



Research

Field Observations on Avian Diversity in a 15 km Radius of Gangaikondan, Tirunelveli, Tamil Nadu

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ARTICLE HISTORY

Received: 1 January 2026

Revised: 6 March 2026

Accepted: 9 March 2026

Published: 15 March 2026

KEYWORDS

avian diversity

wetland

agriculture

greenbelt

environmental impact assessment

Abstract

Gangaikondan is a rapid industrial development in recent decades. This study was carried out in five different habitats such as wetland, agriculture, forest, residential areas, and urban greenbelt. During the study period a total of 111 bird species were recorded, Wetland habitat (Aquatic and pond edge vegetation) compressed of the highest number of species (92 species), followed by agricultural habitat (76 species), forest habitat (62 species), residential habitat (23 species), and urban greenbelt habitat (15). Spotted Dove and Red-vented Bulbul were the common birds species present across five habitats, while habitat-specific dominance shows Eurasian Coot in wetland, Asian Green Bee-eater in forest and agriculture, House Sparrow in residential areas, and Common Myna in urban greenbelts. These findings provide essential baseline information for Environmental Impact Assessments and emphasize the importance of conservation-focused land-use planning in this rapidly industrializing landscape.

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eISSN 2583-942X

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Citation: S, S. *et al.* (2026). Field Observations on Avian Diversity in a 15 km Radius of Gangaikondan, Tirunelveli, Tamil Nadu. *AgroEnvironmental Sustainability*, 4(1), 59–66. <https://doi.org/10.59983/s2026040107>

Statement of sustainability: This study provides baseline information on bird diversity across five different habitat in the rapidly industrializing landscape of Gangaikondan, Tirunelveli District. The findings highlight the ecological importance of wetland, agricultural land, and forest patches in sustaining bird communities. By documenting bird species richness and habitat association to support sustainable land-use planning and biodiversity conservation for urban developers and the industrial sector.

1. Introduction

Rapid urban expansion worldwide, driven by increasing human populations, development activities, is exerting substantial pressure on natural ecosystems, despite urban areas occupying less than 4% of the Earth's terrestrial surface (Antrop, 2000; Redman & Jones, 2005; Ren *et al.*, 2022). With the global urban population projected to increase markedly in the coming decades (United Nations, 2011), understanding patterns of biodiversity within these transformed landscapes has become increasingly critical (Savard *et al.*, 2000; Sanderson *et al.*, 2005).

India supports a rich and diverse avifauna (Grimmett *et al.*, 2011), with Tamil Nadu identified as an important regional hotspot for bird diversity and conservation (Islam & Rahmani, 2004). Habitat heterogeneity is a major determinant of avian species richness and community composition, as structurally diverse landscapes offer a wider range of foraging, nesting, and shelter opportunities (Anderle *et al.*, 2023). In particular, vegetation structure, canopy complexity, and floristic diversity play a important role in shaping bird assemblages across different ecosystems (Bazzaz, 1975; Tews *et al.*, 2004; Fuller, 2012).

Wetlands are most important for birds because they have primary productivity and harbor a wide diversity of bird species (Gibbs, 1993; Manikannan *et al.*, 2012; Wan *et al.*, 2025). Farming and agricultural expansion severe threats to overall biodiversity and the environment (Donald *et al.*, 2001; Robinson & Sutherland, 2002), the suitability of agricultural matrices to support biodiversity, including birds (Yahya *et al.*, 2022). Birds are sensitive to these changes and are often used to study the health of agriculture land (Tanalgo *et al.*, 2015; Kumar & Sahu, 2020). Information on bird distribution in forests and nearby hills is provided by Ali & Ripley

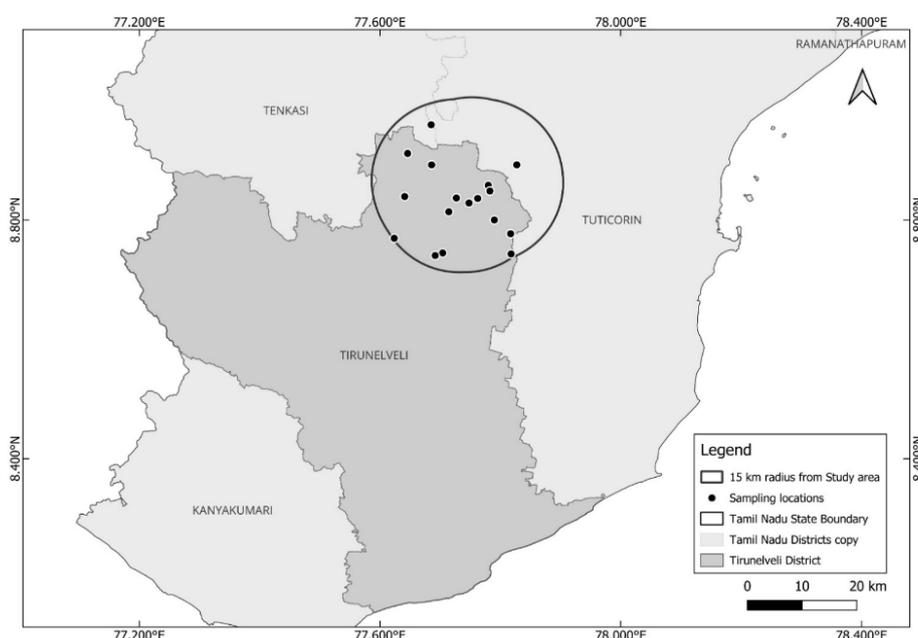
(1987) and for hill ranges in Tamil Nadu, such as the Shervaroys (David et al., 2013), Kolli Hills (Daniels & Saravanan, 1986), and Alagarkovil Range (Narayanan, 2016) for home range of birds.

This study documented avian diversity across five habitats wetland, agriculture, forest, residential areas, and urban greenbelt within a 15 km radius of Gangaikondan village, Tirunelveli District, Tamil Nadu. The results provide baseline data for Environmental Impact Assessments and highlight the need for conservation-oriented land-use planning in this industrializing area.

2. Materials and methods

2.1. Study Area

The study was conducted from October 2023 to September 2024 in Gangaikondan (8°51'29.26"N, 77°46'47.74"E), located about 20 km from Tirunelveli, Tamil Nadu (Figure 1). The area has experienced rapid industrial development with estates and infrastructure. Situated in the tropical semi-arid zone of southern India, it has high temperatures and seasonal rainfall mainly from the northeast monsoon (Kumar et al., 2005). The landscape of Gangaikondan is classified with agricultural land, wetland, seasonal water bodies, industrial complexes, residential settlement and also a Spotted Deer Sanctuary in the close vicinity.



2.2. Sampling Locations

A total of 17 sampling locations were randomly selected across five habitats, wetland (n=5), agriculture (n=5), forest (n=2), residential areas (n=3), and urban greenbelt (n=2) based on the proportional landscape availability.

2.3. Methods

Systematic field observations were carried out using the line transect method, a widely adopted approach for estimating bird species diversity and relative abundance in the study habitats. Surveys were conducted in the post monsoon and winter season basis and also when the bird activity is peak (morning, 06:00–9:00 h and late afternoon to evening 16:00–18:00 h) (Sutherland et al., 2004). Birds were observed using Nikon binoculars (8–16 × 40). Species identification was performed in the field with the aid of standard regional field guides (Grimmett et al., 2011; Ali & Ripley, 1987).

2.4. Data analysis

The relative abundance of each species was estimated from encounter rates. The Relative Abundance (Anjos, 2004; Ayenalem & Bekele, 2008) was analyzed from the collected data during the study period using the following formula:

$$\text{Relative Abundance} = \frac{\text{Number of individuals of species}}{\text{Number of individuals of all species}} \times 100 \quad (1)$$

Simpson's Index (D), and Shannon Wiener Index (H') were computed with PAST (ver. 4.03) software.



3. Results and Discussion

3.1. Taxonomy

A total of 111 bird species were recorded across five different habitats in 15 km radius of Gangaikondan area (Table 1; Figure 2). Wetland were recorded highest species (92), followed by Agricultural (76), forest (62), residential area (23) and urban greenbelt (15). Seven WPA Schedule I species were recorded and namely the Cotton Pygmy-Goose, Gull-billed Tern, Eurasian Spoonbill, Osprey, Brahminy Kite, and Shikra. The majority of species above were recorded in wetland habitats this urges the important of wetland conservation. Menon and Mohanraj (2022) finding that habitat structure, directly relating bird diversity to the availability of food resources. Similarly, Frank et al. (2022) showed that for colonial nesting waterbirds in Tamil Nadu’s wetland, species richness was significantly higher in areas. Byju et al. (2025) identified that the availability of water and nest trees were the main factors influencing the presence of waterbirds in wetland habitat. Species variation based on habitat types, food availability, and structural heterogeneity (Ali & Ripley, 1987).

Table 1. Checklist of birds with relative abundance, IUCN status and WPA.

S. No	Common Name	Scientific Name	IUCN	WPA	WA	AA	F	RA	UG	OA
1	Ashy Prinia	<i>Prinia socialis</i>	LC	II	0.16	1.07	1.55	0	0	0.60
2	Ashy-crowned Sparrow-Lark	<i>Eremopterix griseus</i>	LC	II	0.16	1.07	1.55	0	0	0.60
3	Asian Green Bee-eater	<i>Merops orientalis</i>	LC	II	0.86	5.20	7.54	0	0	2.94
4	Asian Koel	<i>Eudynamys scolopaceus</i>	LC	II	0.16	0.31	0.44	0	0	0.22
5	Asian Openbill	<i>Anastomus oscitans</i>	LC	II	0.93	0	0	0	0	0.45
6	Asian Palm Swift	<i>Cypsiurus balasiensis</i>	LC	II	1.01	0.92	1.33	2.84	0	1.15
7	Bar-headed Goose	<i>Anser indicus</i>	LC	II	3.50	0	0	0	0	1.67
8	Barn Swallow	<i>Hirundo rustica</i>	LC	II	1.79	0.31	0.44	0	0	1.00
9	Baya Weaver	<i>Ploceus philippinus</i>	LC	II	0.93	2.45	3.55	0	0	1.64
10	Bay-backed Shrike	<i>Lanius vittatus</i>	LC	II	0.86	1.83	2.66	0	0	1.30
11	Black Drongo	<i>Dicrurus macrocercus</i>	LC	II	2.57	1.83	1.55	1.42	0	2.05
12	Black Kite	<i>Milvus migrans</i>	LC	II	0.31	1.07	0.89	1.90	0	0.71
13	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	LC	II	0.39	0	0	0	0	0.19
14	Black-headed Ibis	<i>Threskiornis melanocephalus</i>	NT	II	1.71	0	0	0	0	0.82
15	Black-rumped Flameback	<i>Dinopium benghalense</i>	LC	II	0	0.31	0.44	0	0	0.15
16	Black-tailed Godwit	<i>Limosa limosa</i>	NT	II	2.57	0	0	0	0	1.23
17	Black-winged Stilt	<i>Himantopus himantopus</i>	LC	II	0.54	0	0	0	0	0.26
18	Blue-faced Malkoha	<i>Phaenicophaeus viridirostris</i>	LC	II	0	0.31	0.44	0	0	0.15
19	Blue-tailed Bee-eater	<i>Merops philippinus</i>	LC	II	0.16	0.46	0.67	1.42	0	0.41
20	Blyth’s Reed Warbler	<i>Acrocephalus dumetorum</i>	LC	II	0.93	0	0	0	0	0.45
21	Brahminy Kite	<i>Haliastur indus</i>	LC	I	0.62	1.07	0	0	0	0.56
22	Brahminy Starling	<i>Sturnia pagodarum</i>	LC	II	1.71	1.68	2.44	5.21	0	2.05
23	Brown Shrike	<i>Lanius cristatus</i>	LC	II	0.16	1.68	2.44	0	0	0.89
24	Caspian Tern	<i>Hydroprogne caspia</i>	LC	II	0.16	0	0	0	0	0.07
25	Chestnut-bellied Sandgrouse	<i>Pterocles exustus</i>	LC	II	0	1.38	2.00	0	0	0.67
26	Clamorous Reed Warbler	<i>Acrocephalus stentoreus</i>	LC	II	1.01	0	0	0	0	0.48
27	Common Kingfisher	<i>Alcedo atthis</i>	LC	II	0.16	1.22	0	0	0	0.37
28	Common Myna	<i>Acridotheres tristis</i>	LC	II	0	1.68	2.44	5.21	9.20	1.53
29	Common Sandpiper	<i>Actitis hypoleucos</i>	LC	II	1.01	0	0	0	0	0.48
30	Common Tailorbird	<i>Orthotomus sutorius</i>	LC	II	0.93	0.76	1.11	0	5.75	1.00
31	Coppersmith Barbet	<i>Psilopogon haemacephalus</i>	LC	II	0	0.31	0.44	0	4.60	0.30
32	Cotton Pygmy-Goose	<i>Nettapus coromandelianus</i>	LC	I	3.50	0	0	0	0	1.67
33	Eastern Cattle-Egret	<i>Bubulcus coromandus</i>	LC	II	1.87	0.31	0.44	0	0	1.04
34	Eastern Red-rumped Swallow	<i>Cecropis daurica</i>	LC	II	0.93	3.36	4.88	0	0	2.08
35	Eurasian Collared-Dove	<i>Streptopelia decaocto</i>	LC	II	0	1.83	2.66	5.69	0	1.34
36	Eurasian Coot	<i>Fulica atra</i>	LC	II	4.20	0	0	0	0	2.01
37	Eurasian Kestrel	<i>Falco tinnunculus</i>	LC	II	0	0.46	0.44	0	0	0.19
38	Eurasian Moorhen	<i>Gallinula chloropus</i>	NE	II	0.93	0.61	0	0	0	0.60
39	Eurasian Spoonbill	<i>Platalea leucorodia</i>	LC	I	1.71	0.46	0	0	0	0.93
40	Garganey	<i>Spatula querquedula</i>	LC	II	2.65	0	0	0	0	1.26
41	Glossy Ibis	<i>Plegadis falcinellus</i>	LC	II	1.79	3.36	0	0	0	1.67

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Table 1.... Continued from previous page

42	Gray Heron	<i>Ardea cinerea</i>	LC	II	0.39	0.31	0	0	0	0.26
43	Gray-headed Swamphen	<i>Porphyrio poliocephalus</i>	NE	II	0.54	0	0	0	0	0.26
44	Great Egret	<i>Ardea alba</i>	LC	II	2.65	0.46	0	0	0	1.38
45	Greater Coucal	<i>Centropus sinensis</i>	LC	II	0.16	0.31	0.44	0.95	2.30	0.37
46	Green Sandpiper	<i>Tringa ochropus</i>	LC	II	1.01	0	0	0	0	0.48
47	Grey francolin	<i>Ortygornis pondicerianus</i>	LC	II	0	1.83	2.66	0	0	0.89
48	Gull-billed Tern	<i>Gelochelidon nilotica</i>	LC	I	0.86	0	0	0	0	0.41
49	House Crow	<i>Corvus splendens</i>	LC	II	0	2.14	3.10	7.11	3.45	1.71
50	House Sparrow	<i>Passer domesticus</i>	LC	II	0	1.83	2.66	10.43	0	1.71
51	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	LC	II	3.35	0	0	0	0	1.60
52	Indian Golden Oriole	<i>Oriolus kundoo</i>	LC	II	0	0.61	0.89	1.90	0	0.45
53	Indian Paradise-Flycatcher	<i>Terpsiphone paradisi</i>	LC	II	0.31	0.31	0.44	0	0	0.30
54	Indian Peafowl	<i>Pavo cristatus</i>	LC	I	1.01	5.20	0.67	1.42	0	1.97
55	Indian Pond-Heron	<i>Ardeola grayii</i>	LC	II	1.87	5.05	0	0	0	2.12
56	Indian Robin	<i>Copsychus fulicatus</i>	LC	II	0.93	0.76	1.11	1.42	0	0.93
57	Indian Roller	<i>Coracias benghalensis</i>	LC	II	0.16	1.07	1.55	0	0	0.60
58	Indian Silverbill	<i>Euodice malabarica</i>	LC	II	0.47	0.76	1.11	0	0	0.60
59	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	LC	II	2.65	0	0	0	0	1.26
60	Indian Thick-knee	<i>Burhinus indicus</i>	LC	II	0.54	0.61	0.89	0	0	0.56
61	Jerdon's Bushlark	<i>Mirafraga affinis</i>	LC	II	0.62	0.31	0.44	0	0	0.45
62	Jungle Prinia	<i>Prinia sylvatica</i>	LC	II	0	0.46	0.67	1.42	0	0.33
63	Knob-billed Duck	<i>Sarkidiornis melanotos</i>	LC	II	1.95	0	0	0	0	0.93
64	Large-billed Crow	<i>Corvus macrorhynchos</i>	LC	II	0	0.61	0.89	0	2.30	0.37
65	Laughing Dove	<i>Spilopelia senegalensis</i>	LC	II	0	1.83	2.66	5.69	4.60	1.49
66	Lesser Whistling-Duck	<i>Dendrocygna javanica</i>	LC	II	1.79	0	0	0	0	0.86
67	Little Cormorant	<i>Microcarbo niger</i>	LC	II	1.79	0	0	0	0	0.86
68	Little Egret	<i>Egretta garzetta</i>	LC	II	3.42	5.05	0	0	0	2.86
69	Little Grebe	<i>Tachybaptus ruficollis</i>	LC	II	2.49	0	0	0	0	1.19
70	Little Ringed Plover	<i>Thinornis dubius</i>	LC	II	0.39	0	0	0	0	0.19
71	Little Stint	<i>Calidris minuta</i>	LC	II	0.23	1.07	0	0	0	0.37
72	Little Swift	<i>Apus affinis</i>	LC	II	0.86	0.46	0.67	0	0	0.63
73	Marsh Sandpiper	<i>Tringa stagnatilis</i>	LC	II	0.62	0	0	0	0	0.30
74	Medium Egret	<i>Ardea intermedia</i>	LC	II	0.47	0.76	0	0	0	0.41
75	Northern Pintail	<i>Anas acuta</i>	LC	II	3.35	0	0	0	0	1.60
76	Northern Shoveler	<i>Spatula clypeata</i>	LC	II	1.79	0	0	0	0	0.86
77	Oriental Darter	<i>Anhinga melanogaster</i>	LC	II	0.70	0	0	0	0	0.33
78	Oriental magpie-robin	<i>Copsychus saularis</i>	LC	II	0	0.31	0.44	0	0	0.15
79	Oriental Skylark	<i>Alauda gulgula</i>	LC	II	0.16	0.31	0.44	0	0	0.22
80	Osprey	<i>Pandion haliaetus</i>	LC	I	0.08	0.31	0.22	0	0	0.15
81	Paddyfield Pipit	<i>Anthus rufulus</i>	LC	II	0.93	1.83	2.66	0	0	1.34
82	Painted Stork	<i>Mycteria leucocephala</i>	NT	II	1.63	0	0	0	0	0.78
83	Pale-billed Flowerpecker	<i>Dicaeum erythrorhynchos</i>	LC	II	0	0.61	0.89	1.42	6.90	0.63
84	Pied Cuckoo	<i>Clamator jacobinus</i>	LC	II	0.23	0.46	0.67	0	0	0.33
85	Pied Kingfisher	<i>Ceryle rudis</i>	LC	II	0.23	0.46	0	0	0	0.22
86	Plain Prinia	<i>Prinia inornata</i>	LC	II	0.47	1.83	2.66	0	0	1.12
87	Purple Heron	<i>Ardea purpurea</i>	LC	II	0.31	0.31	0	0	0	0.22
88	Purple Sunbird	<i>Cinnyris asiaticus</i>	LC	II	1.01	1.07	2.00	4.27	2.30	1.49
89	Purple-rumped Sunbird	<i>Leptocoma zeylonica</i>	LC	II	0.16	1.38	1.55	3.32	2.30	1.00
90	Red-naped Ibis	<i>Pseudibis papillosa</i>	LC	II	1.79	0	0	0	0	0.86
91	Red-vented Bulbul	<i>Pycnonotus cafer</i>	LC	II	0.39	5.05	3.33	7.11	14.94	3.01
92	Red-wattled Lapwing	<i>Vanellus indicus</i>	LC	II	1.40	1.22	1.77	0	0	1.26
93	Rock Pigeon	<i>Columba livia</i>	LC	-	0	2.45	3.55	7.11	1.15	1.79
94	Rose-ringed Parakeet	<i>Psittacula krameri</i>	LC	II	0	2.29	3.33	5.69	13.79	2.01
95	Rosy Starling	<i>Pastor roseus</i>	LC	II	0.93	1.38	2.00	0	0	1.12
96	Scaly-breasted Munia	<i>Lonchura punctulata</i>	LC	II	1.01	1.38	2.00	0	0	1.15
97	Shikra	<i>Accipiter badius</i>	LC	I	0.16	0.31	0.44	0	0	0.22
98	Spot-billed Pelican	<i>Pelecanus philippensis</i>	NT	II	1.79	0	0	0	0	0.86

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ID	Common Name	Scientific Name	LC	II	0.47	3.36	2.66	16.11	24.14	3.53
99	Spotted Dove	<i>Spilopelia chinensis</i>	LC	II	0.47	3.36	2.66	16.11	24.14	3.53
100	Tricolored Munia	<i>Lonchura malacca</i>	LC	II	0.39	1.83	2.66	0	0	1.08
101	Western Yellow Wagtail	<i>Motacilla flava</i>	LC	II	0.54	0	0	0	0	0.26
102	Whiskered Tern	<i>Chlidonias hybrida</i>	LC	II	0.62	0	0	0	0	0.30
103	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	LC	II	0.86	0	0	0	0	0.41
104	White-browed Wagtail	<i>Motacilla maderaspatensis</i>	LC	II	0.54	0	0	0	0	0.26
105	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	LC	II	0.47	0.31	0.44	0	0	0.37
106	Wood Sandpiper	<i>Tringa glareola</i>	LC	II	0.70	0	0	0	0	0.33
107	Yellow Bittern	<i>Ixobrychus sinensis</i>	LC	II	0.39	0.31	0	0	0	0.26
108	Yellow-billed Babbler	<i>Argya affinis</i>	LC	II	0	0.92	1.33	0.95	2.30	0.60
109	Yellow-throated Sparrow	<i>Gymnoris xanthocollis</i>	LC	II	0.23	0.61	0.89	0	0	0.41
110	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i>	LC	II	0.93	0.31	0.44	0	0	0.60
111	Zitting Cisticola	<i>Cisticola juncidis</i>	LC	II	0.93	0.31	0.44	0	0	0.60

LC-Least concerned; NT-Near threatened; NE- Not Evaluated; Wetland associated -WA; Agricultural associated-AA; Forest-F; Residential Area -RA; Urban Greenbelt-UG; Overall-OA

3.2. Relative Abundance

Red-vented Bulbul (3.01%) and Spotted Dove (3.53%) are the most frequent species in all habitats based on the relative abundance. The Eurasian Coot (4.20%) and Little Egret (3.42%) were found to be most abundant in wetland habitats. The Asian Green Bee-eater maximum relative abundance was 7.54% in forests and 5.20% in agricultural land. The highest relative abundances of House Sparrow (10.43%) and House Crow (7.11%) were found in residential areas, whereas Common Myna (9.20%) and Pale-billed Flowerpecker (6.90%) were found in the habitat of urban greenbelts (Table 1). In the study shows maximum species diversity and richness were observed in wetland on similar result were observed by Bubesh Guptha et al. (2011) and agricultural landscapes that provide a wealth of seasonal resources such seeds, grains, and invertebrates (Davidar & Morton, 1986; Daniels, 1992; Ramarajan et al., 2015; 2021). In general, fewer species, such as House Sparrow and House Crow, were found in residential areas and urban green spaces (Minayo Maet al., 2025; Jayapal et al., 2013).

3.3. Diversity Index

Wetland associated habitats were the highest species richness (92 species) and abundance (1,285 individuals), with high diversity values (Shannon H' = 4.183; Simpson 1-D = 0.9809). Agricultural associated (76 species) and forest habitats (62 species) also supported relatively high diversity. In residential areas (23 species) and urban greenbelts (15 species), lower species richness and diversity were observed. The overall diversity of birds in the study area was high (Shannon H' = 4.439; Simpson 1-D = 0.9856). The results shows wetland and agricultural habitat supportive for avian diversity, while urbanized habitats support comparatively fewer species and also generalist species like common myna, house grow and house sparrow only reported; this may be there was no suitable habitat availability.

Table 2. Bird species richness, abundance, and diversity indices across different habitat.

Parameter	Wetland	Agriculture	Forest	Residential	Urban Greenbelt	Overall
Taxa (S)	92	76	62	23	15	111
Individuals	1285	654	451	211	87	2688
Simpson (1-D)	0.980	0.974	0.973	0.927	0.875	0.985
Shannon (H')	4.183	3.958	3.842	2.841	2.353	4.439

4. Conclusion

The present study clearly indicates that the Gangaikondan habitat supports considerable species diversity. This area provides an important benchmark and baseline resource of information, which is useful for the preparation of Environmental Impact Assessments (EIA), conservation and habitat management plans, and for guiding sustainable industrial development and long-term environmental sustainability.

Author Contributions

Somasundaram S: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Visualization, Writing – original draft, Writing – review & editing; S. Darwin Paul Edison: Field survey, IUCN assessment; Laxmanan Prakash: Methodology,



Figure 2. Common bird species found in the study area.

Resources, Writing – review & editing; Ramarajan S: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Supervision, Project administration, Funding acquisition, Writing – original draft, Writing – review & editing; Leo Sharma C: Methodology, Resources, Writing – review & editing.

Acknowledgments

The authors sincerely acknowledge the support and guidance of the field assistants. We also thank the Hubert Enviro Care System that provided access to project sites and logistical support during fieldwork.

Declarations

Conflicts of interest: The author declares no conflict of interest.

Ethics approval: This study did not involve human participants or animal experiments requiring institutional ethical approval. All field surveys were conducted following relevant environmental regulations and guidelines for biodiversity assessment in India.

Consent for publication: The authors have read and approved the final version of the manuscript.

Data availability: The data supporting the findings of this study are available from the author upon reasonable request.

Supplementary material: No supplementary material is associated with this manuscript.

Additional information: No additional information is associated with this study.



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