

# A survey on avifauna diversity in some selected localities in and around Madurai city

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## ABSTRACT

The present study aims to survey the avifaunal diversity in some selected localities in and around Madurai City, Tamil Nadu during June 2021 to April 2022. Birds were surveyed using short-strip transects counts (SSCT) method. A total of 99 species of birds belonging to 44 families and 86 genera have been recorded in Madurai city, of which 78 species are resident, 14 species are migrant and 7 species are local migrants. The Ardeidae were the most prominent family with 11 species, and their relative diversity index was the highest (RDi = 11.11). Carnivores' bird community was found to be dominant among foraging pattern. According to their frequency of occurrence, 57 species (57.57%) were very common, 30 (30.30%) common and 12 (12.12%) rare. IUCN threat categories classify four species as "Near Threatened" and 95 species as "Least Concern". The present study reveals the highest birds species diversity (Shannon's), richness (Margalef's), and evenness (Pielou's) indices were found in the Madakulam area when compared to that of other study areas. Based on the occurrence of bird species in ten different areas, we can conclude that the diversity and richness of bird species increases with increased vegetation areas and decrease with greater human disturbances. Additionally, researchers have reported that anthropogenic disruptions will reduce the diversity of bird species, as well as other issues such as habitat loss, overhunting, structural collisions, pollution, climate change etc.

**Key words :** Madurai city, Birds diversity, Short-strip transects counts method, Shannon's index, Conservation

## Introduction

India is home to many of the world's most biodiversity ecosystems, including deserts, high mountains, highlands, tropical and temperate forests, swamplands, plains, grasslands, riverine habitats, and the Island Archipelago (National bird of

India, 2007). The avifauna of India comprises 1369 species, 83 of which are endemic, 2 of which are extinct, 212 of which are critically endangered, and one new species (*Bugun liocichla*) was discovered in 2006 in Arunachal Pradesh (Puri, 2007; Ranjit and Asif, 2020; Denis Lepage, 2022). The World Watch Institute reports that 1,200 species will go extinct in

the next century and also declining bird populations in numerous parts of the world (Gill, 1995). There are several factors that contribute to the loss of bird species diversity, including habitat loss, overhunting, urbanization, industrialization, pollution, inter-intra animal competition, predation, oil spills in the ocean, and pesticide use (Moore *et al.*, 2008). In this context, it is imperative to amend legislation, preserve habitats, and reintroduce birds into captivity, in collaboration with government and non-government organizations, to protect birds and their habitats.

Most habitats on earth are inhabited by birds and they perform a wide variety of roles around the world, including (a) dispersing seeds for different plants (Pejchara *et al.*, 2008), (b) bird droppings (guano) increase the nutrient content of different water bodies (Boros *et al.*, 2021), (c) they act as sanitation workers by picking up dead animals and eating their remains (Holmberg, 2021), (d) keeping pest populations under control by consuming large numbers of insects (Garcia *et al.*, 2020), (e) are good indicators of the productivity, stability, and quality of agro-ecosystems (Egwumah *et al.*, 2017) and (f) birds and their eggs have been the source of food for humans since their origins (Møller and Xia, 2020) and so on.

Madurai is one of the most popular pilgrimage destinations in Tamil Nadu and also it is one of the oldest continuously inhabited cities in India. There has been little research done on the birds of the 'fort' of Madurai city as well as the Madurai district to date. The Avifauna of Madura District was first documented by Nichols in three parts: Part I (Nichols, 1944a), Part II (Nichols, 1944b), and Part III (Nichols, 1945). At various times, Dr. Sathasivam has published notes on certain bird species in Madurai, including House sparrow (Sathasivam, 1991), Alpine swifts (Sathasivam, 1992), Pitta mystery (Sathasivam, 1995), Shikras (Sathasivam, 1996) and Glossy ibis (Narayanan and Sathasivam, 2002). In addition, he provided a checklist of birds in Madurai City in 2015 (Sathasivam, 2015). Further, Information on the diversity of birds and their compositions is sparse in and around Madurai city. As bird species diversity, richness, and community composition are frequently used by ecologists to assess the diversity of bird species in the concern ecosystem, therefore, this study aims to assess the bird community structure and diversity at selected habitats in and around Madurai city.

## Materials and Methods

### Study area

A bird's species survey was conducted in and around Madurai City (9.93°N, 78.12°E) in some selected localities. Madurai, one of South India's great temple cities, is known for the famous Meenakshi Temple, which is located on the banks of the Vaigai river. Further, Madurai has a rich cultural heritage dating back more than 2500 years, and it was formerly the capital city of the ancient Pandya kings. The Madurai city is altitude at a height of 101 meters or 330 feet above sea level. The average yearly rainfall is roughly 840 mm. The annual average temperature is 28.8 °C. Humidity varies from season to seasonal. A preliminary survey of bird species was undertaken in the ten sites listed below:

1. Mandela Nagar (rural agro-based habitats - it covers pond, wetland and agricultural area),
2. Thirupparankundram (sub-urban agro-based habitats - it covers lake and agricultural areas),
3. Vaigai River (urban based river bank – it covers from Arapalyam to Sivakangai ring road),
4. Periyar Residential Area (urban habitats),
5. Azhagar Kovil (rural agro-based habitats - it covers bottom of hills and agricultural area),
6. Madakkulam (rural agro-based habitats - it covers lake and agricultural areas),
7. Palanganatham Residential Area (urban habitats),
8. Atchampathu (sub-urban agro-based habitats - covers residential and agricultural areas),
9. Avaniyapuram (sub-urban agro-based habitats - it covers lake and agricultural areas) and
10. Thiagarajar College Campus (urban habitats).

### Data collection and analysis

The data on bird species diversity was collected during June 2021 to April 2022. Short-strip transects counts (SSTC) for continuous walk method was used to observe bird species diversity. The observers walked for 10 minutes continuously and documented the bird species they saw along the way. In the SSTC approach, an average distance of 50m was traversed every ten minutes. All birds within a 20-meter band were recorded. The survey was done between the hours of 6.00 to 8.00 am, and 16.00 to 18.00 pm. The data from the birds was collected for four hours each day, four days per month.

The majority of the documentation was done through photography. When birds were seen, they were sighted using binoculars and identified on the spot with field guides (Ali 1980), and after confirmation of identification, the species were recorded in the data sheet. The checklist is prepared using the guidelines provided by Ali (1980, 2002). Bird's species occurrence was classified into three categories: Abundant (A), Common (C), and Rare (R). The species diversity of the bird was calculated using the following techniques.

1. Based on the following formula, we calculated relative diversity (RDi) of bird species families, resident status, frequency of occurrence, and feeding guild (Torre-Cuadros *et al.*, 2007):

$$\text{RDi} = \frac{\text{No. of bird species in a family or feeding guide}}{\text{Total number of species}} \times 100$$

2. Birds species diversity (Shannon's index), richness (Menhinick's index), and evenness (Pielou's index) indices were calculated using PAST statistical software (Hammer *et al.*, 2001).

## Results

The avian diversity of the Madurai City is represented by a total of 99 species belonging to 44 families and 86 genera (Table 1). Of which 87 species were found in the Madakulam, 78 in Mandela nagar, 63 in Thirupparankundram, 56 in Avaniyapuram, 49 in Azhalagar kovil, 45 in Achampathu, 34 in Vaigai river, 25 in Thiagarajar college campus, 23 in Palanganatham and 17 in Periyar area (Table 2). Out of 98 species, 78 species (78.78%) were resident, 14 species (14.14%) were migrant and 7 species (7.07%) were local migrant in Madurai City. Of the total (99) recorded species, 57 (57.57%) were found to be common, 30 (30.30%) species were rare, 12 (12.12%) species were abundant. Ardeidae was the most diverse families (11 species each, RDi= 11.11), followed by Accipitridae and Cuculidae (5 species each, RDi= 5.05). On the other hand, 17 families namely, Acrocephalidae, Anhingidae, Charadriidae, Coraciidae, Dicruridae, Oriolidae, Pelicanidae, Phalacrocoracidae, Picidae, Podicipedidae, Psittaculidae, Recurvirostridae, Rostratulidae, Timaliidae, Tytonidae, Phoenicopteridae and Caprimulgidae were least represented (1 species each, RDi= 1.01). Eight foraging guilds were found in the study area, carnivores

(36 species, 36.36%) were highly represented guilds, followed by omnivores (30.30%) whereas, piscivores and frugivores (each 1 species, 1.01%) was the least represented.

Of the 99 species recorded, four species (4.04%) were 'Near Threatened' and the rest (96 species, 96.96%) were 'Least Concern' according to the IUCN Red List. Madakulam had the highest species diversity, richness and evenness index (D; 0.60; R: 0.44; and E: 0.90), followed by Mandela nagar (D; 0.56; R: 0.37; and E: 0.87), Thirupparankundram (D; 0.50; R: 0.32; and E: 0.82) and Avaniyapuram (D; 0.42; R: 0.30; and E: 0.75). Whereas the lowest species diversity, richness and evenness index was found in Periyar (D; 0.16; R: 0.20; and E: 0.50), Palanganatham (D; 0.18; R: 0.22; and E: 0.57) and Thiagarajar college campus (D; 0.24; R: 0.25; and E: 0.60) (Table 1). It is noteworthy to observe that 10 bird species out of the 99 species of birds were present in almost all of the study sites such as Shikra (*Accipiter badius*), Asian koel (*Eudynamis scolopacea*), Greater coucal (*Centropus sinensis*), House crow (*Corvus splendens*), Jungle crow (*Corvus macrorhynchos*), Jungle babbler (*Argya striata*), Indian robin (*Saxicoloides fulicata*), Common myna (*Acridotheres tristis*), Purple sunbird (*Cinnyris asiaticus*) Spotted owl (*Athene brama*) Black drongo (*Dicrorus macrocercus*) and Rose-ringed parakeet (*Psittacula krameri*) (Table 1).

## Discussion

Disturbance of ecosystems is one of the most important contemporary phenomena that affect bird species diversity and their habitats. The study of birds in the field has been greatly helped by improvements in ecosystem and they also significantly contribute to the economic values in human society (Møller and Xia, 2020). The present study's findings show that the studied areas' avifaunal diversity and abundance greatly vary. It was found that while species diversity was abundant in Madakulam (88 species) and Mandela nagar (79 species), which are rural agro-based environments; it was less abundant in the urban environments of Periyar (17 species), Palanganatham (23 species), and Thiagarajar college campus (25 species). It is interesting to note that urban study locations had the lowest bird species diversity when compared to rural agro-based study sites. This is probably due to the fact that anthropogenic activities are more common in urban than ru-

**Table 1.** List of Birds in Madurai city in various habitats along with their distribution, feeding guild, resident and IUCN status

S. No.	Common and Scientific Name	Study sites											Resident/ IUCN Status	FG	FO		
		MN	TL	VR	PR	AK	MK	PN	AP	AL	TC	TC					
<b>FAMILY: ARDEIDAE</b>																	
1	Large Egret, <i>Ardea alba</i>	+	+	-	-	-	+	+	+	-	-	+	+	+	-	RT / LC	C
2	Median Egret, <i>Ardea intermedia</i>	+	+	+	-	-	+	+	+	-	-	+	+	+	-	RT / LC	C
3	Grey Heron, <i>Ardea cinerea</i>	+	-	-	-	-	+	+	+	-	-	-	-	-	+	LM / LC	C
4	Purple heron, <i>Ardea purpurea</i>	+	+	-	-	-	+	+	+	-	-	-	-	-	-	RT / LC	C
5	Indian Pond Heron, <i>Ardeola grayii</i>	+	+	+	-	-	+	+	+	+	+	+	+	+	+	RT / LC	C
6	Cattle Egret, <i>Bubulcus ibis</i>	+	+	+	-	-	+	+	+	+	+	+	+	+	-	M / LC	C
7	Little Egret, <i>Egretta garzetta</i>	+	+	+	+	+	+	+	+	-	-	+	+	+	+	RT / LC	C
8	Black-Crowned Night Heron, <i>Nycticorax nycticorax</i>	+	+	-	-	-	+	+	+	-	-	-	-	-	-	RT / LC	O
9	Little Green Heron, <i>Butorides striata</i>	+	+	-	-	-	+	+	+	-	-	-	-	-	-	M / LC	C
10	Yellow Bittern, <i>Ixobrychus sinensis</i>	+	+	-	-	-	+	+	+	-	-	-	-	-	-	RT / LC	C
11	Black Bittern, <i>Ixobrychus flavicollis</i>	+	-	-	-	-	+	+	+	-	-	-	-	-	-	RT / LC	C
<b>FAMILY: ACCIPITRIDAE</b>																	
12	Pariah Kite/ Black Kite, <i>Milvus migrans</i>	+	-	+	-	-	+	+	+	+	-	-	-	-	-	RT / LC	C
13	Shikra, <i>Accipiter badius</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	RT / LC	C
14	Oriental Honey-Buzzard, <i>Pernis ptilorhynchus</i>	-	+	-	-	-	+	+	+	-	-	-	-	-	-	RT / LC	C
15	Black-Winged Kite, <i>Elanus caeruleus</i>	-	+	+	-	-	+	+	+	-	-	-	-	-	-	LM / LC	C
16	Short-toed Snake Eagle, <i>Circaetus gallicus</i>	+	+	-	-	-	+	+	+	-	-	-	-	-	-	RT / LC	C
<b>FAMILY: COLUMBIDAE</b>																	
17	Mountain Imperial –Pigeon, <i>Ducula badia</i>	+	+	-	-	-	+	+	+	+	-	-	-	-	-	RT / LC	G
18	Spotted Dove, <i>Streptopelia chinensis</i>	+	+	-	-	-	+	+	+	+	+	+	+	+	+	LM / LC	G
19	Eurasian Collared-Dove, <i>Streptopelia decaocto</i>	+	+	-	-	-	+	+	+	+	+	+	+	+	+	RT / LC	G
20	Blue –Rock Pigeon, <i>Columba livia</i>	-	+	-	+	-	+	+	+	+	+	+	+	+	+	RT / LC	G
<b>FAMILY: CUCULIDAE</b>																	
21	Asian Koel, <i>Eudynamis scolopaceus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	RT / LC	O
22	Greater Coucal, <i>Centropus sinensis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	RT / LC	O
23	Pied Crested Cuckoo, <i>Clamator jacobinus</i>	+	+	-	-	-	+	+	+	+	+	+	+	+	+	M / LC	O
24	Indian Plaintive Cuckoo, <i>Cacomantis merulinus</i>	+	-	-	-	-	+	+	+	+	+	+	+	+	+	M / LC	I
25	Common hawk cuckoo, <i>Hierococcyx varius</i>	+	-	-	+	-	+	+	+	+	+	+	+	+	+	RT / LC	O
<b>FAMILY: RALLIDAE</b>																	
26	Common Coot, <i>Fulica atra</i>	+	+	-	-	-	+	+	+	+	+	+	+	+	+	RT / LC	O
27	Purple Moorhen, <i>Porphyrio porphyrio</i>	+	+	+	-	-	+	+	+	+	+	+	+	+	+	RT / LC	O
28	Watercock, <i>Gallinix cinerea</i>	+	-	-	-	-	+	+	+	+	+	+	+	+	+	RT / LC	O
29	White Breasted Waterhen, <i>Amauornis phoenicurus</i>	+	+	-	-	-	+	+	+	+	+	+	+	+	+	RT / LC	O
<b>FAMILY: ALCEDINIDAE</b>																	
30	White –Throated Kingfisher, <i>Halcyon smyrnensis</i>	+	+	+	-	-	+	+	+	+	+	+	+	+	+	RT / LC	C
31	Small Blue Kingfisher, <i>Alcedo atthis</i>	+	+	-	-	-	+	+	+	+	+	+	+	+	+	RT / LC	C
32	Pied Kingfisher, <i>Ceryle rudis</i>	+	+	-	-	-	+	+	+	+	+	+	+	+	+	RT / LC	C

Table 1. Continued ...

S. No.	Common and Scientific Name	Study sites										Resident/ IUCN Status		FG	FO			
		MN	TL	VR	PR	AK	MK	PN	AP	AL	TC	AL	TC					
<b>FAMILY: CISTICOLIDAE</b>																		
33	Jungle Prinia, <i>Prinia sylvatica</i>	+	+	-	-	-	+	-	+	+	-	+	+	+	-	RT / LC	I	C
34	Plain Prinia, <i>Prinia inornata</i>	+	+	-	-	+	+	-	+	+	-	+	+	-	-	RT / LC	I	C
35	Common tailorbird, <i>Orthotomus sutorius</i>	-	-	-	-	-	+	-	+	+	-	+	+	-	-	RT / LC	I	R
<b>FAMILY: CORVIDAE</b>																		
36	House Crow, <i>Corvus splendens</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	RT / LC	O	A
37	Jungle Crow, <i>Corvus macrorhynchos</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	RT / LC	O	A
38	Indian Treepie, <i>Dendrocyttia vagabunda</i>	+	+	-	-	+	+	-	+	+	-	+	+	+	+	RT / LC	O	C
<b>FAMILY: LEIOTHRICHIDAE</b>																		
39	Indian Rufous Babbler, <i>Argya subrufa</i>	+	+	-	-	-	+	-	+	+	-	-	-	-	-	RT / LC	O	C
40	Jungle Babbler, <i>Argya striata</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	RT / LC	O	A
41	White Headed Babbler, <i>Turdoides leucocephala</i>	+	+	-	-	-	+	-	+	+	-	-	-	-	-	RT / LC	O	C
<b>FAMILY: MOTACILLIDAE</b>																		
42	Large Pied Wagtail, <i>Motacilla madenaspatensis</i>	+	+	+	-	+	+	-	+	+	-	+	+	+	-	RT / LC	I	C
43	Western Yellow Wagtail, <i>Motacilla flava</i>	-	-	+	-	-	+	-	+	+	-	-	-	-	-	M / LC	I	R
44	Paddyfield Pipit, <i>Anthus rufulus</i>	+	-	-	-	-	+	-	+	+	-	+	+	-	-	RT / LC	I	C
<b>FAMILY: MUSCICAPIDAE</b>																		
45	Oriental Magpie-Robin, <i>Copsychus saularis</i>	-	+	-	-	-	+	-	+	+	-	-	-	-	-	RT / LC	C	R
46	Indian Robin, <i>Saxicoloides fulvicata</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	RT / LC	C	A
47	Pied Bush Chat, <i>Saxicola caprata</i>	+	+	-	-	-	+	-	+	+	-	+	+	-	-	RT / LC	I	R
<b>FAMILY: PHASIANIDAE</b>																		
48	Indian Peafowl, <i>Pavo cristatus</i>	+	+	-	-	-	+	-	+	+	-	+	+	+	-	RT / LC	O	A
49	Grey Francolin, <i>Francolinus pondicerianus</i>	+	+	-	-	-	+	-	+	+	-	+	+	+	-	RT / LC	O	C
50	Common Quail, <i>Coturnix coturnix</i>	+	-	-	-	-	+	-	+	+	-	+	+	-	-	RT / LC	G	R
<b>FAMILY: STURNIDAE</b>																		
51	Common Myna, <i>Acridotheres tristis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	RT / LC	O	A
52	Brahminy Starling, <i>Sturnia pagodarum</i>	+	+	-	-	-	+	-	+	+	-	+	+	-	-	RT / LC	O	C
53	Rosy Starling, <i>Pastor roseus</i>	+	-	-	-	-	+	-	+	+	-	+	+	-	-	M / LC	O	C
<b>FAMILY: THRESKIORNITHIDAE</b>																		
54	Oriental White Ibis, <i>Thereskiornis melanocephalus</i>	+	+	+	-	-	+	-	+	+	-	+	+	+	+	RT / NT	C	C
55	Black Ibis, <i>Pseudibis papillosa</i>	+	+	+	-	-	+	-	+	+	-	+	+	+	-	RT / LC	O	C
56	Glossy Ibis, <i>Plegadis falcinellus</i>	+	-	+	-	-	+	-	+	+	-	+	+	+	-	LM / LC	C	R
<b>FAMILY: ANATIDAE</b>																		
57	Bar-headed Goose, <i>Anser indicus</i>	+	-	-	-	-	+	-	+	+	-	+	+	+	-	RT / LC	O	C
58	Spot-Billed Duck, <i>Anas poecilorhyncha</i>	+	+	-	-	-	+	-	+	+	-	+	+	+	-	RT / LC	O	C
<b>FAMILY: APODIDAE</b>																		
59	Asian Palm Swift, <i>Cypsiurus balasensis</i>	+	-	+	-	-	+	-	+	+	-	+	+	-	-	RT / LC	I	C

Table 1. Continued ...

S. No.	Common and Scientific Name	Study sites											Resident/ IUCN Status		FG	FO		
		MN	TL	VR	PR	AK	MK	PN	AP	AL	TC	TC						
60	Indian Swiftlet, <i>Aerodramusunicolor</i> <b>FAMILY: CICONIIDAE</b>	+	+	+	-	+	+	-	+	+	-	-	+	-	-	RT/LC	I	C
61	Painted Stork, <i>Mycteria leucocephala</i>	+	+	-	-	+	+	-	-	-	-	-	-	-	-	M/NT	C	C
62	Asian Openbill-Stork, <i>Anastomus oscitans</i> <b>FAMILY: ESTRILIDAE</b>	+	+	-	-	+	+	-	-	-	-	-	-	-	-	RT/LC	C	C
63	Spotted Munia, <i>Lonchura punctulata</i>	+	-	-	-	-	-	-	+	-	-	-	-	-	-	RT/LC	C	R
64	Indian silverbill, <i>Euodice malabarica</i> <b>FAMILY: HIRUNDINIDAE</b>	-	-	-	-	-	+	-	-	-	-	-	-	-	-	RT/LC	G	R
65	Red Rumped Swallow, <i>cecropis daurica</i>	+	+	-	-	+	+	-	-	-	-	-	-	-	-	LM/LC	I	C
66	Common Swallow, <i>Hirundo rustica</i> <b>FAMILY: MEROPIIDAE</b>	+	-	-	-	-	-	-	-	-	-	-	-	-	-	M/LC	I	C
67	Blue Tailed Bee Eater, <i>Nyctyornis athertoni</i>	+	+	-	-	+	+	-	+	-	-	-	-	-	-	M/LC	I	C
68	Green Bee Eater, <i>Merops orientalis</i> <b>FAMILY: MONARCHIDAE</b>	+	+	-	-	-	+	-	+	-	-	-	-	-	-	RT/LC	I	C
69	Asian Brown Flycatcher, <i>Muscicapa latirostris</i>	-	+	-	-	+	+	-	+	-	-	-	-	-	-	M/LC	I	R
70	Asian Paradise-Flycatcher-Dark Morph, <i>Terpsiphone paradisi</i> <b>FAMILY: NECTARINIDAE</b>	-	-	-	-	+	+	+	+	-	-	-	-	-	+	RT/LC	I	C
71	Purple Sunbird, <i>Cinnyris asiaticus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	RT/LC	N	A
72	Purple-Rumped Sunbird, <i>Leptocoma zeylonica</i> <b>FAMILY: PASSERIDAE</b>	+	-	-	-	+	+	-	-	-	-	-	-	-	-	RT/LC	N	A
73	House Sparrow, <i>Passer domesticus</i>	-	-	+	-	-	-	-	-	-	-	-	-	-	-	RT/LC	O	R
74	Yellow-Throated Sparrow, <i>Petronia xanthocollis</i> <b>FAMILY: PYCNONOTIDAE</b>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	RT/LC	O	R
75	Red-Vented Bulbul, <i>Pycnonotus cafer</i>	-	-	-	+	+	+	+	+	+	+	+	+	+	+	RT/LC	O	C
76	White Browed Bulbul, <i>Pycnonotus luteolus</i> <b>FAMILY: RHIPIDURIDAE</b>	+	-	-	-	+	-	-	-	-	-	-	-	-	-	RT/LC	O	R
77	White-Browed Fantail Flycatcher, <i>Rhipidura aureola</i>	-	+	+	-	-	+	-	-	-	-	-	-	-	-	RT/LC	I	C
78	White-Throated Fantail Flycatcher, <i>Rhipidura albicollis</i> <b>FAMILY: SCOLOPACIDAE</b>	-	-	-	-	+	+	-	-	-	-	-	-	-	-	RT/LC	I	R
79	Wood Sandpiper, <i>Tringa glareola</i>	+	+	+	-	-	-	-	-	-	-	-	-	-	-	RT/LC	C	C
80	Marsh Sandpiper, <i>Tringa stagnatilis</i> <b>FAMILY: STRIGIDAE</b>	+	-	+	-	-	-	-	-	-	-	-	-	-	-	RT/LC	C	C
81	Short-Eared Owl, <i>Asio flammeus</i>	-	-	-	-	+	+	-	+	-	-	-	-	-	-	M/LC	C	R
82	Spotted Owllet, <i>Athene brama</i> <b>FAMILY: ACROCEPHALIDAE</b>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	RT/LC	C	C
83	Clamorous Reed Warbler, <i>Acrocephalus stentoreus</i> <b>FAMILY: ANHINGIDAE</b>	+	+	-	-	+	+	-	-	-	-	-	-	-	-	RT/LC	I	C

Table 1. Continued ...

S. No.	Common and Scientific Name	Study sites										Resident/ IUCN Status		FO	
		MN	TL	VR	PR	AK	MK	PN	AP	AL	TC	FG	FO		
84	Oriental Darter, <i>Anhinga melanogaster</i> FAMILY: CHARADRIIDAE	+	+	-	-	-	+	-	-	+	-	-	LM / NT	C	C
85	Red-Wattled Lapwing, <i>Vanellus indicus</i> FAMILY: CORACIIDAE	+	+	+	-	-	+	-	-	-	-	-	RT / LC	O	C
86	Indian Roller, <i>Coracias benghalensis</i> FAMILY: DICURIDAE	+	+	+	-	+	+	+	+	+	+	+	RT / LC	C	C
87	Black Drongo, <i>Dicrurus macrocercus</i> FAMILY: ORIOLIDAE	+	+	+	+	+	+	+	+	+	+	+	RT / LC	I	C
88	Indian Golden Oriole, <i>Oriolus kundoo</i> FAMILY: PELECANIDAE	+	-	-	-	-	+	-	-	-	-	-	M / LC	O	R
89	Spot-billed Pelican, <i>Pelecanus philippensis</i> FAMILY: PHALACROCORACIDAE	+	+	-	-	-	+	-	-	+	-	-	M / NT	P	C
90	Little Cormorant, <i>Microcarbo nigar</i> FAMILY: PICIDAE	+	-	-	-	-	+	-	-	+	-	-	LM / LC	C	C
91	Lesser Golden Backed Wood Pecker, <i>Dinopium benghalense</i> FAMILY: PODICIPEDIDAE	-	+	-	+	+	+	+	+	-	+	+	RT / LC	I, N	C
92	Little Grebe, <i>Tachybaptus ruficollis</i> FAMILY: PSITTACULIDAE	+	-	-	-	-	+	-	-	-	-	-	RT / LC	C	C
93	Rose -Ringed Parakeet, <i>Psittacula krameri</i> FAMILY: RECURVIROSTRIDAE	+	+	+	+	+	+	+	+	+	+	+	RT / LC	F	C
94	Black-Winged Stilt, <i>Himantopus himantopus</i> FAMILY: ROSTRATULIDAE	+	-	+	-	-	-	-	-	+	-	-	RT / LC	C	C
95	Greater Painted-Snipe, <i>Rostratula benghalensis</i> FAMILY: TIMALIIDAE	+	-	-	-	-	-	-	-	-	-	-	RT / LC	O	R
96	Tawny -Bellied Babbler, <i>Dumetia hyperythra</i> FAMILY: TYTONIDAE	-	-	-	-	+	-	-	-	-	-	-	RT / LC	I, N	R
97	Barn Owl, <i>Tyto alba</i> FAMILY: PHOENICOPTERIDAE	-	-	-	-	-	+	-	-	-	-	-	RT / LC	C	R
98	Greater Flamingo, <i>Phoenicopterus roseus</i> FAMILY: CAPRIMULGIDAE	-	-	-	-	-	+	-	-	+	-	-	M / LC	C	R
99	Indian Nightjar, <i>Caprimulgus asiaticus</i> DIVERSITY INDICES	79	64	34	17	49	88	23	45	57	25	25			

Table 1. Continued ...

S. No.	Common and Scientific Name	Study sites										Resident/ IUCN Status
		MN	TL	VR	PR	AK	MK	PN	AP	AL	TC	
	<b>Dominance Index</b>	0.93	0.87	0.74	0.58	0.82	0.97	0.62	0.75	0.84	0.68	
	<b>Shannon's (H) Index (Species Diversity)</b>	0.56	0.50	0.29	0.16	0.40	0.60	0.18	0.39	0.42	0.24	
	<b>Margalef's Index (Species Richness)</b>	0.37	0.32	0.25	0.20	0.27	0.44	0.22	0.26	0.30	0.25	
	<b>Pielou's Index (Species Evenness)</b>	0.87	0.82	0.64	0.50	0.74	0.90	0.57	0.68	0.75	0.60	

**Abbreviation:** FO - Frequency of Occurrence, A - Abundant, C - Common, R - Rare, RT - Resident, M - Migrant, LM - Local Migrant, LC - Least Concern, NT - Near Threatened, O - Omnivores, C - Carnivores, P - Piscivores, I - Insectivores, G - Granivores, F - Frugivores, N - Nectarivores, MN - Mandela Nagar, TL - Thirupparankundram Lake, VR - Vaigai River, PR - Periyar Residential Area, AK - Azhagar Kovil, MK - Madakulam, PN - Palanganatham Residential Area, AP - Atchampathu, AL - Avaniyapuram lake, TC - Thiagarajar College Campus, FG - Foraging Guild

ral environment. According to Sunil Kumar *et al* (1997), monoculture plantations and high levels of human disturbance lead to a lower number of ecological diversity. Similarly, the number of bird species in the Periyar, Palanganatham, and Thiagarajar College campuses was low, possibly due to a lack of vegetation and high levels of human activity. Kunte (1997) revealed that human interference was having a significant impact on ecological diversity.

The present study has also found that 78 species of birds were identified as resident, followed by 14 migrant species and 7 local migrant species. According to Mukhopadhyay and Mazumdar (2017), the availability of

food and suitable habitat attracts both resident and migratory birds. Migratory birds are significant elements of wetlands, agricultural environments, and other habitats. Further, agro-environment provides several feeding habitats to the different bird species (Gokula and Anantha Raj, 2013). Sundar and Subramanya (2010) have reported that 351 bird species recorded in agro-ecosystem of India. It has been discovered that the habitat preferences of over 45% of the bird species on the Indian subcontinent are agricultural environments (Sundar and Subramanya, 2010; Yashmita-Ulman and Singh 2021). In the present study, 17 different migrating bird species were found in Madakulam, Mandela Nagar, Thirupparankundram, and Avaniyapuram. These birds travel between continents and nations. Therefore, the above study locations are recognized as great environment examples in local level.

The present study reveals that the Family Ardeidae is the most diverse family followed by Accipitridae and Cuculidae. However, several studies have also reported that the bird family Ardeidae is the most diverse avian family in different ecosystems throughout India (Dal and Vaghela, 2015; Mazumdar, 2017). This finding is consistent with the study of Vijayan *et al* (2006), Surana (2007), Zakaria *et al* (2009), Zakaria and Rajpar (2010), Ali *et al* (2011), Debnath *et al* (2018), Sathish *et al* (2020), Mahato *et al.* (2021) etc. With regard to IUCN threat status four species, namely, Oriental White Ibis, *Thereskiornis melanocephalus*, Painted Stork, *Mycteria leucocephala*, Oriental darter, *Anhinga melanogaster*, and Spot-billed pelican, *Pelecanus philippensis* are classified Near threatened (NT). Rajesh and his colleagues (2021) discovered recently 72 species in the Manjmalai Sacred Grove in the Madurai district fall under the IUCN category of Least Concern. According to BirdLife International (2010), there are 1,186 species of threatened bird's worldwide, and 123 species in India.

A diversity index is an effective tool for quantifying the number of different species present in a community and the distribution of individuals within each species (You *et al.*, 2009). The diversity Index was applied in the present study to investigate the diversity of bird species across the study areas. A diversity index reveals that the Madakulam, where there are 88 species of birds, has the highest diversity index values (richness and evenness), whereas Periyar, where there are only 17 species, has the lowest diversity index values. The high species rich-



ness of the bird's population in the study area may be due to the presence of diverse habitats in and around this area including built-up areas combined with wetlands, riverbanks, large expanses of paddy cultivation, monoculture plantations, uncultivated grazing pastures, backyard gardens, orchards, etc. It is reported that the environmental circumstances, the number of species, and the distribution of individuals within each species are the elements that affect the value of Shannon's index (Qiptiyah, 2015). According to Kiros *et al* (2018), the diversity, richness, and abundance of bird species vary depending on the vegetation's composition, which affects the birds' choice of food sources, nesting sites, and protection.

### Conclusion

The preliminary survey provides effort towards documentation of avifaunal diversity in and around Madurai city. This survey reveals that the higher avifaunal diversity was recorded in the rural agro-based habitats like Madakulam and Mandela nagar. These two habitats have large water bodies and agricultural landscapes, that provide a variety of foods, refuge, places for nesting and breeding and other amenities that have an influence on the increasing bird's population. Both habitats need to be planted with more number of nesting plants in order to enhance the avifaunal diversity, and it is also necessary to stop some anthropogenic activities that may be detrimental to the avifaunal diversity. Future research in this areas. should focus on the ecology bird nesting, breeding and feeding, which would help us to better understand birds more accurately and enable us to develop more effective conservation strategies. This study recommends for contacting the awareness programme to the local people to educate them about the importance of waterbirds and wetlands. In addition, NGOs and Education institutes (schools, colleges, universities etc.) are required to initiate bird population census program for monitoring and conserving of the birds in more populated areas.

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