculated by dividing the total number of individuals of each species during a certain season by the total area of the wetland (Ramamurthy and Rajakumar, 2014).

Results and Discussion

The current investigation revealed that 147 species of birds belonging to 48 families and 18 orders were recorded during last 3 years in Vaduvloor bird sanctuary. During this study, 140 Least Concern, four Near Threatened species viz., Curlew Sandpiper *Calidris ferruginea*, Spot billed Pelican *Pelacanus philippensis*, Black Headed Ibis *Threskiornis melanosephalus* and Oriental Darter *Anhinga melanogaster*; two Vulnerable viz., Yellow Throated Bulbul *Pycnonotus xantholaemus* and River Tern *Sterna hirundo* and one Endangered – Lesser Sand Plover (*Charadrius mongolus*) were observed (Figure 1). [Vijayanet](#)

al. (2006) was conducted the survey in Vaduvloor bird sanctuary who recorded the totally 24 species of wetland birds. This research finding was in line with findings of Baranidharan *et al.* (2022) in Karaivetti bird sanctuary, with a total of 36 species of birds belonging to 13 families and 4 orders with Six Near Threatened species observed Oriental Darter (*Anhinga melanogaster*), Painted Stork (*Mycteria leucocephala*), Spot billed Pelican (*Pelecanus philippensis*), White Necked Stork (*Ciconia episcopus*), White Ibis (*Threskiornis melanocephalus*) and Black-Tailed Godwit (*Limosa limosa*). In addition, one IUCN Red List Vulnerable Species River Tern (*Sterna aurantia*) was found to be in the Karaivetti bird sanctuary. Similar study was conducted by Krishnamoorthi *et al.* (2020) who found the 72 species of birds belonging to 38 families and 17 orders with three Near Threatened species Oriental Darter *Anhinga melanogaster*, Painted Stork *Mycteria leucocephala* and Spot billed Pelican *Pelecanus philippensis* in Vellode bird sanctuary. A similar study was done by Vas *et al.* (2023) in Neyveli Lignite Corporation India Limited (NLCIL) in Neyveli, Tamil Nadu who identified the 107 different species comprising of 21 orders and 45 orders with three Near Threatened species.

Species diversity

Regarding the species diversity in Vaduvloor bird sanctuary during different years, the maximum species diversity was recorded in the 2024 (3.05) followed by 2022 (2.63) whereas the minimum species diversity was obtained in the 2023 (2.11). Similar findings were found by Manohara *et al.* (2016) on analysing the species diversity in Magadi bird sanctuary, Karnataka and they reported that the maximum diversity in 2012-2013 (1.01) and minimum diversity in 2015-16 (0.64). Concerning to the species richness of Vaduvloor bird sanctuary, the highest richness was found in the 2022 (117) followed by 2023 (93) and the lowest species richness was noted in the 2024 (84). A similar finding was found by Manohara *et al.* (2016) in Magadi bird sanctuary, Karnataka with maximum species richness was observed in 2012-13 (33) and minimum in 2015-16 (27). Pertaining to evenness of Vaduvloor bird sanctuary the highest evenness was noted during 2024 (0.37) followed by 2022 (0.29) and the lowest evenness was recorded during 2023 (0.21) (Table 1 & Figure 2 & 3). The results were in accordance with findings of Anika and Parasharya (2013) with maximum evenness during summer (0.6273 ± 0.0518) and minimum in winter (0.5117 ± 0.0285) in Khodiyar wetland, Gujarat.

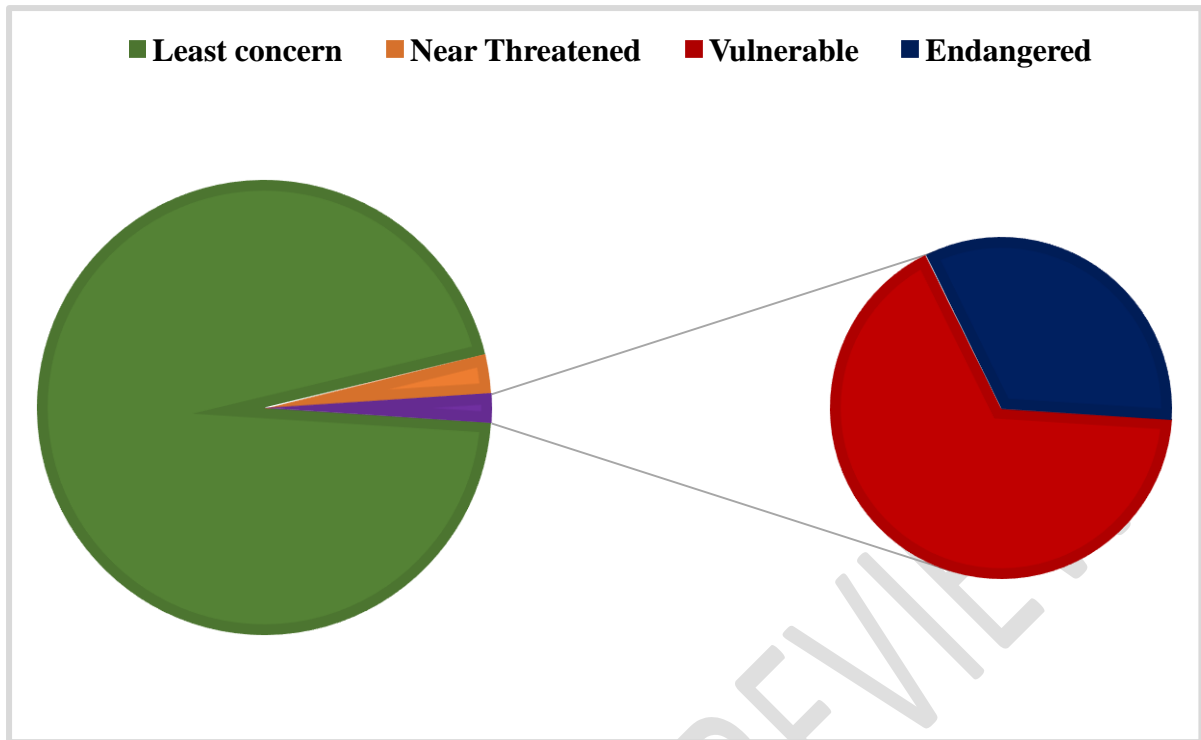


Figure 1. IUCN status of **birds in** Vaduvooor bird sanctuary

Table 1. Year-wise avian species diversity, total density richness and evenness of Vaduvooor bird sanctuary

Year	Total density	Richness	Diversity	Evenness
2022	72.07	117	2.63	0.29
2023	162.68	93	2.11	0.21
2024	27.82	84	3.05	0.37

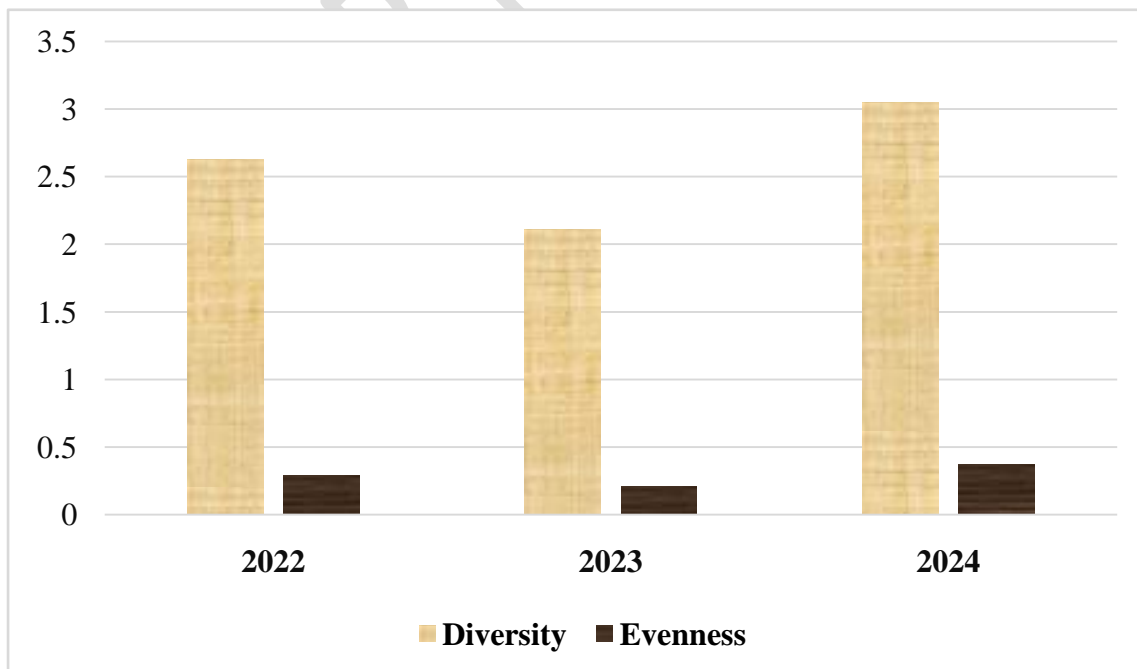


Figure 2. Year-wise avian diversity and evenness of Vaduvooor bird sanctuary

Total density

The current investigation revealed that the maximum total density of Vaduvorbird sanctuary was recorded in 2023 (162.68/ha) followed by 2022 (72.07/ha) whereas the minimum total density was recorded in 2024 (27.82/ha). This result was in line with the results of Krishnamoorthiet *al.* (2020) who stated that the maximum total density was observed in monsoon season (1556.99/sq.km) and the lowest observed in the winter season (948.18 /sq.km) in Vellore bird sanctuary (Table 1 & Figure 3). Pertaining to the species density, the highest density was obtained in the Black Headed Ibis (31.226/ha) followed by Asian Open Billed Stork (6.766/ha) and Baya weaver (4.356/ha) while the lowest density (0.003/ha) was noted in the Cinnamon bittern, Wood sandpiper, Glossy ibis, Yellow Bittern, Ruff, Indian paradise flycatcher, Crested Serpent Eagle, Indian pitta, Western Marsh Harrier and Jerdon's Bushlark. In 2023, the maximum density was obtained in Cattle Egret (46.838/ha) followed by Asian Open-bill Stork (36.230/ha) and Black-headed Ibis (36.066/ha) while the minimum density (0.008/ha) was obtained in the Sirkeer Malkoha, Blue-faced Malkoha, Grey-bellied Cuckoo, Common Cuckoo, Shikra, Greater Racket-tailed Drongo, Loten's Sunbird, Gray Wagtail and White-browed wagtail. In 2024, the highest density was noted in the Cattle Egret (4.411/ha) followed by Common Myna (3.903/ha) and House Crow (3.123/ha) and the lowest (0.008/ha) in Blue-faced Malkoha, Indian Cuckoo, Common Tern, Purple Heron, Indian Golden Oriole and Booted Warbler. This result was in consonance with the results of Baranidharan *et al.* (2022) who stated that the maximum density was recorded in Large Egret (57/sq. km) followed by Cattle Egret (56/sq.km), Little Cormorant (50/sq.km), Spot Bill duck (32/sq.km) and the lowest density as recorded in Darter, Purple Heron, Eurasian Spoon Bill and Common Teal (1.5 /sq.km) in Karaivetti bird sanctuary.

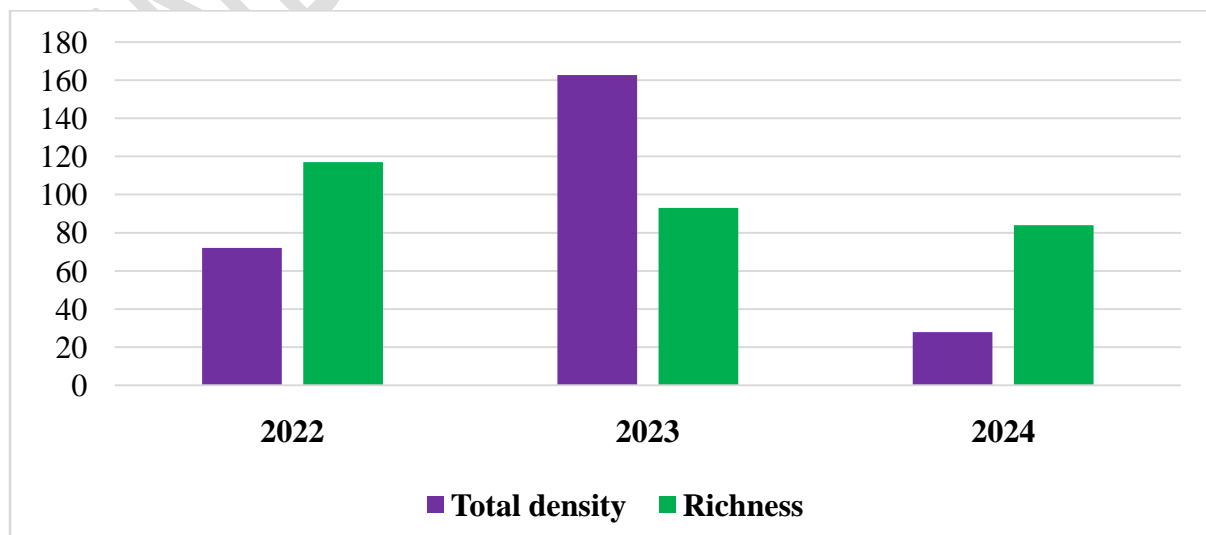


Figure 3. Year-wise avian density and richness of Vaduvloor bird sanctuary

Relative Abundance

Pertaining to relative abundance during different years, the highest relative abundance was noted in the Black headed ibis (43.32%) followed by Asian open billed stork (9.38%) and Baya weaver (6.04%) while the minimum (0.004%) was noted in the Cinnamon bittern, Wood sandpiper, Glossy ibis, Yellow Bittern, Ruff, Indian paradise flycatcher, Crested Serpent Eagle, Indian pitta, Western Marsh Harrier and Jerdon's Bushlark in 2022. In 2023, the highest relative abundance was observed in Cattle Egret (28.79%) followed by Asian Open-bill Stork (22.27%) and Black-headed Ibis (22.16%) while the lowest relative abundance (0.005%) was recorded in the Sirkeer Malkoha, Blue-faced Malkoha, Grey-bellied Cuckoo, Common Cuckoo, Shikra, Greater Racket-tailed Drongo, Loten's Sunbird, Gray Wagtail and White-browed wagtail. In 2024, the maximum relative abundance was noted in the Cattle Egret (15.85%) followed by Common Myna (14.03%) and House Crow (11.22%) and the lowest (0.028%) in Blue-faced Malkoha, Indian Cuckoo, Common Tern, Purple Heron, Indian Golden Oriole and Booted Warbler. Bibi *et al.*, (2003) reported similar findings "in Taunsa Barrage wildlife sanctuary, Pakistan and observed Eurasian Coot was the most abundant species (13.3%) followed by Cattle Egret (12.3%), Little White Egret (11.5%), Common Pochard (8.9%), House Crow (5.8%) etc".

Conclusion

The Vaduvloor Bird Sanctuary plays a crucial role as a feeding and wintering site for a significant population of resident and migratory waterbirds. This research offers valuable insights, information, and understanding regarding the avifauna present in the sanctuary located in Thiruvavur district. Of particular note are the findings concerning several bird species categorized as follows: Four Near Threatened species, namely the Curlew Sandpiper, Spot-billed Pelican, Black-headed Ibis, and Oriental Darter; two Vulnerable species, the Yellow-throated Bulbul and River Tern; and one Endangered species, the Lesser Sand Plover. Specific conservation strategies are needed to safeguard these species, utilizing information gleaned from this study and future management activities. These strategies may include adaptation measures to mitigate the impacts of climate change, community engagement initiatives, policy advocacy efforts, as well as measures to control grazing and protect habitats.

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Appendix 1. Species composition of wetland birds and wetland associated birds of Vaduvloor Bird Sanctuary

S.No	Order	Family	Species	Scientific name	IUCN status	2022	2023	2024
1.	Accipitriformes	Accipitridae	Black eagle	<i>Ictinaetusmalayensis</i>	LC	✓		
2.			Black kite	<i>Milvusmigrans</i>	LC	✓	✓	
3.			Black-winged Kite	<i>Elanuscaeruleus</i>	LC			✓
4.			Brahminy Kite	<i>Haliasturindus</i>	LC	✓	✓	✓
5.			Crested Serpent Eagle	<i>Spilornischeela</i>	LC	✓		
6.			Oriental honey-buzzard	<i>Pernisptilorhynchus</i>	LC	✓	✓	
7.			Shikra	<i>Accipiter badius</i>	LC	✓	✓	✓
8.			Western Marsh Harrier	<i>Circus aeruginosus</i>	LC	✓		
9.			White eyed buzzard	<i>Butasturteesa</i>	LC	✓		
10.	Anseriformes	Anatidae	Bar-headed Goose	<i>Anserindicus</i>	LC	✓		
11.			Common Teal	<i>Anascrecca</i>	LC	✓		
12.			Cotton Pygmy Goose	<i>Nettapuscoromandelianus</i>	LC	✓		
13.			Fulvous Whistling-Duck	<i>Dendrocygnabicolor</i>	LC			✓
14.			Garganey duck	<i>Spatula querquedula</i>	LC	✓	✓	
15.			Knob billed duck	<i>Sarkidiorinismelanotes</i>	LC	✓		
16.			Lesser Whistling Duck	<i>Dendrocygnajavanica</i>	LC	✓	✓	✓
17.			Northern Shoveler	<i>Spatula clypeata</i>	LC	✓	✓	
18.			Pin-tailed Duck	<i>Anasacuta</i>	LC	✓		
19.	Spot billed duck	<i>Anaspoecilorhyncha</i>	LC	✓		✓		
20.	Bucerotiformes	Upupidae	Eurasian Hoopoe	<i>Upupaepops</i>	LC	✓	✓	
21.	Caprimulgiformes	Apodidae	Asian palm swift	<i>Cypsiurusbalasiensis</i>	LC	✓	✓	✓
22.			Common swift	<i>Apus apus</i>	LC		✓	
23.	Charadriiformes	Charadriidae	Lesser Sand Plover	<i>Charadriusmongolus</i>	EN	✓		
24.			Little ringed plover	<i>Charadriusdubius</i>	LC	✓		✓
25.			Red wattled lapwing	<i>Vanellusindicus</i>	LC	✓		✓

26.	Charadriiformes		Yellow wattled lapwing	<i>Vanellusmalabaricus</i>	LC	✓	✓		
27.		Jacaniidae	Pheasant tailed jacana	<i>Hydrophasianuschirurgus</i>	LC	✓	✓		
28.		Laridae		Common tern	<i>Sterna hirundo</i>	LC		✓	✓
29.				Gull-billed Tern	<i>Gelochelidonnilotica</i>	LC		✓	
30.				Little terns	<i>Sternulaalbifrons</i>	LC	✓		
31.				River tern	<i>Sterna aurantia</i>	VU	✓		✓
32.				Whiskered tern	<i>Chlidoniashybrida</i>	LC		✓	✓
33.			Recurvirostridae	Black winged stilt	<i>Himantopus himantopus</i>	LC	✓	✓	✓
34.		Scolopacidae		Common Greenshank	<i>Tringanebularia</i>	LC			✓
35.				Common Redshank	<i>Tringatotanus</i>	LC	✓		
36.				Common sandpiper	<i>Actitis hypoleucos</i>	LC	✓	✓	✓
37.				Curlew Sandpiper	<i>Calidris ferruginea</i>	NT	✓		
38.				Green sandpiper	<i>Tringa ochropus</i>	LC	✓		
39.				Little stint	<i>Calidris minuta</i>	LC	✓		
40.				Marsh sandpiper	<i>Tringa stagnatilis</i>	LC	✓		
41.				Ruff	<i>Philomachus pugnax</i>	LC	✓		
42.				Sanderling	<i>Calidris alba</i>	LC	✓		
43.				Wood sandpiper	<i>Tringa glareola</i>	LC	✓	✓	✓
44.		Ciconiiformes	Ciconiidae	Asian open billed stork	<i>Anastomus oscitans</i>	LC	✓	✓	✓
45.					Painted Stork	<i>Mycteria leucocephala</i>	LC	✓	✓
46.	Columbiformes	Columbidae	Blue Rock pigeon	<i>Columba livia</i>	LC	✓	✓	✓	
47.				Eurasian collared dove	<i>Streptopelia decaocto</i>	LC	✓	✓	
48.				Laughing dove	<i>Spilopelia senegalensis</i>	LC	✓		
49.				Spotted dove	<i>Spilopelia chinensis</i>	LC	✓	✓	✓
50.	Alcedinidae	Alcedinidae	Common Kingfisher	<i>Alcedo atthis</i>	LC	✓	✓	✓	
51.				Pied kingfisher	<i>Ceryle rudis</i>	LC	✓	✓	✓
52.				White throated kingfisher	<i>Halcyon smyrnensis</i>	LC	✓	✓	✓

53.	Coraciiformes	Coraciidae	Indian roller	<i>Coraciasbenghalensis</i>	LC	✓	✓	✓		
54.		Meropidae	Blue-bearded Bee-eater	<i>Nyctyornisathertoni</i>	LC			✓		
55.			Blue-tailed Bee-eater	<i>Meropsphilippinus</i>	LC		✓	✓		
56.			Green Bee-eater	<i>Meropsorientalis</i>	LC	✓	✓	✓		
57.	Cuculiformes	Cuculidae	Asian koel	<i>Eudynamysscolopaceus</i>	LC	✓	✓	✓		
58.			Common cuckoo	<i>Cuculuscanorus</i>	LC		✓			
59.			Common hawk-cuckoo	<i>Hierococcyxvarius</i>	LC	✓	✓	✓		
60.			Grey bellied cuckoo	<i>Cacomantispasserinus</i>	LC	✓	✓			
61.			Indian coucal	<i>Centropussinensis</i>	LC	✓	✓	✓		
62.			Indian cuckoo	<i>Cuculusmicropterus</i>	LC		✓	✓		
63.			Jacobin cuckoo	<i>Clamatorjacobinus</i>	LC	✓	✓			
64.			Lesser coucal	<i>Centropusbengalensis</i>	LC	✓				
65.			SirheerMalkoha	<i>Taccocualeschenaultii</i>	LC		✓			
66.			Small Green billed Malkoha	<i>Phaenicophaeustristis</i>	LC	✓	✓	✓		
67.			Galliformes	Phasianidae	Grey francolin	<i>Fracolinuspondicerianus</i>	LC	✓	✓	✓
68.					Indian Peafowl	<i>Pavocristatus</i>	LC	✓	✓	✓
69.	Gruiformes	Rallidae	Common coot	<i>Fulicaatra</i>	LC	✓		✓		
70.			Common Moorhen	<i>Gallinulachloropus</i>	LC	✓	✓	✓		
71.			Gray headed swamphen	<i>Porphyriopoliocephalus</i>	LC	✓	✓	✓		
72.			White breasted waterhen	<i>Amauornisphoenicurus</i>	LC	✓	✓	✓		
73.		Acrocephalidae	Blyth's reed warbler	<i>Acrocephalusdumetorum</i>	LC	✓				
74.			Booted Warbler	<i>dunacaligata</i>	LC			✓		
75.			Clamorous reed warbler	<i>Acrocephalusstentoreus</i>	LC	✓				
76.		Aegithinidae	Common Iora	<i>Aegithinatiphia</i>	LC	✓	✓	✓		
77.		Alaudidae	Ashy-crowned Sparrow Lark	<i>Eremopterixgriseus</i>	LC	✓				
78.			Indian Bushlark	<i>Mirafraerythroptera</i>	LC		✓	✓		
79.	Jerdon'sBushlark		<i>Mirafraaffinis</i>	LC	✓					

80.	Passeriformes	Campephagidae	Small minivet	<i>Pericrocotuscinnamomeus</i>	LC	✓		
81.		Cisticolidae	Ashy Prinia	<i>Prinia socialis</i>	LC	✓	✓	✓
82.			Common tailorbird	<i>Orthotomussutorius</i>	LC		✓	✓
83.			Plain Prinia	<i>Prinia inornata</i>	LC		✓	
84.		Corvidae	House crow	<i>Corvus splendens</i>	LC	✓	✓	✓
85.			Large billed crow	<i>Corvus macrorhynchos</i>	LC	✓	✓	✓
86.			Rufous treepie	<i>Dendrocitta vagabunda</i>	LC	✓	✓	✓
87.		Dicruridae	Black Drongo	<i>Dicrurus macrocercus</i>	LC	✓	✓	✓
88.			Greater Racket-tailed Drongo	<i>Dicrurus paradiseus</i>	LC		✓	
89.		Estrildidae	Indian silverbill or white-throated munia	<i>Euodice malabarica</i>	LC	✓		✓
90.			Scaly breasted munia	<i>Lonchura punctulata</i>	LC	✓		✓
91.			Tricoloured munia	<i>Lonchura malacca</i>	LC	✓	✓	
92.			White-rumped Munia	<i>Lonchura striata</i>	LC		✓	
93.		Hirundinidae	Barn swallow	<i>Cypsiurus balasiensis</i>	LC	✓	✓	✓
94.		Hirundinidae	Wire-tailed Swallow	<i>Hirundo smithii</i>	LC		✓	
95.	Leiothrichidae	Common babbler	<i>Argyacaudata</i>	LC		✓		
96.		Yellow billed babbler	<i>Argya affinis</i>	LC	✓	✓	✓	
97.	Monarchidae	Indian paradise flycatcher	<i>Terpsiphone paradisi</i>	LC	✓	✓		
98.	Motacillidae	Grey wagtail	<i>Motacilla cinerea</i>	LC		✓		
99.		Paddy field pipit	<i>Anthus rufulus</i>	LC	✓	✓	✓	
100.		Western Yellow Wagtail	<i>Motacilla flava</i>	LC	✓			
101.		White browed wagtail	<i>Motacilla maderaspatensis</i>	LC	✓	✓	✓	
102.		White wagtail	<i>Motacilla alba</i>	LC		✓		
103.	Muscicapidae	Indian Blue Robin	<i>Larvivora brunnea</i>	LC		✓		
104.		Indian robin	<i>Copsychus fulicatus</i>	LC	✓	✓	✓	
105.		Oriental magpie robin	<i>Copsychus saularis</i>	LC	✓		✓	

106.	Passeriformes		Pied Bushchat	<i>Saxicolacaprita</i>	LC	✓		
107.		Nectariniidae	Loten's sunbird	<i>Cinnyrislotenius</i>	LC		✓	
108.			Purple rumped sunbird	<i>Cinnyrisasiaticus</i>	LC	✓	✓	✓
109.			Purple Sunbird	<i>Cinnyrisasiaticus</i>	LC	✓	✓	✓
110.		Oriolidae	Eurasian golden oriole	<i>Oriolusoriolus</i>	LC	✓		
111.			Indian golden oriole	<i>Orioluskundoo</i>	LC	✓	✓	✓
112.		Passeridae	House Sparrow	<i>Passer domesticus</i>	LC	✓	✓	✓
113.		Pittidae	Indian pitta	<i>Pitta brachyura</i>	LC	✓		
114.		Ploceidae	Baya weaver	<i>Ploceusphilippinus</i>	LC	✓	✓	✓
115.			Streaked Weaver	<i>Ploceusmanyar</i>	LC			✓
116.		Pycnonotidae	Red-vented bulbul	<i>Pycnonotuscafer</i>	LC	✓	✓	✓
117.			Red-whiskered bulbul	<i>Pycnonotusjocosus</i>	LC			✓
118.			White-browed Bulbul	<i>Pycnonotusluteolus</i>	LC		✓	
119.			Yellow-throated Bulbul	<i>Pycnonotusxantholaemus</i>	VU		✓	
120.	Sturnidae	Brahminy starling	<i>Sturniapagodarum</i>	LC	✓	✓	✓	
121.		Common myna	<i>Acridotherestrictis</i>	LC	✓	✓	✓	
122.		Rosy Starling	<i>Pastor roseus</i>	LC	✓		✓	
123.	Vangidae	Common Woodshrike	<i>Tephrodornispondicerianus</i>	LC		✓		
124.	Pelecaniformes	Ardeidae	Cattle egret (46 cm)	<i>Bubulcus ibis</i>	LC	✓	✓	✓
125.			Greater egret	<i>Ardea alba</i>	LC	✓	✓	✓
126.			Grey heron	<i>Ardeolacinera</i>	LC	✓	✓	✓
127.			Indian pond heron	<i>Ardeolagrayerii</i>	LC	✓	✓	✓
128.			Intermediate egret (80 cm)	<i>Ardea intermedia</i>	LC	✓	✓	✓
129.			Little egret (63 cm)	<i>Egrettazarzetta</i>	LC	✓	✓	✓
130.			Black crowned night heron	<i>Nycticoraxnycticorax</i>	LC	✓	✓	✓
131.			Purple heron	<i>Ardeapurpurea</i>	LC	✓	✓	✓
132.			Western Reef Egret	<i>Egrettaularis</i>	LC	✓		

133.			Yellow Bittern	<i>Ixobrychussinensis</i>	LC	✓		
134.		Pelecanidae	Pelican	<i>Pelecanusphilippensis</i>	NT	✓		
135.		Threskiornithidae	Black headed ibis	<i>Threskiornismelanosephalus</i>	NT	✓	✓	✓
136.			Glossy ibis	<i>Plegadisfalcinellus</i>	LC	✓		✓
137.				Spoon bill	<i>Platalealeucorodia</i>	LC	✓	
138.	Piciformes	Megalaimidae	Coppersmith barbet	<i>Psilopogonhaemacephalus</i>	LC	✓		
139.		Picidae	Black - rumpedflameback	<i>Dinopiumbenghalense</i>	LC	✓	✓	
140.				Common Flameback	<i>Dinopiumjavanense</i>	LC		
141.	Podicipediformes	Podicipedidae	Little grebe	<i>Tachibaptusruficollis</i>	LC	✓	✓	✓
142.	Psittaciformes	Psittaculidae	Rose ringed parakeet	<i>Psittaculakrameri</i>	LC	✓	✓	✓
143.	Strigiformes	Strigidae	Spotted owlet	<i>Athenebrama</i>	LC	✓		✓
144.			Tytonidae	Barn owl	<i>Tyto alba</i>	LC	✓	✓
145.	Suliformes	Anhingidae	Oriental darter	<i>Anhinga melanogaster</i>	NT	✓	✓	✓
146.		Phalacrocoracidae	Indian cormorant	<i>Phalacrocoraxfuscicollis</i>	LC	✓		✓
147.				Little cormorant	<i>Microcarboniger</i>	LC	✓	✓

Appendix 2. Avian density and relative abundance during 2022 of Vaduvloor Bird Sanctuary

S. No.	Species	Density (ha)	Relative abundance (%)
1.	Asian Open Billed Stork	6.766	9.387
2.	Black Headed Ibis	31.226	43.323
3.	Black Winged Stilt	1.327	1.841
4.	Cinnomon Bittern	0.003	0.004
5.	Common Coot	0.338	0.469
6.	Gray Headed Swamphen	0.013	0.018
7.	White Breasted Water Hen	0.143	0.199
8.	Little Grebe	0.031	0.043
9.	Little Ringed Plover	0.039	0.054
10.	Little Stint	0.018	0.025
11.	Northern Shoveler	0.598	0.830
12.	Oriental Darter	0.109	0.152
13.	Paddy Field Pipit	0.052	0.072
14.	Pheasant Tailed Jacana	0.005	0.007
15.	Spoon Bill	0.044	0.061
16.	Red Wattled Lapwing	0.177	0.245
17.	Yellow Wattled Lapwing	0.005	0.007
18.	River Tern	0.005	0.007
19.	Grey Heron	0.268	0.372
20.	Indian Pond Heron	0.419	0.581
21.	Night Heron	1.561	2.166
22.	Purple Heron	0.029	0.040
23.	Indian Cormorant	1.795	2.491
24.	Little Cormorant	1.954	2.711
25.	Cattle Egret	2.758	3.827
26.	Greater Egret	0.096	0.134
27.	Intermediate Egret	0.151	0.209
28.	Little Egret	1.743	2.419
29.	Garganey	0.005	0.007
30.	Northern Pintail	0.820	1.137
31.	Indian Spot Billed Duck	0.960	1.332
32.	Common Sandpiper	0.122	0.170
33.	Wood Sandpiper	0.003	0.004
34.	Glossy Ibis	0.003	0.004
35.	Western Reef Egret	0.021	0.029
36.	Yellow Bittern	0.003	0.004
37.	Bar-Headed Goose	0.005	0.007
38.	Cotton Pygmy Goose	0.026	0.036
39.	Common Teal	0.973	1.350
40.	Green Bee-Eater	0.304	0.422
41.	Lesser Sand Plover	0.018	0.025
42.	Curlew Sandpiper	0.026	0.036
43.	Common Moorhen	0.018	0.025
44.	Lesser Whistling Duck	0.489	0.679

45.	Little Terns	0.010	0.014
46.	Ruff	0.003	0.004
47.	Sanderling	0.026	0.036
48.	Green Sandpiper	0.008	0.011
49.	Marsh Sandpiper	0.036	0.051
50.	Common Redshank	0.008	0.011
51.	Common Sandpiper	0.148	0.206
52.	Painted Stork	0.016	0.022
53.	Pelican	0.008	0.011
54.	Knob Billed Duck	0.042	0.058
55.	Asian Koel	0.109	0.152
56.	Asian Palm Swift	0.807	1.119
57.	Barn Swallow	0.167	0.231
58.	Baya Weaver	4.356	6.044
59.	Black Drongo	0.081	0.112
60.	Black Eagle	0.018	0.025
61.	Brahminy Kite	0.055	0.076
62.	Brahminy Starling	0.221	0.307
63.	Blyth's Reed Warbler	0.034	0.047
64.	Clamorous Reed Warbler	0.195	0.271
65.	Common Iora	0.247	0.343
66.	Common Myna	1.124	1.560
67.	Coppersmith Barbet	0.008	0.011
68.	Greater Coucal	0.187	0.260
69.	Eurasian Hoopoe	0.021	0.029
70.	Grey Francolin	0.026	0.036
71.	House Crow	1.106	1.534
72.	House Sparrow	0.919	1.274
73.	Lesser Coucal	0.034	0.047
74.	Indian Peafowl	0.161	0.224
75.	Indian Roller	0.010	0.014
76.	Large Billed Crow	0.161	0.224
77.	Purple Rumped Sunbird	0.107	0.148
78.	Purple Sunbird	0.213	0.296
79.	Red-Vented Bulbul	0.320	0.444
80.	Blue Rock Pigeon	0.507	0.704
81.	Rose Ringed Parakeet	0.422	0.585
82.	Rufous Tree Pie	0.250	0.347
83.	Small Minivet	0.359	0.498
84.	Indian Paradise Flycatcher	0.003	0.004
85.	Pied Bushchat	0.258	0.357
86.	Common Kingfisher	0.044	0.061
87.	Pied Kingfisher	0.044	0.061
88.	White Throated Kingfisher	0.151	0.209
89.	Western Yellow Wagtail	0.008	0.011
90.	White Browed Wagtail	0.005	0.007
91.	Common Hawk-Cuckoo	0.016	0.022
92.	Jacobin Cuckoo	0.005	0.007

93.	Laughing Dove	0.185	0.256
94.	Spotted Dove	0.133	0.184
95.	Scaly Breasted Muniya	0.859	1.191
96.	Tricoloured Muniya	1.561	2.166
97.	Indian Golden Oriole	0.047	0.065
98.	Eurasian Eurasian Golden Oriole	0.010	0.014
99.	Oriental Magpie Robin	0.161	0.224
100.	Indian Robin	0.088	0.123
101.	Oriental Honey-Buzzard	0.008	0.011
102.	Shikra	0.044	0.061
103.	White Eyed Buzzard	0.013	0.018
104.	Eurasian Collared Dove	0.026	0.036
105.	Rufous-Bellied Plaintive	0.018	0.025
106.	Small Green Billed Malkoha	0.010	0.014
107.	Indian Silverbill	0.039	0.054
108.	Crested Serpent Eagle	0.003	0.004
109.	Ashy-Crowned Sparrow Lark	0.029	0.040
110.	Indian Pitta	0.003	0.004
111.	Western Marsh Harrier	0.003	0.004
112.	Jerdon's Bushlark	0.003	0.004
113.	Ashy Prinia	0.049	0.069
114.	Rosy Starling	0.034	0.047
115.	Spotted Owlet	0.034	0.047
116.	Jungle Babbler	0.169	0.235
117.	Barn Owl	0.010	0.014

Appendix 3. Avian density and relative abundance during 2023 of Vaduvor Bird Sanctuary

S. No.	Species	Density (ha)	Relative abundance (%)
1.	Lesser Whistling-Duck	0.898	0.552
2.	Garganey	0.156	0.096
3.	Northern Shoveler	0.047	0.029
4.	Indian Peafowl	0.234	0.144
5.	Gray Francolin	0.078	0.048
6.	Little Grebe	0.023	0.014
7.	Rock Pigeon	0.390	0.240
8.	Eurasian Collared-Dove	0.062	0.038
9.	Spotted Dove	0.039	0.024
10.	Southern Coucal	0.016	0.010
11.	SirkeerMalkoha	0.008	0.005
12.	Blue-Faced Malkoha	0.008	0.005
13.	Pied Cuckoo	0.016	0.010
14.	Asian Koel	0.078	0.048
15.	Grey-Bellied Cuckoo	0.008	0.005
16.	Common Hawk-Cuckoo	0.016	0.010
17.	Indian Cuckoo	0.016	0.010
18.	Common Cuckoo	0.008	0.005

19.	Common Swift	0.055	0.034
20.	Asian Palm-Swift	0.265	0.163
21.	Eurasian Moorhen	0.016	0.010
22.	Gray-Headed Swamphen	0.039	0.024
23.	White-Breasted Waterhen	0.055	0.034
24.	Black-Winged Stilt	7.650	4.702
25.	Yellow-Wattled Lapwing	0.078	0.048
26.	Pheasant-Tailed Jacana	0.117	0.072
27.	Common Sandpiper	0.585	0.360
28.	Wood Sandpiper	0.031	0.019
29.	Gull-Billed Tern	0.039	0.024
30.	Whiskered Tern	0.398	0.245
31.	Common Tern	0.039	0.024
32.	Asian Open-Bill Stork	36.230	22.270
33.	Painted Stork	0.016	0.010
34.	Oriental Darter	0.234	0.144
35.	Little Cormorant	2.030	1.248
36.	Grey Heron	2.342	1.440
37.	Purple Heron	0.016	0.010
38.	Great Egret	0.062	0.038
39.	Intermediate Egret	0.117	0.072
40.	Little Egret	0.390	0.240
41.	Cattle Egret	46.838	28.791
42.	Indian Pond-Heron	1.069	0.657
43.	Black-Crowned Night-Heron	3.138	1.929
44.	Black-Headed Ibis	36.066	22.169
45.	Oriental Honey-Buzzard	0.016	0.010
46.	Shikra	0.008	0.005
47.	Black Kite	0.016	0.010
48.	Brahminy Kite	0.078	0.048
49.	Barn Owl	0.016	0.010
50.	Eurasian Hoopoe	0.016	0.010
51.	Common Kingfisher	0.055	0.034
52.	White-Throated Kingfisher	0.078	0.048
53.	Pied Kingfisher	0.031	0.019
54.	Green Bee-Eater	0.078	0.048
55.	Blue-Tailed Bee-Eater	0.039	0.024
56.	Indian Roller	0.039	0.024
57.	Black-RumpedFlameback	0.016	0.010
58.	Rose-Ringed Parakeet	0.351	0.216
59.	Indian Golden Oriole	0.023	0.014
60.	Common Woodshrike	0.047	0.029
61.	Common Iora	0.023	0.014
62.	Black Drongo	0.281	0.173
63.	Greater Racket-Tailed Drongo	0.008	0.005
64.	Indian Paradise-Flycatcher	0.016	0.010
65.	Rufous Treepie	0.039	0.024
66.	House Crow	3.903	2.399

67.	Indian Jungle Crow	0.781	0.480
68.	Indian Bushlark	0.016	0.010
69.	Common Tailorbird	0.047	0.029
70.	Ashy Prinia	0.023	0.014
71.	Plain Prinia	0.016	0.010
72.	Barn Swallow	0.094	0.058
73.	Wire-Tailed Swallow	0.031	0.019
74.	Red-Vented Bulbul	0.234	0.144
75.	Yellow-Throated Bulbul	0.016	0.010
76.	White-Browed Bulbul	0.047	0.029
77.	Yellow-Billed Babbler	0.226	0.139
78.	Common Babbler	0.078	0.048
79.	Brahminy Starling	0.148	0.091
80.	Common Myna	8.774	5.393
81.	Indian Robin	0.031	0.019
82.	Indian Blue Robin	0.078	0.048
83.	Purple-Rumped Sunbird	0.016	0.010
84.	Purple Sunbird	0.055	0.034
85.	Loten's Sunbird	0.008	0.005
86.	Baya Weaver	0.625	0.384
87.	White-Rumped Munia	0.078	0.048
88.	Tricolored Munia	5.878	3.613
89.	House Sparrow	0.117	0.072
90.	Gray Wagtail	0.008	0.005
91.	White-Browed Wagtail	0.008	0.005
92.	White Wagtail	0.047	0.029
93.	Paddy Field Pipit	0.016	0.010

Appendix 4. Avian density and relative abundance during 2024 of Vaduvor Bird Sanctuary

S. No.	Species	Density (ha)	Relative abundance (%)
1.	Fulvous Whistling-Duck	0.016	0.056
2.	Lesser Whistling-Duck	0.078	0.281
3.	Indian Spot-Billed Duck	0.757	2.722
4.	Indian Peafowl	0.390	1.403
5.	Gray Francolin	0.016	0.056
6.	Little Grebe	0.031	0.112
7.	Rock Pigeon	0.937	3.367
8.	Spotted Dove	0.109	0.393
9.	Southern Coucal	0.062	0.224
10.	Blue-Faced Malkoha	0.008	0.028
11.	Asian Koel	0.062	0.224
12.	Common Hawk-Cuckoo	0.133	0.477
13.	Indian Cuckoo	0.008	0.028
14.	Asian Palm-Swift	0.094	0.337
15.	Eurasian Moorhen	0.016	0.056
16.	Eurasian Coot	0.039	0.140

17.	Gray-Headed Swamphen	0.016	0.056
18.	White-Breasted Waterhen	0.109	0.393
19.	Black-Winged Stilt	1.468	5.275
20.	Red-Wattled Lapwing	0.141	0.505
21.	Little Ringed Plover	0.086	0.309
22.	Common Sandpiper	0.101	0.365
23.	Common Greenshank	0.023	0.084
24.	Wood Sandpiper	0.062	0.224
25.	Whiskered Tern	0.125	0.449
26.	Common Tern	0.008	0.028
27.	River Tern	0.484	1.740
28.	Asian Openbill	1.249	4.489
29.	Painted Stork	0.023	0.084
30.	Oriental Darter	0.453	1.627
31.	Little Cormorant	0.234	0.842
32.	Indian Cormorant	0.016	0.056
33.	Grey Heron	0.687	2.469
34.	Purple Heron	0.008	0.028
35.	Great Egret	0.180	0.645
36.	Intermediate Egret	0.429	1.543
37.	Little Egret	0.515	1.852
38.	Cattle Egret	4.411	15.853
39.	Indian Pond-Heron	0.226	0.814
40.	Black-Crowned Night-Heron	2.342	8.418
41.	Glossy Ibis	1.093	3.928
42.	Black-Headed Ibis	0.492	1.768
43.	Black-Winged Kite	0.031	0.112
44.	Shikra	0.016	0.056
45.	Brahminy Kite	0.062	0.224
46.	Barn Owl	0.016	0.056
47.	Spotted Owlet	0.016	0.056
48.	Common Kingfisher	0.031	0.112
49.	White-Throated Kingfisher	0.117	0.421
50.	Pied Kingfisher	0.078	0.281
51.	Blue-Bearded Bee-Eater	0.039	0.140
52.	Green Bee-Eater	0.078	0.281
53.	Blue-Tailed Bee-Eater	0.062	0.224
54.	Indian Roller	0.031	0.112
55.	Common Flameback	0.016	0.056
56.	Rose-Ringed Parakeet	0.078	0.281
57.	Indian Golden Oriole	0.008	0.028
58.	Common Iora	0.031	0.112
59.	Black Drongo	0.234	0.842
60.	Rufous Treepie	0.039	0.140
61.	House Crow	3.123	11.223
62.	Indian Jungle Crow	0.172	0.617
63.	Indian Bushlark	0.016	0.056
64.	Common Tailorbird	0.031	0.112

65.	Ashy Prinia	0.023	0.084
66.	Booted Warbler	0.008	0.028
67.	Barn Swallow	0.016	0.056
68.	Red-Vented Bulbul	0.187	0.673
69.	Red-Whiskered Bulbul	0.234	0.842
70.	Yellow-Billed Babbler	0.703	2.525
71.	Rosy Starling	0.016	0.056
72.	Brahminy Starling	0.016	0.056
73.	Common Myna	3.903	14.029
74.	Indian Robin	0.016	0.056
75.	Oriental Magpie Robin	0.094	0.337
76.	Purple-Rumped Sunbird	0.047	0.168
77.	Purple Sunbird	0.016	0.056
78.	Streaked Weaver	0.016	0.056
79.	Baya Weaver	0.117	0.421
80.	Indian Silverbill	0.078	0.281
81.	Scaly-Breasted Munia	0.078	0.281
82.	House Sparrow	0.117	0.421
83.	White-Browed Wagtail	0.039	0.140
84.	Paddy Field Pipit	0.039	0.140