



# Seasonal Dynamics and Avian Diversity along the Adyar Riverbank: Insights from a Year-Long Survey

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## Authors' contributions

This work was carried out in collaboration among all authors. Authors SM and IS planned the study on bird diversity along the Adyar River, conducted the field observations, performed the statistical analysis, developed the research protocol, and wrote the initial draft of the manuscript. Author SR supervised the interpretation of the results and contributed to refining the manuscript. All authors read and approved the final manuscript.

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## ABSTRACT

The avian survey conducted along the Adyar Riverbank (Manapakkam) from January 2023 to December 2023 documented a total of 3120 individual birds across 75 species from 16 avian orders, highlighting the significant biodiversity within this urban ecosystem. This study aimed to assess seasonal variations in bird diversity and abundance, emphasizing the river's role as an

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important habitat. The highest diversity was observed during winter, specifically in February 2023, with a diversity index of 296.80 and a Simpson's index of 0.22. A total of 36 species and 636 individuals were recorded. In contrast, the lowest diversity was observed in summer, particularly in July 2023, with a diversity index of 29.29 and a Simpson's index of 0.05, corresponding to 18 species and 114 individuals. The monsoon and post-monsoon periods exhibited a prominent increase in diversity due to the arrival of migratory species and improved habitat conditions. Important species recorded throughout the year included the Paddy Field Pipit, House Crow, and Rufous Treepie, while conservation-significant species such as the Black-headed Ibis and Spot-billed Pelican were also observed. Thus, the present study underscores the Adyar River's ecological importance and highlights the need for continuous monitoring and targeted conservation efforts to maintain avian biodiversity in urban river ecosystems.

**Keywords:** *Adyar Riverbank; avian biodiversity; urban ecology; migratory birds; threatened species; conservation.*

## 1. INTRODUCTION

The Adyar River, a significant urban waterway flowing through Chennai, serves as a critical ecological corridor in an area undergoing rapid urbanization. Though there are considerable anthropogenic pressures that characterize the city, including industrial discharge, solid waste accumulation, and habitat fragmentation, yet the Adyar River and its surrounding habitats, such as wetlands, riparian zones, and open water bodies, remain vital for maintaining diverse avian communities. These habitats are increasingly noted for their role in sustaining urban biodiversity, providing essential resources and ecological services that contribute to the overall health and resilience of urban ecosystems [1-3].

Urban rivers like the Adyar offer unique shelters for bird species, acting as ecological lifelines amongst urban stretch. They support not only resident species but also migratory birds that rely on these habitats for stopover sites during their journeys. Recent studies highlight the importance of such urban green spaces in mitigating the effects of habitat loss and fragmentation, emphasizing their role in preserving biodiversity amidst cities [4,5]. Furthermore, the Adyar River's ability to support diverse avifauna, despite ongoing environmental degradation, underscores the flexibility of urban ecosystems and the critical need for their protection.

The degradation of the Adyar River due to pollution, encroachment, and alterations to its natural flow has led to significant changes in its ecological dynamics, affecting both water quality and habitat availability. These changes, in turn, influence avian community structure, species richness, and behaviour, making the bird diversity study along the riverbanks a priority for

urban conservation efforts [6,7]. Understanding these dynamics is crucial not only for assessing the current ecological health of the river but also for developing targeted conservation strategies that can enhance habitat quality and connectivity in urban landscapes [8-10].

This study aims to systematically document and analyse the avian diversity along the Adyar River's banks, focusing on seasonal dynamics linked with species composition, behaviours, and habitat preferences. By determining how birds interact with different habitat types within this urban river system, this study will provide valuable insights into the ecological functions of urban waterways and their role in supporting biodiversity. These findings will be instrumental in informing conservation strategies that aim to restore and protect the ecological integrity of the Adyar River, contributing to broader efforts to integrate biodiversity conservation into urban planning [11-13]. Additionally, this study will also address the need for more comprehensive urban biodiversity data, which is essential for effective management and policy-making in rapidly urbanizing regions.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

The present bird diversity survey was conducted along a 5-kilometer stretch of the Adyar River (approximately 13.011° N latitude and 80.191° E longitude) in Chennai, Tamil Nadu, India (Fig. 1). The point count method was employed to systematically document avian species and their distribution, a widely accepted technique for assessing bird populations and habitat associations [14]. This method was chosen for its effectiveness in providing detailed insights into

bird community structure and spatial distribution across varied habitats. The survey focused on riparian zones and adjacent urban areas along the riverbank, incorporating a range of habitats, including wetlands, open water bodies, and urban green spaces. These habitat types were selected to capture the diversity of avifauna that utilize different environmental features within the urban river system.

## 2.2 Survey Methodology

Point count method was established at 10-15 predetermined locations along the riverbank, spaced at least 200 meters apart to minimize overlap in observations and ensure independent data collection [15]. At each station, bird species seen or heard within a 50-100-meter radius were recorded over a 10-15-minute period. Observers also noted bird behaviours, habitat characteristics, and approximate distances from the observation point.

Surveys were conducted during peak bird activity times, such as early morning (06:30 hrs to 11:00

hrs) and late afternoon (16:00 hrs to 18:00 hrs) in order to maximize detection rates. Surveys were scheduled in such a way to avoid adverse weather conditions, such as heavy rainfall or strong winds, ensuring data reliability and consistency [16]. Observers recorded data in a field notebook and used a GPS device for precise location tracking. Photographic documentation was captured using a digital camera, and optionally bird calls were recorded with sound recording equipment when necessary for accurate species identification [17,18].

## 2.3 Equipment

Key field equipment included binoculars (8x42 magnification) for general bird observations and a spotting scope for identifying distant or small birds in more detail. A digital camera was used to document rare or cryptic species, while sound recording devices were employed optionally to capture bird calls, aiding in species identification when visual observations were unclear. GPS devices ensured accurate georeferencing of point count locations.

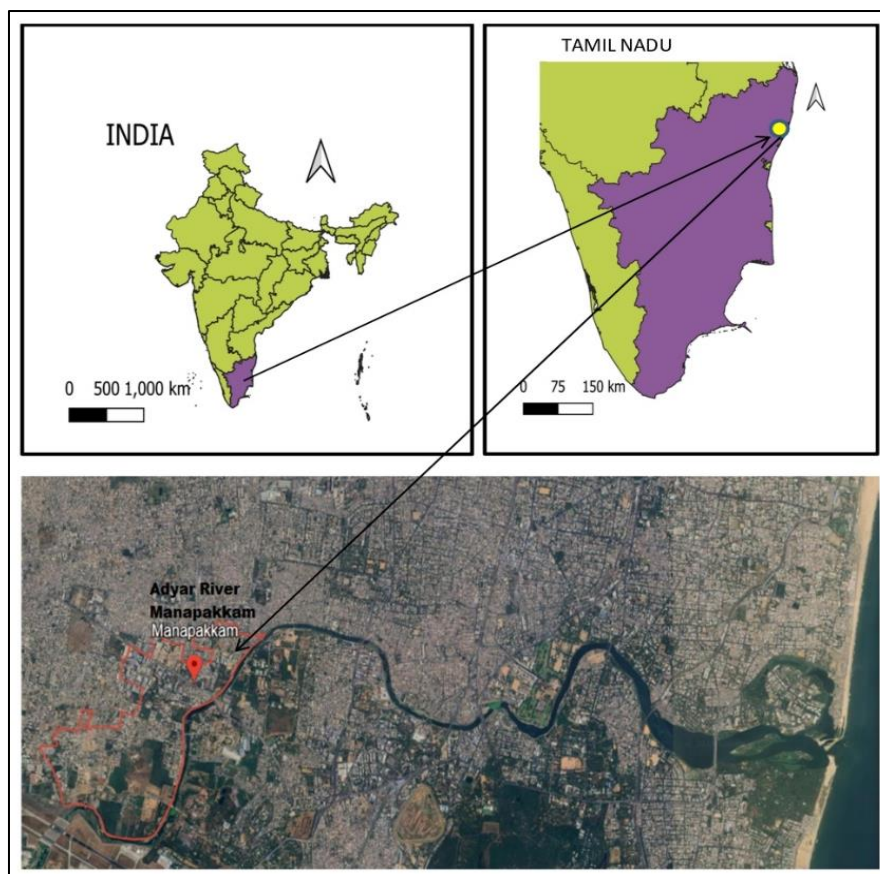


Fig. 1. The location map of Adyar River, Chennai, Tamil Nadu

## 2.4 Species Identification and Documentation

Bird species were identified using field guides [19] and avian databases. Identification was performed visually and acoustically, with special care taken to differentiate between species with similar appearances or calls. In cases where species identification was challenging, photographs or sound recordings were used for later confirmation.

## 2.5 Conservation-significant Species

Specific attention was given to the documentation of conservation-significant species, including those listed on the IUCN Red List [20], such as the Black-headed Ibis, Spot-billed Pelican, and Painted Stork. Their occurrence and habitat preferences were analysed to provide recommendations for conservation efforts focused on protecting critical habitats along the Adyar River.

## 2.6 Data Analysis

For data analysis, diversity metrics such as species richness (the total number of species recorded) and abundance (the total number of individuals observed) were calculated. The relationship between bird species and different habitat types was also explored to gain insights into habitat preferences and ecological significance [21,22]. Avian species were categorized into functional guilds, such as insectivores, piscivores, and omnivores, to analyze how these groups responded to specific habitat features along the river. Seasonal patterns were further examined by comparing species richness, Simpson's index and abundance across winter, summer, monsoon, and post-monsoon periods.

### Diversity index = $S-1/1nN$

S – Number of species

n - Total number of individual species

N – Total number of species

### Simpson's index (D):

$$D = \sum ni(ni-1)/N(N-1)$$

where:

$ni$  — Number of individuals in the  $i$ -th species; and

$N$  — Total number of individuals in the community.

## 3. RESULTS AND DISCUSSION

The avian survey conducted along the Adyar Riverbank from January 2023 to December 2023 recorded a total of 3120 individual birds across 75 species from 16 different avian orders, highlighting the significant biodiversity of this urban ecosystem (Table 1; Figs. 2 and 3). This richness, observed in a highly urbanized area, underscores the river's ecological importance and its role as a critical habitat among human-dominated landscapes. The results of the present study corroborate with earlier findings that highlights urban rivers as important biodiversity hotspots, essential for species adapted to altered environments [23,24].

The species abundance fluctuated throughout the year, revealing seasonal patterns in diversity in this area. For instance, the highest diversity of avian was recorded in winter, particularly in February 2023, with a diversity index of 296.80 and Simpson's index 0.22. This peak included 36 species and 636 individual birds (Table 2). Winter, being a very vital season for many migratory species, that use the Adyar River as a stopover or wintering ground. Migratory species such as the Western Yellow Wagtail (*Motacilla flava*, Order Passeriformes), Citrine Wagtail (*Motacilla citreola*, Order Passeriformes), and Blue-tailed Bee-eater (*Merops philippinus*, Order Coraciiformes) were prominently recorded during this time. In addition, the survey also documented 36 individuals from these migratory species such as Barn Swallow (*Hirundo rustica*), Green Sandpiper (*Tringa ochropus*) and Western Yellow Wagtail (*Motacilla flava*) emphasizing the river's role in facilitating seasonal migrations (Fig. 4). This aligns with earlier research highlighting the significance of urban rivers as ecological corridors for migratory birds [25,26].

In contrast, the lowest diversity was recorded in summer, specifically in July 2023, with a diversity index of 29.29 and Simpson's index 0.05, corresponding to 18 species and 114 individual birds (Table 2). This sharp decline in both species richness and abundance during this specific period may be attributed to the severe environmental conditions, such as high temperatures and reduced water availability, which likely resulted in reduced habitat suitability for both resident and migratory species.

Interestingly, the summer period also recorded low numbers of water birds and insectivores, suggesting that the seasonal drying of the river may limit food resources and habitat availability for these guilds. Resident species like the Pacific golden plover

(*Pluvialis fulva*), House Crow (*Corvus splendens*) and Rose ringed parakeet (*Psittacula krameri*) remained abundant throughout the year, demonstrating their adaptability to seasonal changes in habitat conditions.

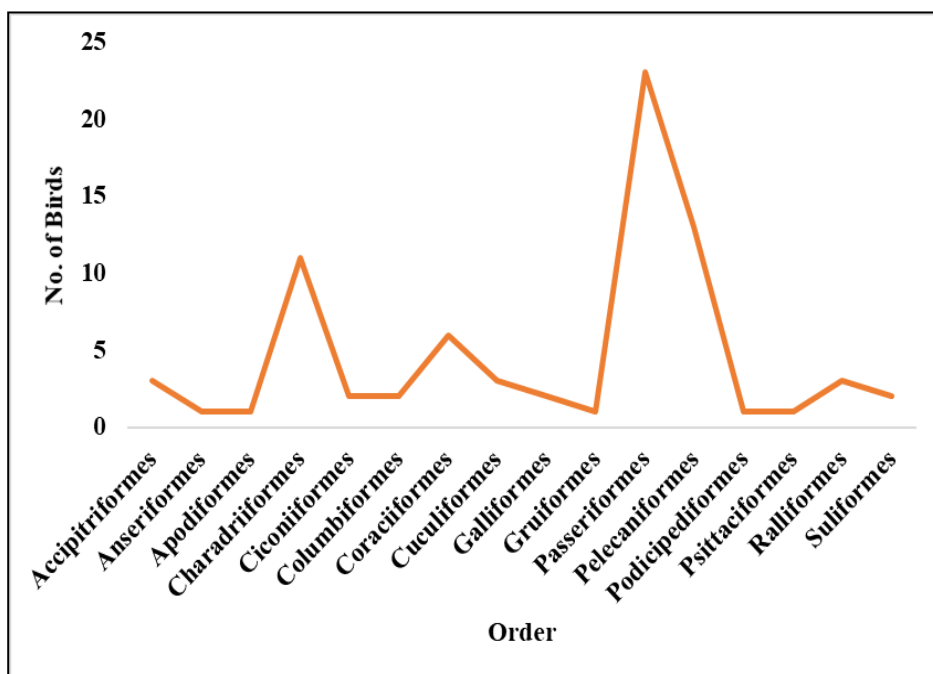


Fig. 2. Number of bird species in different orders observed in the Adyar River, Chennai, Tamil Nadu

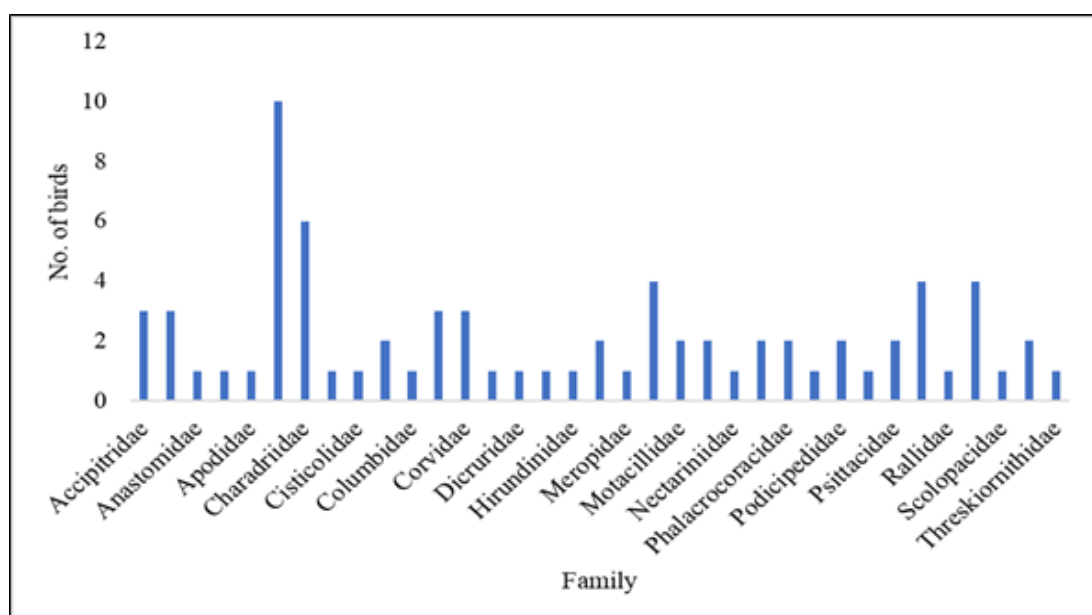
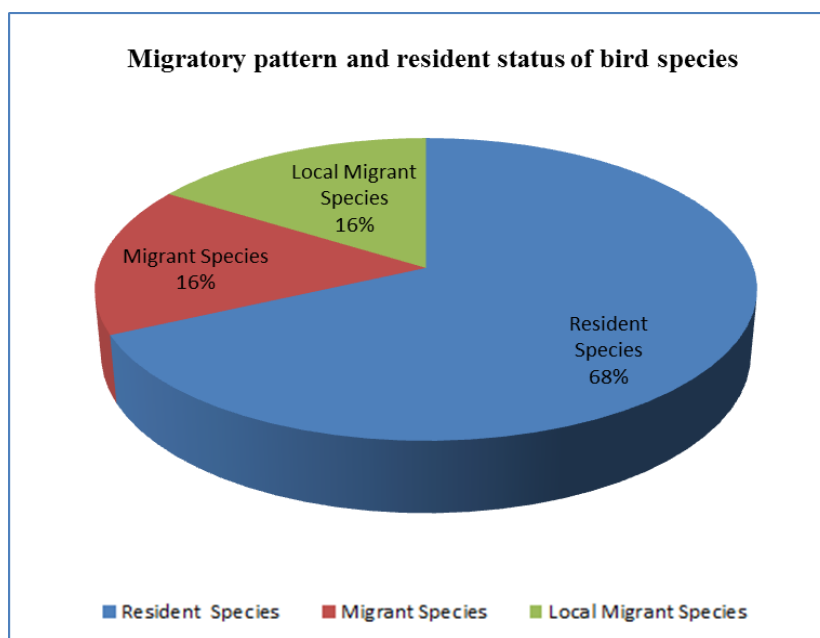
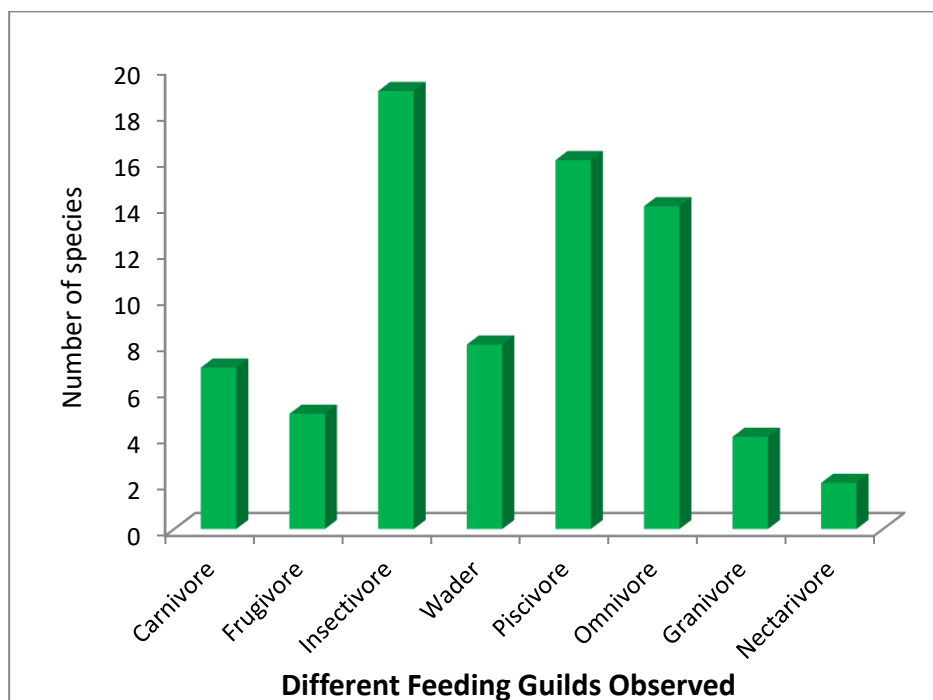


Fig. 3. Number of bird species in different families observed in the Adyar River, Chennai, Tamil Nadu



**Fig. 4. A comprehensive view of the avian diversity in relation to their migratory patterns and residency status**



**Fig. 5. Species richness in different feeding guilds of birds observed in Adyar River, Chennai, Tamil Nadu**

During the monsoon and post-monsoon months (August to November), the diversity and abundance of birds exhibited a clear retrieval. An increase in the diversity index was observed in August, with a score of 83.44 and Simpson's index is 0.32, despite fewer total individuals,

indicating an influx of different species (Table 2). This is because of the arrival of early migrants and the recovery of the river's wetlands after the monsoon rains, which create favorable feeding conditions for species like waders and shorebirds. 190 individuals of the Black-winged

Stilt (*Himantopus himantopus*, Order Charadriiformes) and 305 individuals of the Western Cattle Egret (*Bubulcus ibis*, Order Pelecaniformes) were found to be present during this period. These species depend on the flooded wetlands for foraging, emphasizing the river's importance as a seasonal habitat for water-dependent species. In addition, the

presence of piscivores like the Indian Cormorant (*Phalacrocorax fuscicollis*, Order Suliformes) and Spot-billed Pelican (*Pelecanus philippensis*, Order Pelecaniformes) further provides insights on the river's role in supporting species that rely on aquatic prey during the post-monsoon months when fish populations prosper (Fig. 5).

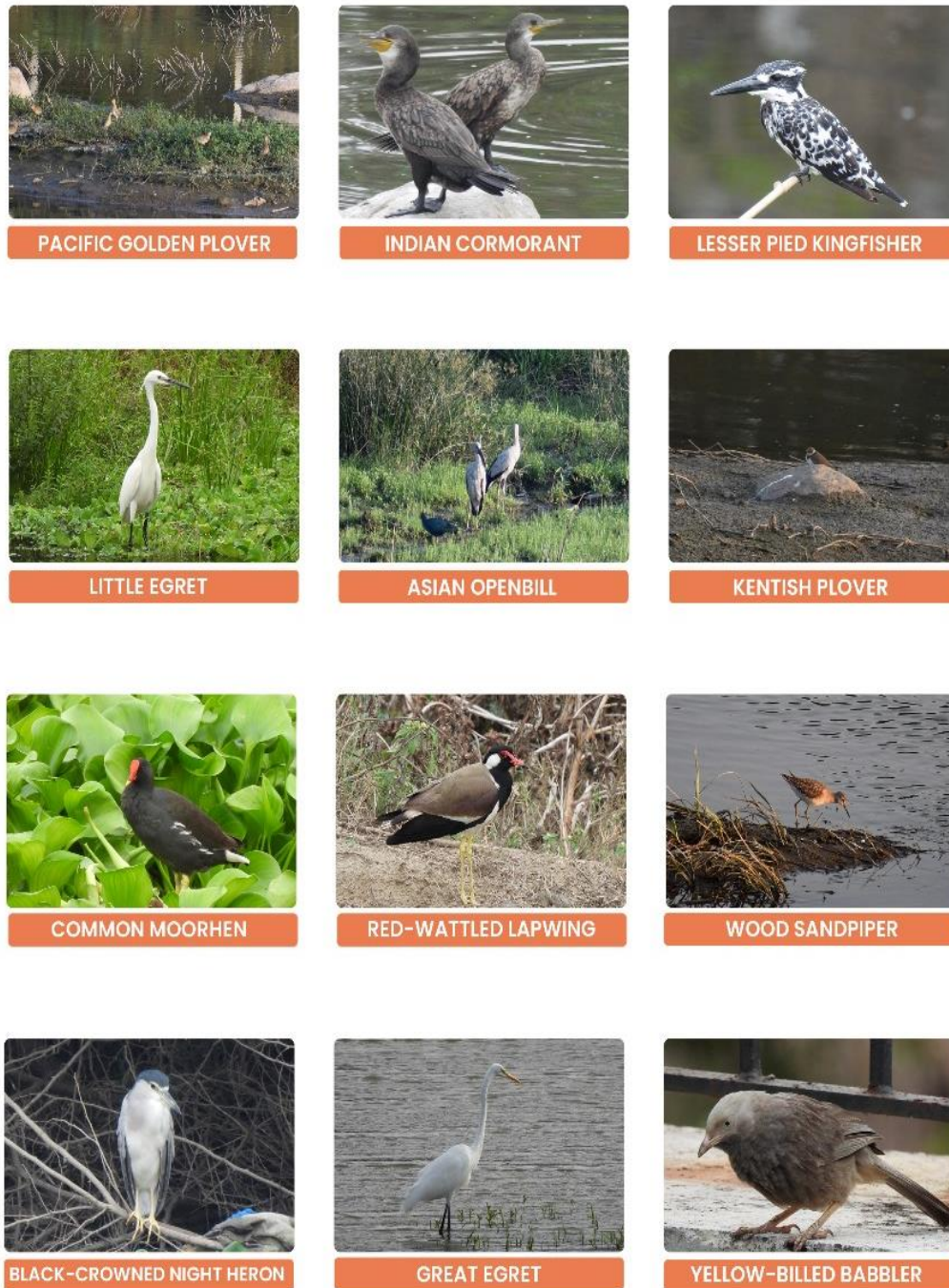


Image 1. Photograph of birds observed in study area

**Table 1. Avian species count along the Adyar Riverbank from January 2023 to December 2023**

S.NO	Species Name	Scientific Name	Jan 2023 to Dec 2023	Guild Membership	Residing status
1	Ashy Prinia	<i>Prinia socialis</i>	4	Insectivore (foliage gleaner)	Resident
2	Asian Green Bee Eater	<i>Merops orientalis</i>	2	Insectivore (aerial forager)	Resident
3	Asian Koel	<i>Eudynamys scolopaceus</i>	11	Frugivore	Resident (local migrant)
4	Asian Openbill	<i>Anastomus oscitans</i>	72	Carnivore (molluscivore)	Resident (local migrant)
5	Asian Palm Swift	<i>Cypsiurus balasiensis</i>	99	Insectivore (aerial forager)	Resident
6	Barn Swallow	<i>Hirundo rustica</i>	132	Insectivore (aerial forager)	Long-distance migrant
7	Black Drongo	<i>Dicrurus macrocercus</i>	31	Insectivore (aerial forager)	Resident
8	Black Kite	<i>Milvus migrans</i>	10	Carnivore (scavenger)	Resident
9	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	6	Carnivore (piscivore)	Resident
10	Black-headed Ibis	<i>Threskiornis melanocephalus</i>	1	Carnivore (insectivore/piscivore)	Resident (local migrant)
11	Black-winged Stilt	<i>Himantopus himantopus</i>	190	Insectivore (wader)	Resident (local migrant)
12	Blue-tailed Bee-Eater	<i>Merops philippinus</i>	33	Insectivore (aerial forager)	Local migrant
13	Booted Eagle	<i>Hieraaetus pennatus</i>	1	Carnivore (raptor)	Long-distance migrant
14	Western Cattle Egret	<i>Bulbulcus ibis</i>	305	Insectivore (ground forager)	Resident (local migrant)
15	Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i>	2	Carnivore (piscivore)	Resident
16	Citrine Wagtail	<i>Motacilla citreola</i>	2	Insectivore (ground forager)	Long-distance migrant
17	Common Kingfisher	<i>Alcedo atthis</i>	18	Carnivore (piscivore)	Resident
18	Common Myna	<i>Acridotheres tristis</i>	86	Omnivore	Resident
19	Common Sandpiper	<i>Tringa Hypoleucos</i>	3	Insectivore (wader)	Long-distance migrant
20	Common Tailorbird	<i>Orthotomus sutorius</i>	4	Insectivore (foliage gleaner)	Resident
21	Euraian Moorhen	<i>Gallinula chloropus</i>	14	Omnivore	Resident (local



S.NO	Species Name	Scientific Name	Jan 2023 to Dec 2023	Guild Membership	Residing status
22	Eurasian Coot	<i>Fulica atra</i>	1	Omnivore	migrant) Local migrant
23	Glossy Ibis	<i>Plegadis falcinellus</i>	4	Carnivore (insectivore)	Long-distance migrant
24	Gray Francolin	<i>Ortygornis pondicerianus</i>	2	Omnivore	Resident
25	Gray Heron	<i>Ardea cinerea</i>	8	Carnivore (piscivore)	Resident
26	Gray-headed Lapwing	<i>Vanellus cinereus</i>	24	Insectivore (wader)	Long-distance migrant
27	Gray-headed Swamp hen	<i>Porphyrio poliocephalus</i>	15	Omnivore	Resident
28	Great Egret	<i>Ardea alba</i>	12	Carnivore (piscivore)	Resident (local migrant)
29	Greater Coucal	<i>Centropus sinensis</i>	15	Omnivore	Resident
30	Green Sandpiper	<i>Tringa ochropus</i>	2	Insectivore (wader)	Long-distance migrant
31	House Crow	<i>Corvus splendens</i>	380	Omnivore (scavenger)	Resident
32	House Sparrow	<i>Passer domesticus</i>	8	Omnivore	Resident
33	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	3	Carnivore (piscivore)	Resident
34	Indian Paradise-Flycatcher	<i>Terpsiphone paradisi</i>	2	Insectivore (aerial forager)	Local migrant
35	Indian Peafowl	<i>Pavo cristatus</i>	2	Omnivore	Resident
36	Indian Pond-Heron	<i>Ardeola grayii</i>	124	Carnivore (piscivore)	Resident
37	Indian Roller	<i>Coracias benghalensis</i>	1	Insectivore (ground forager)	Resident
38	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	14	Omnivore (dabbling duck)	Resident
39	Kentish Plover	<i>Anarhynchus alexandrinus</i>	8	Insectivore (wader)	Local migrant
40	Large-billed Crow	<i>Corvus macrorhynchos</i>	69	Omnivore (scavenger)	Resident
41	Lesser Cuckoo	<i>Cuculus poliocephalus</i>	7	Insectivore (brood parasite)	Long-distance migrant
42	Little Cormorant	<i>Microcarbo niger</i>	59	Carnivore (piscivore)	Resident
43	Little Egret	<i>Egretta garzetta</i>	27	Carnivore (piscivore)	Resident
44	Little Grebe	<i>Tachybaptus ruficollis</i>	5	Carnivore (piscivore)	Resident
45	Little Ringed Plover	<i>Charadrius dubius</i>	21	Insectivore (wader)	Local migrant
46	Little Stint	<i>Calidris minuta</i>	17	Insectivore (wader)	Long-distance migrant
47	Medium Egret	<i>Ardea intermedia</i>	4	Carnivore (piscivore)	Resident

S.NO	Species Name	Scientific Name	Jan 2023 to Dec 2023	Guild Membership	Residing status
48	Oriental Magpie-Robin	<i>Copsychus saularis</i>	1	Insectivore (ground forager)	Resident
49	Pacific Golden-Plover	<i>Pluvialis fulva</i>	383	Insectivore (wader)	Long-distance migrant
50	Paddy-field pipit	<i>Anthus rufulus</i>	1	Insectivore (ground forager)	Resident
51	Painted Stork	<i>Mycteria leucocephala</i>	3	Carnivore (piscivore)	Resident
52	Pied Bush chat	<i>Saxicola caprata</i>	3	Insectivore (ground forager)	Resident
53	Pied Kingfisher	<i>Ceryle rudis</i>	25	Carnivore (piscivore)	Resident
54	Plain Prinia	<i>Prinia inornata</i>	2	Insectivore (foliage gleaner)	Resident
55	Purple Heron	<i>Ardea purpurea</i>	8	Carnivore (piscivore)	Resident
56	Purple Sunbird	<i>Cinnyris asiaticus</i>	8	Nectarivore/Insectivore	Resident
57	Purple-rumped Sunbird	<i>Leptocoma zeylonica</i>	5	Nectarivore/Insectivore	Resident
58	Red-vented Bulbul	<i>Pyconotus cafer</i>	13	Frugivore/Insectivore	Resident
59	Red-wattled Lapwing	<i>Vanellus indicus</i>	159	Insectivore (ground forager)	Resident
60	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	1	Frugivore/Insectivore	Resident
61	Rock Pigeon	<i>Columba livia</i>	136	Granivore	Resident
62	Rose-ringed Parakeet	<i>Psittacula krameri</i>	340	Granivore/Frugivore	Resident
63	Rufous Treepie	<i>Dendrocitta vagabunda</i>	9	Omnivore	Resident
64	Scaly-breasted Munia	<i>Lonchura punctulata</i>	8	Granivore	Resident
65	Shikra	<i>Accipiter badius</i>	1	Carnivore (raptor)	Resident
66	Spot-billed Pelican	<i>Pelecanus philippensis</i>	22	Carnivore (piscivore)	Resident
67	Spotted Dove	<i>Spilopelia chinensis</i>	3	Granivore/Frugivore	Resident
68	Striated Heron	<i>Butorides striata</i>	2	Carnivore	Resident
69	Western Yellow Wagtail	<i>Motacilla flava</i>	6	Insectivore	Migrant
70	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	1	Omnivore	Resident
71	White-browed Wagtail	<i>Motacilla moderaspatensis</i>	6	Insectivore	Resident
72	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	13	Carnivore	Resident
73	Wood Sandpiper	<i>Tringa glareola</i>	29	Carnivore/Insectivore	Migrant
74	Yellow-billed Babbler	<i>Argya affinis</i>	61	Omnivore	Resident
75	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i>	11	Insectivore	Resident
<b>Total Number of Species</b>			<b>3120</b>		

**Table 2. Diversity of bird species in Adyar riverbank (Manapakkam) from January 2023 to December 2023**

S.No	Month	Number of species (S)	Total number of birds (N)	Total number of individual species (n)	Diversity Index = $S-1/1n N$	Simpson index D
1	January 2023	32	368	75	152.11	0.17
2	February 2023	36	636	75	296.80	0.22
3	March 2023	23	295	75	86.53	0.09
4	April 2023	36	348	75	162.40	0.22
5	May 2023	36	321	75	155.73	0.22
6	June 2023	26	153	75	50.99	0.11
7	July 2023	18	114	75	29.29	0.05
8	August 2023	43	149	75	83.44	0.32
9	September 2023	26	197	75	65.66	0.11
10	October 2023	21	108	75	28.80	0.07
11	November 2023	28	224	75	81.36	0.13
12	December 2023	34	207	75	91.08	0.20

Among the species recorded year-round, the most abundant were the Pacific golden plover (*Pluvialis fulva*, Order Charadriiformes) with 383 individuals, the House Crow (*Corvus splendens*, Order Passeriformes) with 380 individuals, and the Rose ringed parakeet (*Psittacula krameri*, Order Psittaciformes) with 340 individuals. These species, mostly belong to the Order Passeriformes, are highly adapted to urban environments and are able to demonstrate generalist feeding habits. Their abundance across all seasons illustrates the adaptability of these omnivorous species, which can exploit a wide range of resources, from insects to human-generated waste. Moreover, omnivores like the Common Myna (*Acridotheres tristis*, Order Passeriformes) and House Crow dominated urban settings, consistent with previous studies wherein urban ecosystems favored species with flexible diets [27,28].

In addition, 19 Insectivores species, was found to possess dominant feeding guild in this chosen ecosystem, with species including the Ashy Prinia (*Prinia socialis*, Order Passeriformes), Barn Swallow (*Hirundo rustica*, Order Passeriformes), and Asian Green Bee-eater (*Merops orientalis*, Order Coraciiformes). Interestingly, these insectivores showed higher numbers during the monsoon and post-monsoon periods when insect populations peak, providing abundant food resources. The riverbank also supported piscivorous species like the Little Cormorant (*Microcarbo niger*, Order Suliformes) and White-throated Kingfisher (*Halcyon smyrnensis*, Order Coraciiformes), which were particularly active during the wet season when

fish populations were most accessible (Fig. 5). Furthermore, as earlier research on sub-Himalayan wetlands have shown, evaluating the biotic health of aquatic ecosystems requires an understanding of guild structures and niche features. This kind of data makes it easier to understand how various species exchange resources, interact with their surroundings, and preserve the equilibrium of ecosystems. More efficient conservation techniques to preserve ecosystem functionality and conserve biodiversity can be created by looking into these aspects of wetland ecosystems. These methods are essential for other habitats, such as the Adyar River, where thorough guild and niche assessments could greatly aid in conservation planning, in addition to wetlands in the sub-Himalayan region [29].

The survey further highlighted conservation-significant species listed on the IUCN Red List, such as the Black-headed Ibis (*Threskiornis melanocephalus*, Order Pelecaniformes), Spot-billed Pelican (*Pelecanus philippensis*, Order Pelecaniformes), and Painted Stork (*Mycteria leucocephala*, Order Ciconiiformes) (Fig. 4). The presence of these near-threatened species underscores the ecological value of the Adyar River, particularly during the monsoon and post-monsoon seasons when wetland conditions are ideal. Despite being surrounded by an urban matrix, the river continues to offer major habitats for both common and rare species, illustrating the resilience of urban ecosystems when appropriate conservation efforts are applied [30,31].

Overall, the seasonal fluctuations in bird diversity along the Adyar Riverbank emphasize the dynamic nature of this urban ecosystem. The wet season, from August to November, plays a vital role in supporting migratory species, waders, and piscivores, while winter months are important for both resident and migratory species. Summer season presents challenges for bird populations due to habitat and resource scarcity, but resilient species such as the House Crow and Rufous Treepie persist throughout. These findings highlight the importance of continuous monitoring and seasonal management strategies to maintain and enhance avian biodiversity in urban river ecosystems like the Adyar River.

#### 4. CONCLUSION

In conclusion, the Adyar Riverbank's avian diversity and abundance highlight its vital role in Chennai's urban ecosystem. The dynamic nature of bird communities influenced by factors such as resource availability and migration patterns, calls for ongoing monitoring and conservation efforts. Ensuring the preservation of this urban waterway is essential for maintaining its ecological integrity and supporting the diverse birdlife it sustains. This study contributes valuable insights into urban avian biodiversity and underscores the need for continued efforts to protect and manage these vital urban habitats.

#### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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