



Original Research

# Waterbird Assemblage Structure, Seasonal Dynamics and Anthropogenic Pressures in Sengulam Lake, An Urban Wetland of the Noyyal River Basin, South India

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## Abstract

Urban wetlands are increasingly threatened by pollution, habitat modification, and unregulated human activities, despite supporting significant avifaunal diversity. This study assessed the waterbird assemblage structure and anthropogenic pressures in Sengulam Lake, an urban wetland in Coimbatore within the Noyyal River basin, south India (March 2025 to February 2026), using vantage point count method. A total of 151 avian species belonging to 19 orders and 56 families were recorded. Passeriformes was the dominant order (57 species), while Ardeidae was the dominant family (11 species). The resident species predominated (110 species), followed by winter visitors (36 species) and local migrants (5 species). The assemblage was largely composed of Least Concern species (148 species), with two Near Threatened species - Indian Roller *Coracias benghalensis* and Asian Woollyneck *Ciconia episcopus*, and one Vulnerable species River Tern *Sterna aurantia*. Carnivorous and omnivorous birds formed the dominant feeding guilds throughout the study period. Species richness (119 species) and abundance (1676 individuals) were the highest in December. Shannon diversity remained consistently high (3.16–3.80), with low Simpson's dominance values (0.038–0.090), indicating the absence of strong dominance by any single species. Temporal beta diversity ( $\beta$ SOR = 0.634) was mainly driven by species turnover ( $\beta$ SIM = 0.476). Major threats were sewage inflow, solid waste dumping, water hyacinth invasion, recreational disturbance, stray dogs, and habitat alteration. These pressures affected multiple avifaunal guilds through habitat degradation, altered foraging behaviour, and displacement. The study highlights the need for sewage management, invasive species control, and shoreline protection, thereby emphasising the conservation importance of Sengulam Lake.

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**Statement of Sustainability:** Sengulam Lake functions as an important urban wetland within the Noyyal basin by sustaining diverse avifaunal assemblages despite increasing anthropogenic pressures from sewage inflow, invasive vegetation, habitat alteration, and recreational disturbance. The study documents seasonal changes in bird diversity, feeding guild structure, and habitat use in relation to fluctuating wetland conditions and localized impacts of human activities. The findings highlight the ecological importance of small urban wetlands and provide baseline information relevant to urban wetland monitoring, wastewater management, habitat restoration, biodiversity conservation, and environmentally sustainable city planning.



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## 1. Introduction

Globally, urbanization is reshaping landscapes, hydrological systems, and ecological communities at unprecedented rates (Seto et al., 2012). Current projections indicate that nearly 68% of the world's population will reside in urban areas by 2050 (UNDESA, 2018). Among the ecosystems most vulnerable to this expansion are wetlands, which have historically been perceived as expendable spaces for urban growth and economic development (Kenmegne et al., 2025). Consequently, urban wetlands have undergone extensive drainage, reclamation, fragmentation, and pollution, leading to significant losses in biodiversity and ecosystem functionality (Nguyen et al., 2023).

Despite these anthropogenic threats, wetlands remain among the most productive ecosystems on Earth and provide essential ecological services that sustain urban resilience and human well-being (Xu et al., 2019). Wetlands function as natural hydrological buffers by regulating floods, recharging groundwater, stabilizing shorelines, and moderating local climatic conditions (Mathibalan et al., 2026). They also facilitate nutrient cycling, carbon sequestration, natural sewage treatment, and fish production through complex biogeochemical processes (Adhurya et al., 2018). Because of these ecosystem services, wetland conservation has become closely aligned with several Sustainable Development Goals (SDGs), particularly SDG-6 (Clean Water and Sanitation), SDG-11 (Sustainable Cities and Communities), SDG-13 (Climate Action), and SDG-14 (Life Below Water) (Ramsar Convention Secretariat, 2018).

Urban wetlands, described as “kidneys of the landscape” (Mitsch and Gosselink, 2015), in developing countries, particularly in India, are experiencing rapid ecological degradation due to untreated sewage discharge, encroachment, eutrophication, invasive species proliferation, solid waste accumulation, and hydrological alterations (Jena et al., 2025). The ecological consequences of these disturbances are profound, often resulting in habitat simplification and declining biodiversity (Sauer and Chang, 2023; Vadrevu et al., 2023). Yet, there remains a substantial knowledge gap regarding long-term ecological monitoring of urban wetlands (Naveen Kumar et al., 2025) and the responses of faunal communities to anthropogenic pressures (Byju et al., 2024a). Therefore, systematic ecological assessments are important to understand ecosystem health, identify conservation priorities, and formulate science-based management strategies for wetland sustainability (Byju et al., 2025a).

Among wetland-dependent organisms, waterbirds are widely recognized as reliable ecological indicators of habitat quality and environmental change (Ogden et al. 2014). Waterbirds occupy multiple trophic levels and ecological guilds, thereby reflecting the functional complexity of aquatic ecosystems. Changes in waterbird abundance, diversity, and feeding guild structure can therefore provide early warning signals of habitat degradation, eutrophication, and ecological imbalance (Byju et al., 2024b). Urban development often exerts strong ecological filtering on avian assemblages, favouring habitat generalists and human-adapted species while eliminating specialists dependent on intact wetland habitats. This process, commonly termed “taxonomic homogenization”, is frequently characterized by the dominance of omnivorous and opportunistic species capable of exploiting anthropogenic food resources and disturbed habitats (Clergeau et al., 2006; Balfors et al., 2016).

Within this broader context, the wetlands of Coimbatore in Tamil Nadu represent a historically significant urban hydrological landscape. Located in the semi-arid rain-shadow region of the Western Ghats, Coimbatore has long depended on a network of interconnected wetlands associated with the Noyyal River basin. During the Kongu Chola period (8th–9th century CE), an intricate system of approximately 30 irrigation tanks and wetlands was engineered to harvest monsoonal runoff, regulate floodwaters, support irrigation, and recharge groundwater in a water-scarce environment. This traditional wetland network sustained agriculture, biodiversity, and human settlements for several centuries and exemplified an early model of integrated socio-ecological water management (ICID, 2022).

In recent decades, however, rapid urbanization and industrial expansion in Coimbatore have drastically altered the ecological integrity of these wetlands. Encroachments, sewage inflow, habitat fragmentation, and changing land-use patterns have transformed many wetlands into heavily modified urban ecosystems (Reginald et al., 2007; Raj et al., 2010). Among these, Sengulam Lake is a critical urban wetland that continues to support diverse avifaunal communities despite increasing anthropogenic pressures. The lake functions as an important habitat for resident and migratory waterbirds by providing feeding, roosting, and breeding grounds within an urban matrix. At the same time, its ecological condition reflects the cumulative impacts of urban development and changing hydrological regimes in Coimbatore city. Understanding the structure and dynamics of avian assemblages in Sengulam Lake is therefore essential for evaluating the ecological health of this urban wetland. Such studies are also crucial for identifying ecological thresholds, monitoring habitat quality, and developing evidence-based conservation strategies for urban wetlands under increasing developmental pressures (Kati and Sekericioglu, 2006).

The present study aims to investigate the avian assemblages and ecological significance of Sengulam Lake as an urban wetland ecosystem in Coimbatore. The specific objectives are: 1) to document the diversity, abundance, and seasonal distribution of waterbirds and associated avifauna in Sengulam Lake; 2) to analyze the feeding guild composition and habitat utilization patterns of bird communities in relation to wetland characteristics; 3) to assess the influence of anthropogenic disturbances and urbanization on avian assemblage structure and wetland ecological health. The study further highlights the ecological importance of Sengulam Lake as a refuge for resident and migratory waterbirds within an urban landscape and provides baseline scientific information for urban wetland conservation and sustainable management.

## 2. Materials and Methods

### 2.1. Study Area

Sengulam Lake ( $10^{\circ}57'09.8''\text{N}$   $76^{\circ}56'28.6''\text{E}$ , altitude 437 m MSL) is an urban wetland within the Coimbatore corporation limits, spanning an area of over ~93 hectares (Figure 1). The primary source of water to the lake is through channels from Thenkarai anaikut built across the river Noyyal. This lake has two non-functional irrigation outlets and two surplus ones to Kurichi lake and the other to Kumittipathi river. The latter acts as a river link barrage to connect the east-flowing Noyyal river to the west-flowing Kumittipathi river. The lake is surrounded by farmlands, residential areas and industries.

The lakebed vegetation was primarily composed of native species such as Babul *Acacia nilotica*, Sessile joyweed *Alternanthera sessilis*, Palmyra palm *Borassus flabellifer*, Indian mallow *Abutilon indicum*, Peepal *Ficus religiosa*, Banyan *Ficus benghalensis*, Portia *Thespesia populnea*, and Crown flower *Calotropis gigantea*. Freshwater sections of the lake supported patches of White-water lily *Nymphaea alba*, while the peripheries were dominated by reed vegetation. The surrounding landscape included plantations and agricultural fields consisting mainly of Coconut *Cocos nucifera*, Areca Palm *Areca catechu*, Teak *Tectona grandis*, vegetable gardens, and corn fields.

Several invasive and non-native plant species were also recorded in and around the lake, including Mesquite *Neltuma juliflora*, Water hyacinth *Pontederia crassipes*, Mexican prickly poppy *Argemone mexicana*, Congress grass *Parthenium hysterophorus*, Bush morning glory *Ipomoea carnea*, Siam weed *Chromolaena odorata*, and Turkey berry *Solanum torvum*. These species were particularly abundant along disturbed margins and shallow portions of the lakebed. The lake experiences both the south-west monsoon (June–August) and the north-east monsoon (October–December), with summer prevailing from March to May.

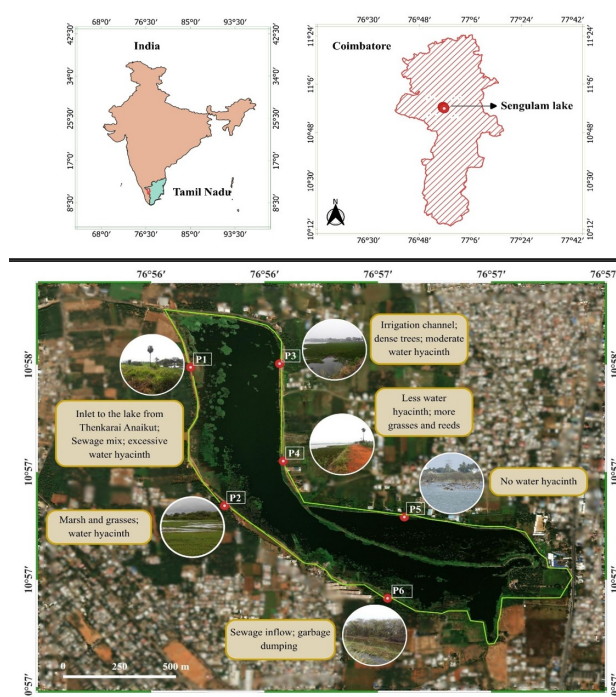


Figure 1. Map showing the Sengulam lake with vantage points and the respective habitat characteristics.

### 2.2. Data Collection

The bird survey was carried out from March 2025 to February 2026 with four observers. Twenty-four field visits were carried out, twice a month at fortnightly intervals. The birds were observed from 06.00–10.00 and 16.00–18.00 hours through direct visual count and by bird acoustics (Bibby et al., 2000). Acoustic detections were not treated as separate abundance counts, but only as confirmations of presence when species could not be clearly observed visually during some survey days. Birds were counted from six vantage points that were 400–800 m apart along the lake edge. To minimise double-counting between adjacent vantage points, bird movement, flock direction, and the timing of flights between points were carefully monitored. Observations were made through a Nikon Aculon Binocular ( $8 \times 42$ ), Pentax ( $12 \times 50$ ), Solognac ( $10 \times 50$ ), and photographs were taken using a Nikon P950, Nikon P900 and Canon 7D Mark II (150 to 600mm lens). Species that were in doubt in the field were later identified using the field guide (Grimmett et al, 2011). IUCN Red List status was followed according to the most recent update (IUCN, 2026). The feeding



guild data were taken from the literature (Ali and Ripley, 1987; Byju et al., 2024c).

### 2.3. Data Analysis

Species richness (S) was determined as the total number of species recorded each month and was assessed using the Shannon–Wiener diversity index ( $H'$ ), while community dominance was evaluated using Simpson’s dominance index (D). Species evenness was estimated using Pielou’s evenness index ( $J'$ ) (Shannon and Weaver, 1949; Pielou, 1966). Relative abundance (%) of feeding guilds was calculated as the percentage contribution of each guild to the total number of individuals recorded per month.

Temporal patterns in community composition were further evaluated through beta diversity partitioning using the *betapart* and *vegan* R packages. Total beta diversity was partitioned into turnover and nestedness components following the Sørensen dissimilarity framework, where turnover represented species replacement between sampling periods and nestedness reflected differences associated with species loss or gain (Baselga, 2010). Sampling adequacy was evaluated using a species accumulation curve and non-parametric Chao1 richness estimator (Chao, 1984) using the R package *vegan* (Oksanen et al., 2024). Statistical analysis was carried out using R version 4.5.1 (R Core Team, 2026).

### 2.4. Threat Analysis

Threats observed in all the months were categorized into major classes, including pollution, biological disturbance, invasive species, habitat modification, hydrological variation, human disturbance, resource exploitation, and grazing pressure. For each threat, the affected bird guilds, type of behavioural response, probable ecological mechanism, and potential ecological consequences were qualitatively assessed based on direct field observations and habitat conditions.

## 3. Results

A total of 151 avifaunal species belonging to 19 orders and 56 families were recorded during the study. Passeriformes was the most species-rich order, contributing 57 species, followed by Charadriiformes (19 species) and Pelecaniformes (14 species). Among families, Ardeidae was the dominant family with 11 species, followed by Scolopacidae (9 species).

Conservation status assessment showed that the assemblage was dominated by Least Concern species (148 species), with two Near Threatened species Indian Roller *Coracias benghalensis*, Asian Woollyneck *Ciconia episcopus* and one Vulnerable species River Tern *Sterna aurantia*. Based on residential status, resident species were predominant (110 species), followed by winter visitors (36 species) and local migrants (5 species) (Table 1).

Total abundance varied markedly across months, ranging from 469 individuals in March 2025 to 1676 in December 2025. Species richness fluctuated between 60 (July 2025) and 119 (December 2025) species. Shannon diversity ( $H'$ ) ranged from 3.16 (September 2025) to 3.80 (December 2025), indicating high diversity throughout the study period. Evenness ( $J'$ ) values ranged from 0.739 to 0.855, indicating a relatively uniform distribution of individuals among species throughout the study period (Figure 2). Simpson’s dominance (D) remained low (0.038–0.090), suggesting the absence of strong dominance by any single species within the assemblage.

Temporal beta diversity of the bird assemblage was moderate ( $\beta_{SOR} = 0.634$ ), indicating variation in species composition across months. Turnover ( $\beta_{SIM} = 0.476$ ) contributed more to total beta diversity than nestedness ( $\beta_{SNE} = 0.159$ ).

The Chao1 estimator predicted a true richness of 175.09 species, compared to the observed richness of 151 species, indicating that the survey captured a substantial proportion of the assemblage although some additional species may remain undetected. The species accumulation curve substantiated this with a rapid initial rise followed by clear deceleration, though it did not reach a complete asymptote (Figure 3).

Table 1. Checklist of avifauna recorded in Sengulam Lake with their IUCN, migratory status and feeding guilds .

Common Name	Scientific Name	IUCN Status	Migratory Status	Feeding Guild
Order: Anseriformes				
Family: Anatidae				
Lesser Whistling Duck	<i>Dendrocygna javanica</i>	LC	R	O
Knob-billed Duck	<i>Sarkidiornis melanotos</i>	LC	R	O
Cotton Pygmy Goose	<i>Nettapus coromandelianus</i>	LC	WV	O
Garganey	<i>Spatula querquedula</i>	LC	WV	O
Northern Shoveler	<i>Spatula clypeata</i>	LC	WV	O
Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	LC	R	O
Northern Pintail	<i>Anas acuta</i>	LC	WV	O
Order: Galliformes				
Family: Phasianidae				
Indian Peafowl	<i>Pavo cristatus</i>	LC	R	O

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Table 1. continued...

Gray Francolin	<i>Ortygornis pondicerianus</i>	LC	R	G
Order: Podicipediformes				
Family: Podicipedidae				
Little Grebe	<i>Tachybaptus ruficollis</i>	LC	R	C
Order: Columbiformes				
Family: Columbidae				
Rock Pigeon	<i>Columba livia</i>	LC	R	G
Eurasian Collared Dove	<i>Streptopelia decaocto</i>	LC	R	G
Spotted Dove	<i>Spilopelia chinensis</i>	LC	R	G
Order: Cuculiformes				
Family: Cuculidae				
Greater Coucal	<i>Centropus sinensis parroti</i>	LC	R	C
Blue-faced Malkoha	<i>Phaenicophaeus viridirostris</i>	LC	R	I
Pied Cuckoo	<i>Clamator jacobinus</i>	LC	R	I
Asian Koel	<i>Eudynamis scolopaceus</i>	LC	R	O
Grey-bellied Cuckoo	<i>Cacomantis passerinus</i>	LC	R	I
Common Hawk-Cuckoo	<i>Hierococcyx varius</i>	LC	R	I
Common Cuckoo	<i>Cuculus canorus</i>	LC	WV	I
Order: Caprimulgiformes				
Family: Caprimulgidae				
Jerdon's Nightjar	<i>Caprimulgus atripennis</i>	LC	R	I
Order: Apodiformes				
Family: Apodidae				
Brown-backed Needle tail	<i>Hirundapus giganteus</i>	LC	R	I
Alpine Swift	<i>Tachymarptis melba</i>	LC	R	I
Asian Palm Swift	<i>Cypsiurus balasiensis</i>	LC	R	I
Order: Gruiformes				
Family: Rallidae				
Eurasian Moorhen	<i>Gallinula chloropus</i>	LC	R	C
Eurasian Coot	<i>Fulica atra</i>	LC	R	C
Gray-headed Swamphen	<i>Porphyrio poliocephalus</i>	LC	R	C
Watercock	<i>Gallinulex cinerea</i>	LC	R	C
White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	LC	R	C
Baillon's Crake	<i>Zapornia pusilla</i>	LC	WV	C
Ruddy-breasted Crake	<i>Zapornia fusca</i>	LC	R	C
Order: Charadriiformes				
Family: Recurvirostridae				
Black-winged Stilt	<i>Himantopus himantopus</i>	LC	R	I
Family: Charadriidae				
Little Ringed Plover	<i>Charadrius dubius</i>	LC	R	I
Red-wattled Lapwing	<i>Vanellus indicus</i>	LC	R	O
Family: Rostratulidae				
Greater Painted-Snipe	<i>Rostratula benghalensis</i>	LC	R	C
Family: Jacanidae				
Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i>	LC	R	C
Bronze-winged Jacana	<i>Metopidius indicus</i>	LC	R	C
Family: Scolopacidae				
Pin-tailed Snipe	<i>Gallinago stenura</i>	LC	WV	C
Common Snipe	<i>Gallinago gallinago</i>	LC	WV	C
Common Sandpiper	<i>Actitis hypoleucos</i>	LC	WV	C
Green Sandpiper	<i>Tringa ochropus</i>	LC	WV	C
Marsh Sandpiper	<i>Tringa stagnatilis</i>	LC	WV	C
Wood Sandpiper	<i>Tringa glareola</i>	LC	WV	C
Common Greenshank	<i>Tringa nebularia</i>	LC	WV	C
Temminck's Stint	<i>Calidris temminckii</i>	LC	WV	C
Little Stint	<i>Calidris minuta</i>	LC	WV	C
Family: Turnicidae				
Barred Buttonquail	<i>Turnix suscitator</i>	LC	R	C
Family: Laridae				
Gull-billed Tern	<i>Gelochelidon nilotica</i>	LC	WV	P/C
Whiskered Tern	<i>Chlidonias hybrida</i>	LC	WV	P/C
River Tern	<i>Sterna aurantia</i>	VU	R	P/C
Order: Ciconiiformes				
Family: Ciconiidae				
Asian Openbill	<i>Anastomus oscitans</i>	LC	R	C
Asian Woollyneck	<i>Ciconia episcopus</i>	NT	R	C

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Table 1. continued...

Painted Stork	<i>Mycteria leucocephala</i>	LC	R	C
Family: Anhingidae				
Oriental Darter	<i>Anhinga melanogaster</i>	LC	R	P/C
Family: Phalacrocoracidae				
Little Cormorant	<i>Microcarbo niger</i>	LC	R	P/C
Great Cormorant	<i>Phalacrocorax carbo</i>	LC	R	P/C
Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	LC	R	P/C
Order: Pelecaniformes				
Family: Ardeidae				
Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i>	LC	R	P/C
Yellow Bittern	<i>Ixobrychus sinensis</i>	LC	R	P/C
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	LC	R	P/C
Little Egret	<i>Egretta garzetta</i>	LC	R	P/C
Striated Heron	<i>Butorides striata</i>	LC	R	P/C
Indian Pond Heron	<i>Ardeola grayii</i>	LC	R	P/C
Eastern Cattle Egret	<i>Bubulcus coromandus</i>	LC	R	P/C
Great Egret	<i>Ardea alba</i>	LC	R	P/C
Medium Egret	<i>Ardea intermedia</i>	LC	R	P/C
Grey Heron	<i>Ardea cinerea</i>	LC	R	P/C
Purple Heron	<i>Ardea purpurea</i>	LC	R	P/C
Family: Threskiornithidae				
Glossy Ibis	<i>Plegadis falcinellus</i>	LC	R	C
Black-headed Ibis	<i>Threskiornis melanocephalus</i>	LC	R	C
Eurasian Spoonbill	<i>Platalea leucorodia</i>	LC	R	C
Order: Accipitriformes				
Family: Pandionidae				
Oriental Honey Buzzard	<i>Pernis ptilorhynchus</i>	LC	R	C
Booted Eagle	<i>Hieraetus pennatus</i>	LC	WV	C
Western Marsh Harrier	<i>Circus aeruginosus</i>	LC	WV	C
Shikra	<i>Accipiter badius</i>	LC	R	C
Black Kite	<i>Milvus migrans</i>	LC	R	C
Brahminy Kite	<i>Haliastur indus</i>	LC	R	C
Order: Strigiformes				
Family: Strigidae				
Spotted Owlet	<i>Athene brama</i>	LC	R	C
Order: Bucerotiformes				
Family: Upupidae				
Eurasian Hoopoe	<i>Upupa epops</i>	LC	R	I
Family: Bucerotidae				
Indian Grey Hornbill	<i>Ocyeros birostris</i>	LC	R	O
Order: Coraciiformes				
Family: Alcedinidae				
Common Kingfisher	<i>Alcedo atthis</i>	LC	R	P/C
Stork-billed Kingfisher	<i>Pelargopsis capensis</i>	LC	R	P/C
White-throated Kingfisher	<i>Halcyon smyrnensis</i>	LC	R	P/C
Pied Kingfisher	<i>Ceryle rudis</i>	LC	R	P/C
Family: Meropidae				
Asian Green Bee-eater	<i>Merops orientalis</i>	LC	R	I
Blue-tailed Bee-eater	<i>Merops philippinus</i>	LC	LM	I
Family: Coraciidae				
Indian Roller	<i>Coracias benghalensis</i>	NT	R	I
Order: Piciformes				
Family: Megalaimidae				
Coppersmith Barbet	<i>Psilopogon haemacephalus</i>	LC	R	O
White-cheeked Barbet	<i>Psilopogon viridis</i>	LC	R	O
Family: Picidae				
Black-rumped Flameback	<i>Dinopium benghalense</i>	LC	R	I
Order: Falconiformes				
Family: Falconidae				
Eurasian Kestrel	<i>Falco tinnunculus</i>	LC	WV	C
Peregrine Falcon	<i>Falco peregrinus peregrinator</i>	LC	R	C
Order: Psittaciformes				
Family: Psittacidae				
Rose-ringed Parakeet	<i>Psittacula krameri</i>	LC	R	F
Plum-headed Parakeet	<i>Psittacula cyanocephala</i>	LC	R	F
Order: Passeriformes				

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Table 1. continued...

Family: Pittidae				
Indian Pitta	<i>Pitta brachyura</i>	LC	LM	I
Family: Oriolidae				
Indian Golden Oriole	<i>Oriolus kundoo</i>	LC	LM	O
Family: Artamidae				
Ashy Woodswallow	<i>Artamus fuscus</i>	LC	R	I
Family: Vanghidae				
Common Woodshrike	<i>Tephrodornis pondicerianus</i>	LC	R	I
Family: Aegithinidae				
Common Iora	<i>Aegithina tiphia</i>	LC	R	I
Family: Dicruridae				
Black Drongo	<i>Dicrurus macrocercus</i>	LC	R	I
Family: Monarchidae				
Indian Paradise Flycatcher	<i>Terpsiphone paradisi</i>	LC	LM	I
Family: Laniidae				
Brown Shrike	<i>Lanius cristatus</i>	LC	WV	I
Bay-backed Shrike	<i>Lanius vittatus</i>	LC	R	I
Long-tailed Shrike	<i>Lanius schach</i>	LC	R	I
Family: Corvidae				
Rufous Treepie	<i>Dendrocitta vagabunda</i>	LC	R	O
House Crow	<i>Corvus splendens</i>	LC	R	O
Large-billed Crow	<i>Corvus macrorhynchos</i>	LC	R	O
Family: Alaudidae				
Jerdon's Bushlark	<i>Mirafra affinis</i>	LC	R	I
Oriental Skylark	<i>Alauda gulgula</i>	LC	R	I
Family: Cisticolidae				
Common Tailorbird	<i>Orthotomus sutorius</i>	LC	R	I
Ashy Prinia	<i>Prinia socialis</i>	LC	R	I
Plain Prinia	<i>Prinia inornata</i>	LC	R	I
Zitting Cisticola	<i>Cisticola juncidis</i>	LC	R	I
Family: Acrocephalidae				
Booted Warbler	<i>Iduna caligata</i>	LC	WV	I
Sykes's Warbler	<i>Iduna rama</i>	LC	WV	I
Blyth's Reed Warbler	<i>Acrocephalus dumetorum</i>	LC	WV	I
Clamorous Reed Warbler	<i>Acrocephalus stentoreus</i>	LC	WV	I
Family: Hirundinidae				
Barn Swallow	<i>Hirundo rustica</i>	LC	WV	I
Red-rumped Swallow	<i>Cecropis daurica</i>	LC	R	I
Streak-throated Swallow	<i>Petrochelidon fluvicola</i>	LC	LM	I
Family: Pycnonotidae				
Red-vented Bulbul	<i>Pycnonotus cafer</i>	LC	R	O
Family: Phylloscopidae				
Greenish Warbler	<i>Phylloscopus trochiloides</i>	LC	WV	I
Family: Sylviidae				
Lesser Whitethroat	<i>Curruca curruca</i>	LC	WV	I
Family: Timaliidae				
Large Grey Babbler	<i>Argya malcolmi</i>	LC	R	I
Yellow-billed Babbler	<i>Argya affinis</i>	LC	R	I
Family: Sturnidae				
Rosy Starling	<i>Pastor roseus</i>	LC	WV	O
Brahminy Starling	<i>Sturnia pagodarum</i>	LC	R	O
Chestnut-tailed Starling	<i>Sturnia malabarica</i>	LC	WV	O
Common Myna	<i>Acridotheres tristis</i>	LC	R	O
Jungle Myna	<i>Acridotheres fuscus</i>	LC	R	O
Family: Muscicapidae				
Asian Brown Flycatcher	<i>Muscicapa dauurica</i>	LC	WV	I
Oriental Magpie-Robin	<i>Copsychus saularis</i>	LC	R	I
Siberian Stonechat	<i>Saxicola maurus</i>	LC	WV	I
Pied Bushchat	<i>Saxicola caprata</i>	LC	R	I
Family: Dicaeidae				
Pale-billed Flowerpecker	<i>Dicaeum erythrorhynchos</i>	LC	R	N
Family: Nectariniidae				
Purple-rumped Sunbird	<i>Leptocoma zeylonica</i>	LC	R	N
Purple Sunbird	<i>Cinnyris asiaticus</i>	LC	R	N
Loten's Sunbird	<i>Cinnyris lotenius</i>	LC	R	N
Family: Ploceidae				

Continued on next page...



Table 1. continued...

Baya Weaver	<i>Ploceus philippinus</i>	LC	R	G
Family: Estrildidae				
Indian Silverbill	<i>Euodice malabarica</i>	LC	R	G
Scaly-breasted Munia	<i>Lonchura punctulata</i>	LC	R	G
White-rumped Munia	<i>Lonchura striata</i>	LC	R	G
Tricolored Munia	<i>Lonchura malacca</i>	LC	R	G
Red Avadavat	<i>Amandava amandava</i>	LC	R	G
Family: Passeridae				
House Sparrow	<i>Passer domesticus</i>	LC	R	G
Family: Motacillidae				
Western Yellow Wagtail	<i>Motacilla flava</i>	LC	WV	I
Eastern Yellow Wagtail	<i>Motacilla tschutschensis</i>	LC	WV	I
Citrine Wagtail	<i>Motacilla citreola</i>	LC	WV	I
White-browed Wagtail	<i>Motacilla maderaspatensis</i>	LC	R	I
Richard's Pipit	<i>Anthus richardi</i>	LC	WV	I
Paddyfield Pipit	<i>Anthus rufulus</i>	LC	R	I

IUCN status: LC— Least Concern, NT— Near Threatened, VU— Vulnerable. Resident status: R— Resident, WV— Winter visitor, LM— Local Migrant. Feeding guilds: I— Insectivore, G— Granivore, C— Carnivore, O— Omnivore, N— Nectarivore, F— Frugivore, P— Piscivore.

### 3.1. Feeding Guild Composition

Carnivorous and omnivorous birds constituted the predominant feeding guilds throughout the study period. Carnivorous birds dominated the assemblage during April (36.5%), May (34.4%), August (24.0%), and September (36.4%), whereas omnivorous birds showed higher proportions during June (30.1%), November (38.5%), December (31.2%), and January (34.6%). Granivorous and nectarivorous birds consistently contributed lower proportions across all months, with granivores peaking during August (9.8%) and nectarivores remaining below 1.1% throughout the study (Figure 4).

### 3.2. Threats and Affected Avifaunal Guilds

Pollution-related threats, including sewage inflow, solid waste, and plastic litter, primarily affected dabbling ducks, piscivores, waders and scavengers, often resulting in altered foraging behaviour, attraction to waste-associated resources, and increased risks of ingestion, entanglement, and long-term health decline. Biological disturbance from stray dogs and recreational activities mainly impacted ground-nesting birds and waders through disturbance, nest abandonment, and trampling. Invasive species like Water hyacinth impacted mainly piscivores and ducks, while habitat alteration influenced multiple avifaunal guilds like tree nesting species and arboreal species such as Coppersmith Barbet *Psilopogon haemacephalus*, Indian Grey Hornbill *Ocyrceros birostris*, etc. Hydrological variation associated with freshwater influx zones promoted positive response by aggregation of ducks and waterfowls, whereas disturbances like firecracker bursts caused temporary displacement of migratory waterbirds more strongly than resident species (Figure 5).

## 4. Discussion

The present study documented that Sengulam Lake supports a diverse urban wetland avifaunal assemblage despite intense anthropogenic pressures, with 151 bird species highlighting the wetland's ecological significance as an important site within a rapidly urbanising landscape, as seen in similar urban wetlands (Guptha et al., 2011; Kumar et al., 2014; Parameswaran et al., 2023; Naveen Kumar et al., 2025). In India, Urban wetlands often function as biodiversity islands by providing feeding, roosting, and breeding habitats for resident and migratory birds in otherwise modified environments (Raj et al., 2010; Singh and Bhatnagar, 2012). The predominance of resident species indicated that Sengulam provides year-round habitat resources, while the seasonal influx of winter visitors suggests its supplementary importance along migratory pathways (Mathibalan et al., 2026). The marked increase in abundance and species richness during November–December corresponds with the arrival of migratory waterbirds and the availability of post-monsoon aquatic habitats (Byju et al., 2025b). Seasonal hydrological changes strongly influence tropical wetland bird communities by altering water depth, prey accessibility, and vegetation structure (Keddy, 2010; Byju et al., 2025c). The relatively high Shannon diversity and low Simpson dominance indexes throughout the study period indicate that the avifaunal community remained structurally diverse without extreme dominance by a few opportunistic species. Similar patterns have been documented in other Indian urban wetlands where habitat heterogeneity promotes coexistence of multiple guilds (Urfi, 2003; Sundar, 2006).

Temporal beta diversity analysis showed a greater contribution of turnover relative to nestedness, suggesting that temporal variation in the assemblage was associated more with species replacement between months than with systematic species loss or gain. This pattern indicates a dynamic community structure, likely influenced by seasonal species replacement rather than simple accumulation or depletion of species in Sengulam. Such turnover-dominated patterns are commonly associated with wetlands that undergo periodic environmental fluctuations and habitat restructuring (Baselga, 2010). Migratory species arriving during winter likely replaced several monsoon-associated or transient species, producing high temporal heterogeneity (Byju et al., 2023). This



finding indicates that Sengulam functions as a dynamic habitat mosaic capable of supporting different ecological guilds.

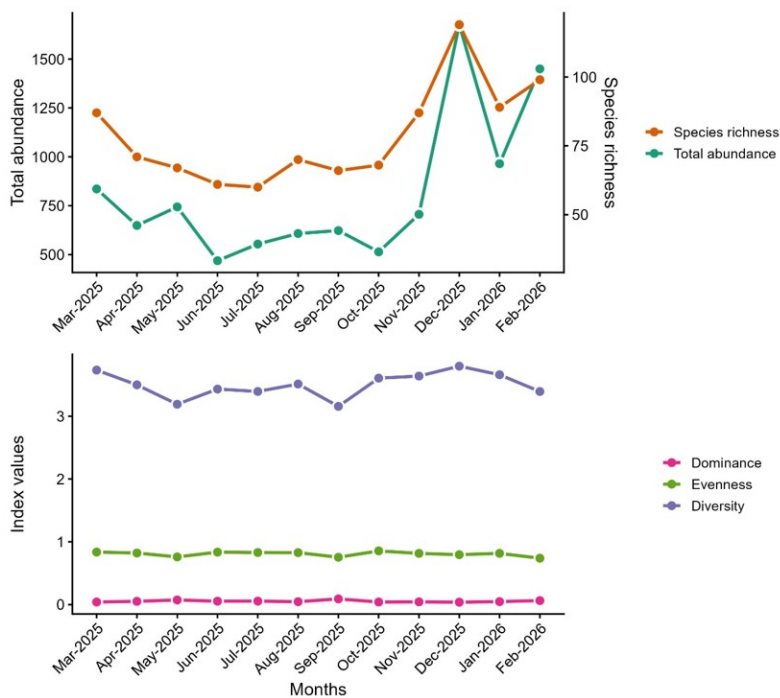


Figure 2. Total monthly abundance, species richness and diversity indices of the avifaunal community in Sengulam.

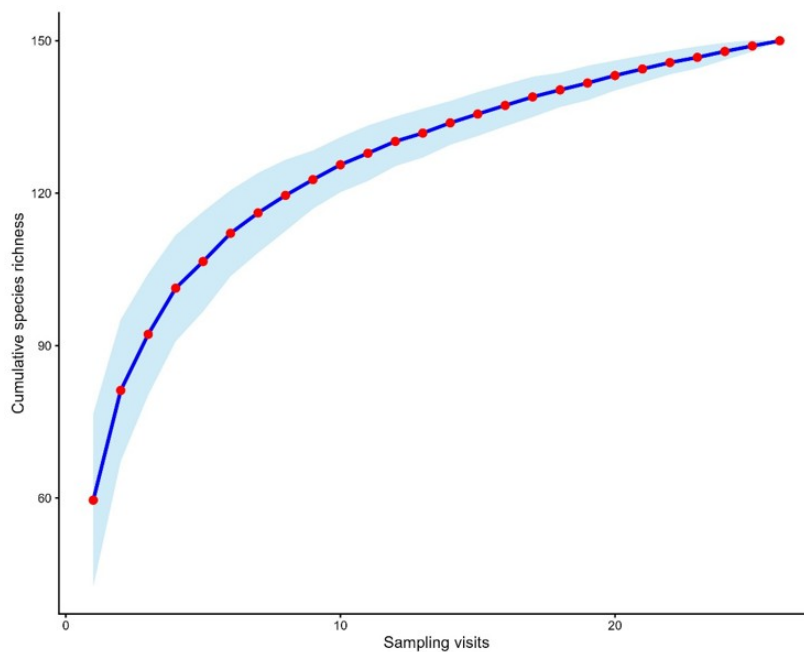


Figure 3. Species accumulation curve showing cumulative bird species richness across sampling visits, with shaded areas representing 95% confidence intervals.

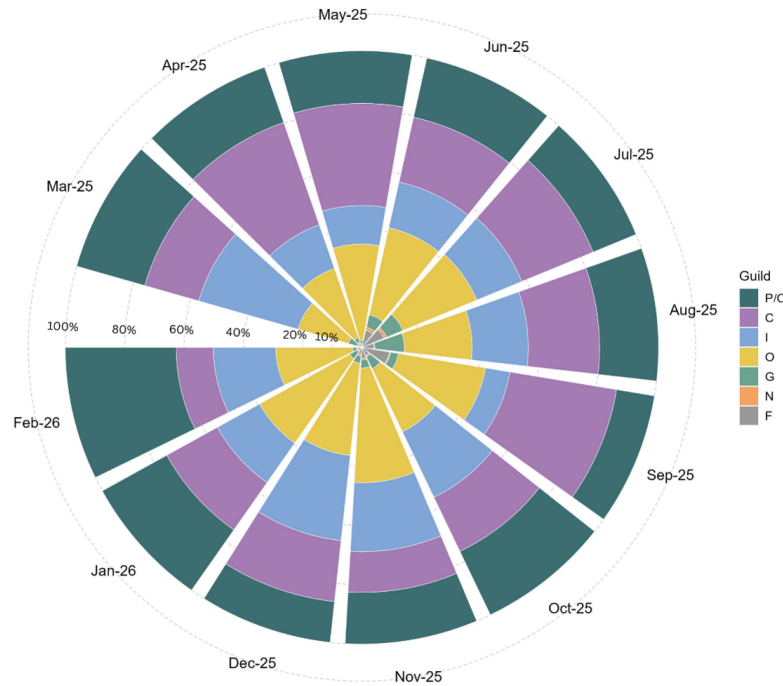


Figure 4. Monthly relative abundance (%) of the various feeding guilds of avifauna in Sengulam (I: Insectivore, G: Granivore, C: Carnivore, O: Omnivore, N: Nectarivore, F: Frugivore, P: Piscivore)

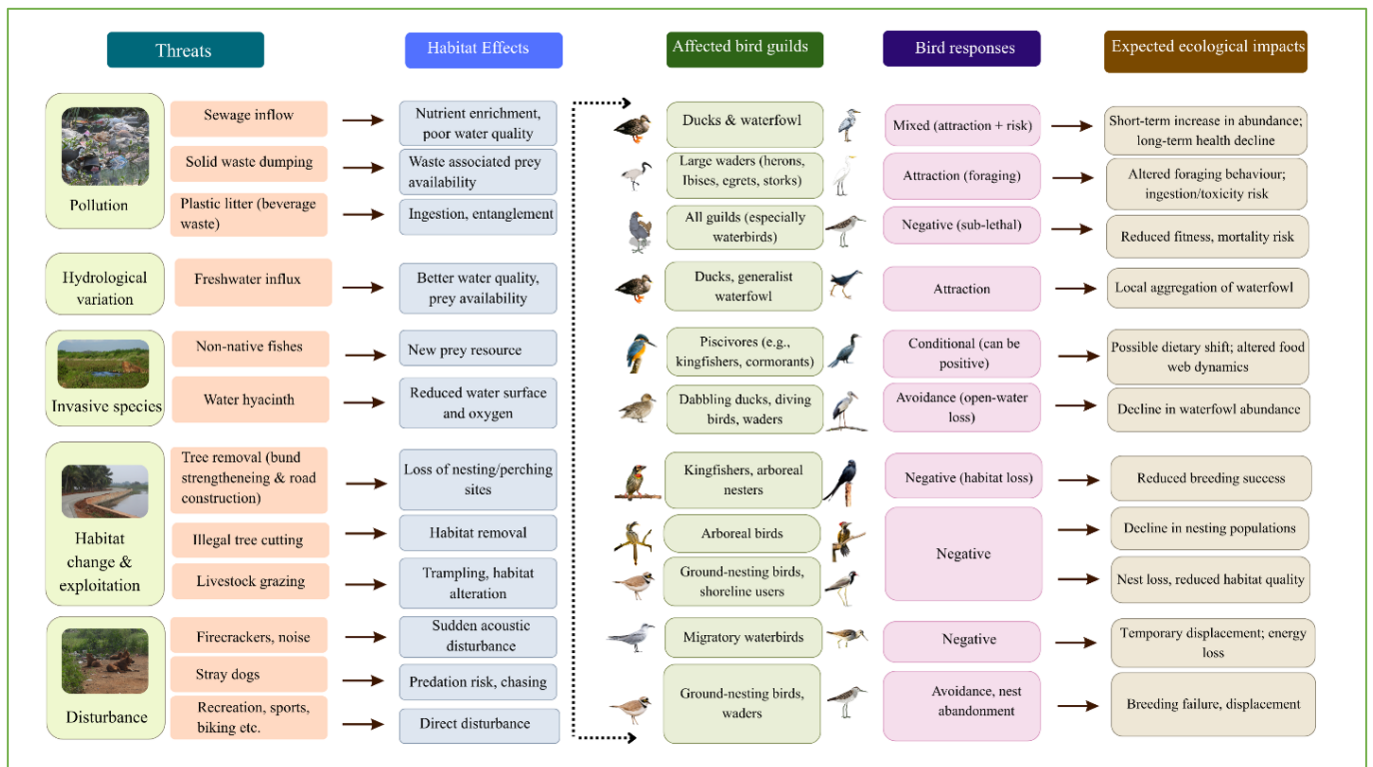


Figure 5. Schematic representation of threat-specific responses of bird guilds in Sengulam Lake.

Feeding guild analysis showed strong dominance of carnivorous and omnivorous birds, which is characteristic of disturbed urban wetlands receiving anthropogenic nutrient inputs. Nutrient enrichment from sewage inflow often increases populations of fish, invertebrates, and organic waste resources, thereby favouring opportunistic carnivores and omnivores (Blumstein et al., 2005).



The increased abundance of herons, egrets, ibises, and scavenging species near sewage discharge points and garbage accumulation areas suggests anthropogenic resource-driven behavioural adaptation. Such habitats may provide predictable food resources; however, long-term dependence on polluted habitats can reduce physiological fitness and increase exposure to toxins, pathogens, and plastics (Burger and Gochfeld, 2004).

The sewage inflow observed at multiple points of the wetland represents one of the most significant ecological threats affecting bird assemblages, especially during the drier part of the year. Untreated sewage may influence nutrient dynamics, increases eutrophication, and reduces dissolved oxygen concentrations in wetlands (Mitsch and Gosselink, 2015). The pungent odour and dark water observed near the inlet zones, as fresh water from Thenkarai anaikut built across the Noyyal River mixes up, suggest organic pollution in the wetland. Although certain generalist species appeared attracted to these nutrient-rich areas, such attraction may potentially create ecological trap like conditions, where apparently suitable habitats reduce long-term survival or reproductive success (Battin, 2004). Sewage-contaminated zones may also expose waders and piscivores to heavy metals, microplastics, and other pollutants commonly associated with urban wetlands. Similar sewage-associated behavioural shifts have been reported in urban wetlands across India, where waterbirds increasingly exploit anthropogenic food sources (Nayak and Sasmal, 2022; Byju et al., 2024d).

The rapid expansion of the invasive macrophyte Water hyacinth constituted another major ecological concern during the study period. By the end of the survey, larger portion of the shoreline had become covered, drastically modifying wetland structure by reducing open-water habitats, suppressing native vegetation, and lowering oxygen availability (Villamagna and Murphy, 2010). The observed decline in duck population within heavily infested shoreline areas strongly suggests reduced foraging opportunities for dabbling species. Open mudflats and shallow shorelines are critical feeding habitats for waders, and their replacement by floating invasive vegetation can substantially reduce habitat suitability (Bolgagni, 2021).

The contrast between heavily infested zones and the relatively clearer freshwater sections containing white water lilies demonstrates the importance of hydrological quality in shaping habitat use. Marsh vegetation near certain sections appeared to partially filter sewage inflow, improving water transparency and possibly maintaining localized habitat. Such wetland filtration processes are ecologically important because emergent vegetation can reduce nutrient loads and trap suspended particles (Kadlec and Wallace, 2009). However, continued nutrient enrichment will likely accelerate invasive plant proliferation unless sewage inflow is regulated.

Disturbance from stray dogs, recreational activities, and human intrusion had particularly strong impacts on ground-associated bird guilds. Waders and ground-nesting species are highly sensitive to repeated disturbance because frequent flushing increases energetic expenditure and reduces foraging efficiency (Weston et al., 2012). Field observations of stray dogs chasing birds and disturbing foraging areas indicate direct behavioural stress. Similar impacts have been documented globally, where free-ranging dogs reduce breeding success and habitat occupancy of wetland birds (Weston and Stankowich, 2014; Byju et al., 2024a). Recreational intrusion during drier months, including vehicle movement and sports activities within exposed grasslands, likely further intensified habitat disturbance.

The sensitivity of migratory species to stochastic disturbances was particularly evident during high-decibel religious events and firecracker bursts. Migratory waterbirds rapidly vacated disturbed areas, whereas many resident birds showed partial tolerance (Chace and Walsh, 2006). Migrants are generally more disturbance-sensitive because they rely on limited seasonal stopover resources and possess lower familiarity with local disturbances (Gill et al., 2001). Repeated acoustic disturbance may reduce habitat suitability by interrupting feeding and roosting behaviour, particularly during energetically demanding migratory periods (Lilleyman et al., 2016).

Infrastructure development around the lake has also contributed substantially to habitat degradation. Road construction, bund modification, and vegetation removal increased human accessibility and habitat fragmentation. Of particular significance was the destruction of a Pied Kingfisher nesting burrow during active roadwork. Kingfishers depend on undisturbed earthen banks for nesting, and alteration of bund structure can directly eliminate breeding sites (Turčoková et al., 2016). The installation of streetlights along the lake edge may additionally disrupt nocturnal ecological processes and alter bird behaviour. Artificial lighting near wetlands is known to affect orientation, predator-prey interactions, and migratory movements in birds (Longcore and Rich, 2004).

Habitat specialists appeared considerably more vulnerable to environmental modification than ecological generalists. Species dependent on open water, intact shoreline vegetation, or specialised nesting substrates showed stronger negative responses to habitat alteration. In contrast, generalist species such as herons, egrets, and ibises appeared capable of exploiting disturbed habitats, including garbage accumulation sites and sewage zones (Balfors et al., 2016). This pattern aligns with urban ecological theory, where anthropogenic disturbance tends to favour adaptable generalists while reducing specialist populations (McKinney, 2006). Such shifts may ultimately lead to biotic homogenisation and reduced ecological integrity of urban wetlands (Clergeau et al., 2006).

The study also highlights the paradox of urban wetlands: wetlands continue to attract diverse bird assemblages because they provide water and food resources, yet simultaneously experience severe degradation from urban expansion and human pressure (Aronson et al., 2014). Sengulam, therefore, represents both a biodiversity refuge and a vulnerable ecosystem undergoing rapid ecological transformation. Despite disturbance, observations of breeding behaviour in species such as Indian Spot-billed Duck



*Anas poecilorhyncha*, Lesser Whistling Duck *Dendrocygna javanica*, Eurasian Coot *Fulica atra*, Grey-headed Swamphen *Porphyrio poliocephalus*, Little Ringed Plover *Thinornis dubius*, Indian Grey Hornbill *Ocyrceros birostris* and Coppersmith Barbet *Psilopogon haemacephalus* indicate that the wetland still retains important reproductive habitat functions (Table 2).

Table 2. Key field observations.

Month	Notable observations
Mar-2025	Little Ringed Plover nest with single egg is observed on water receded grassy area.
Apr-2025	Courtship behaviour of Little Egret, Eurasian Coot nesting with 3 eggs in <i>Ipomoea carnea</i> , and Eurasian coot feeding chicks.
May-2025	Nest of Indian Grey Hornbill on coconut tree, Lesser whistling ducks with chicks and Common Myna visiting the hole of a dead coconut tree frequently.
Jul-2025	Great Egret in breeding plumage; Eurasian coot, Grey-headed Swamphen, Coppersmith Barbet, Black Drongo and Large Grey Babbler with chicks
Aug-2025	Pied Cuckoo with juveniles; nesting material collection by House Sparrow
Sep-2025	Indian Spot-billed Duck and Eurasian Coot with chicks
Nov-2025	Female Rose ringed parakeet was observed inside the hole of a dead coconut tree.
Dec-2025	Pied Kingfisher nest building near the ongoing construction road; Mating of Grey-headed Swamphen; Nest material collection by Indian Silverbill

#### 4.1. Conservation Significance and Recommendations

Recent reforms in India, such as the Biological Diversity (Amendment) Rules 2025 and the Amrit Dharohar initiative, underscore the national commitment to wetland conservation. The inclusion of wetlands in the Mission LiFE (Lifestyle for Environment) framework promotes the “wise use” of these ecosystems, aligning local management with global climate action goals.

The findings from Sengulam Lake emphasize that while urban wetlands remain highly productive and biodiverse, their current trajectory is unsustainable without active intervention. Immediate management should prioritize the regulation of sewage inflow and the scientific removal of Water hyacinth to prevent the collapse of open-water niches. Immediate focus must be placed on the inlets where sewage enters the lake. The construction of decentralized wastewater treatment systems or constructed wetlands at these points could significantly reduce the nutrient load, thereby suppressing the growth of invasive weeds and improving the health of the avian community. Additionally, the regulation of human activities such as garbage dumping and noise-intensive events is necessary to minimize stress on migratory species. Efforts should be made to restore the native vegetation along the lake’s bunds. Maintaining trees and earthen banks for nesting would support habitat specialists like hornbills and kingfishers. Furthermore, the creation of small islands within the lake could provide safe breeding grounds for waterbirds, protected from the disturbance of humans and stray dogs.

The integration of Sengulam Lake into the city’s master plan as a “satellite corridor” for biodiversity is essential for its long-term survival. This involves not only physical protection but also the fostering of community stewardship. By treating urban wetlands as critical infrastructure for sustainability, comparable to roads or power grids, city administrations can leverage their natural capacity for flood control and climate mitigation to build a more resilient and liveable Coimbatore.

#### 5. Conclusion

Sengulam Lake represents a profound paradox of the modern era, a site of remarkable biodiversity that is simultaneously a sink for urban waste and a victim of rapid expansion. The data suggest that the lake’s avian community is currently in a state of dynamic resilience, maintained by its high habitat heterogeneity and the adaptability of its constituent species. However, the continued encroachment and pollution threaten to push this ecosystem beyond its tipping point. Achieving environmental sustainability in the Noyyal basin requires a return to the “wise use” principles, updated with modern nature-based solutions and global conservation approaches.

#### Author Contributions

S. Naveen Kumar: Methodology, Investigation, Writing – review & editing; K. Sureshababu: Investigation; S. Ravi Krishna: Investigation; G. J. Miller: Investigation; H. Maitreyi: Formal analysis, Visualization, Writing – original draft, Writing – review & editing; H. Byju: Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing.

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