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Cover: Parts of *Vachellia nilotica*, medium - watercolours. © P Kritika



Diversity and habitat associations of avifauna in the Poovar Estuary, Kerala, India

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Abstract: This study assessed bird diversity in Poovar, a coastal wetland complex in Thiruvananthapuram district, Kerala, India, from August 2024 to July 2025. 88 bird species from 17 orders and 37 families were documented, encompassing both resident and migratory populations. According to the IUCN Red List, all species were categorized as ‘Least Concern’ except for the River Tern *Sterna aurantia* and Oriental Darter *Anhinga melanogaster*, listed as ‘Vulnerable’ and ‘Near Threatened’, respectively. Based on migratory status, 56 species were residents and 32 were winter visitors, highlighting the role of Poovar as a significant refuge for migratory waterbirds along the southwest coast of India. Feeding guild analysis showed that 34% of species were insectivorous, followed by carnivores and piscivores, reflecting the functional diversity of the community. Habitat association indicated waterbirds utilized varied habitats, showing overlap in habitat-specific assemblages such as backwater, mangroves, and beaches, emphasizing the influence of habitat heterogeneity on avian distribution. Urban areas showed a distinctive species composition having little overlap with farmland assemblages. The habitat mosaic of Poovar supports a diverse and dynamic avifaunal assemblage. Habitat association analysis indicated that waterbirds utilized a variety of habitats.

Keywords: Avifaunal list, biodiversity, backwater, beach, estuary, habitats, Kerala, migratory birds, species assemblage, urban birds.

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Author contribution: BSB—data collection, first draft writing; VR—research planning, data curation, writing and supervision; HM—data curation, analysis and writing; HB—supervision, planning, writing and editing.

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INTRODUCTION

Tropical coastal ecosystems are among the most productive and biologically rich environments globally, supporting a high diversity of avifauna that fulfil critical ecological roles (Rashiba et al. 2022). Birds make significant contributions to ecosystem functioning through processes such as pollination, seed dispersal, regulation of invertebrate and rodent populations, scavenging, and nutrient cycling (Şekercioğlu 2006; Archana et al. 2024). The composition and structure of avian communities in these dynamic landscapes are strongly influenced by habitat heterogeneity, resource availability, and seasonal hydrological fluctuations (Byju et al. 2024a, 2025a). Their specific habitat requirements and trophic positions make birds sensitive to environmental change and reliable bioindicators for assessing ecosystem health and the impacts of anthropogenic disturbances (Byju et al. 2024b; Kumar et al. 2025).

In the Indian subcontinent, coastal wetlands, estuaries, and mangrove systems along both the east and west coasts provide crucial habitats for a vast array of resident and migratory birds (Byju et al. 2023a,b, 2025b) and serve as vital stopover and wintering grounds within the Central Asian Flyway (CAF). Recent avifaunal studies from diverse coastal sites such as the Gulf of Mannar lagoons (Byju et al. 2025c,d), islands (Byju et al. 2023c), and Muthukkad backwaters on the eastern coast (Shree & Malathi 2024), and Changaram wetlands (Anand et al. 2023), on the western coast, highlight the regional significance of these understudied habitats for sustaining biodiversity. However, many smaller, ecologically complex estuaries remain under-surveyed, leading to gaps in our understanding of local species assemblages and their conservation needs.

The Poovar estuary, situated at the southern tip of Kerala on the southwestern coast of India, represents one such understudied coastal mosaic. This dynamic system, formed by the confluence of the Neyyar River, backwaters, the Arabian Sea, and fringing mangroves creates a heterogeneous landscape of sandbars, mudflats, freshwater marshes, and anthropogenically modified areas. The region is important along the CAF, providing critical resources for foraging, roosting, and breeding birds. In this context, systematic baseline studies are imperative for generating robust scientific data to inform conservation planning and sustainable management. This study represents the first systematic, habitat-based avifaunal assessment of the Poovar region. The research objectives are to compile a

systematic checklist of bird species, documenting their relative abundance, habitat associations, and temporal occurrence, thus addressing a significant knowledge gap in the avifauna of Kerala's coast, and provide insights for local and regional conservation strategies.

MATERIALS AND METHODS

Study area

Poovar is a coastal village in the Neyyattinkara Taluk of Thiruvananthapuram District, Kerala, India (8.3002–8.3502 °N; 77.0336–77.0836 °E). It lies within the Poovar Grama Panchayat under the Parassala Block Panchayat. The area represents a unique ecological confluence of marine, estuarine, riverine, mangrove, and terrestrial ecosystems, supporting high habitat heterogeneity and avian diversity. Four distinct habitats were selected for the present study (Image 1): 1. Poovar Backwater: A 6-km stretch of the Neyyar River backwater (50–200 m wide), providing feeding and roosting habitats for waterbirds; 2. Poovar Beach: A ~12 km sandy shoreline where the Neyyar River meets the Arabian Sea, important for migratory shorebirds and coastal avifauna; 3. Poovar Mangroves: Estuarine fringes (5 km, 20–80 m wide) with dense mangrove vegetation, functioning as nurseries and foraging sites; and 4. Human-settled areas: Settlements, agricultural fields, and transport corridors (~7 km), supporting synanthropic species.

Bird surveys

Avifaunal surveys were conducted from August 2024 to July 2025. Point counts were conducted with fixed points established across habitats, using 10-minute observations within a 50-m radius (Bibby et al. 2000). Surveys were conducted monthly, once at 0700–1000 h and again at 1600–1800 h, coinciding with peak bird activity. Birds were observed using Olympus 8 × 40 binoculars and photographed with a Nikon Z6III and NIKKOR 200–500 mm lens. Double-counting was avoided by recording flight directions and repeated movements, and avoiding species count coming from behind the observer. Permanent survey routes and observation points across habitats were monitored once per month to assess temporal variation. Birds were identified using standard field guides (Grimmett et al. 2011). We followed the taxonomy, nomenclature and Indian Wildlife Protection Act (IWPA) status based on IOC World Bird List v.14.1 (Praveen et al. 2023; Gill et al. 2024). Conservation status was assessed using the IUCN Red List (IUCN 2025).

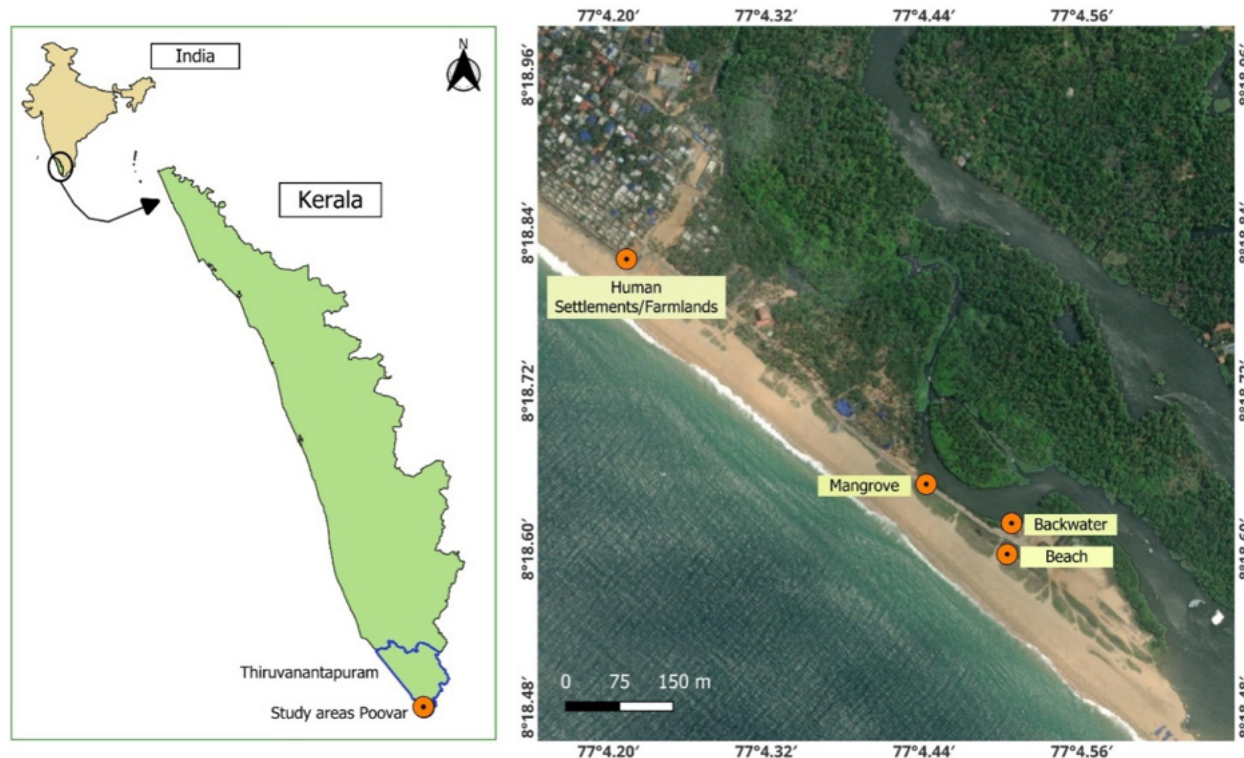


Image 1. Map of Poovar estuary regions study area.

Relative diversity index (RDi) of the avian families was calculated with the following formula (Torre-Cuadros et al. 2007):

$$\text{RDi} = \frac{\text{Number of avifaunal species in a family}}{\text{Total number of avifaunal species}} \times 100$$

Multiple correspondence analysis (MCA) was performed to analyze the association between bird species and habitat categories. MCA is an extension of correspondence analysis designed for multivariate categorical data, allowing simultaneous visualization of relationships between species occurrences and habitat types in a low-dimensional space (Greenacre & Blasius 2006). 75% confidence ellipses were added around habitat groupings to represent the dispersion and overlap of species compositions within each habitat. Overlap among ellipses indicates shared species assemblages and distributions across habitats. The analysis was done using R software version 4.5.1. (R core team 2025).

RESULTS AND DISCUSSION

During the study period, a total of 88 avian species were recorded, representing 17 orders and 37 families, which included 70 genera. Poovar avifauna

comprised 46 species of waterbirds and 42 species of landbirds. Among the waterbirds, order Charadriiformes predominated ($n = 25$ species), with four families, followed by Pelecaniformes ($n = 12$) with two families. Landbirds were majorly represented by Passeriformes ($n = 24$), with 14 families, followed by Coraciiformes (6 species) (Image 2).

The family-wise analysis of avifauna revealed variation in relative diversity. Laridae (14 species, RDi 16.0%) was the most dominant, followed by Ardeidae (9 species, RDi 10.2%) and Scolopacidae (6 species, RDi 6.8%). Alcedinidae, Charadriidae, & Sturnidae (4 species each, RDi 4.5%); Accipitridae, Corvidae, Cuculidae, Dicruridae, Motacillidae, & Threskiornithidae (3 species each, RDi 3.4%); and Ciconiidae, Cisticolidae, Meropidae, & Phalacrocoracidae (2 species each, RDi 2.2%), followed the dominance. The remaining 21 families recorded the lowest species richness (one species each and RDi 1.1%) (Image 3).

Feeding guild analysis showed that while 34% of the total avifauna were insectivorous (30 species), the remaining were carnivorous (22 species), omnivorous (18 species) and piscivorous (15 species). There were only two nectarivores, Pale-billed Flowerpecker *Dicaeum erythrorhynchos*, which is also a frugivore, and Purple-rumped Sunbird *Leptocoma zeylonica*. Another frugivore

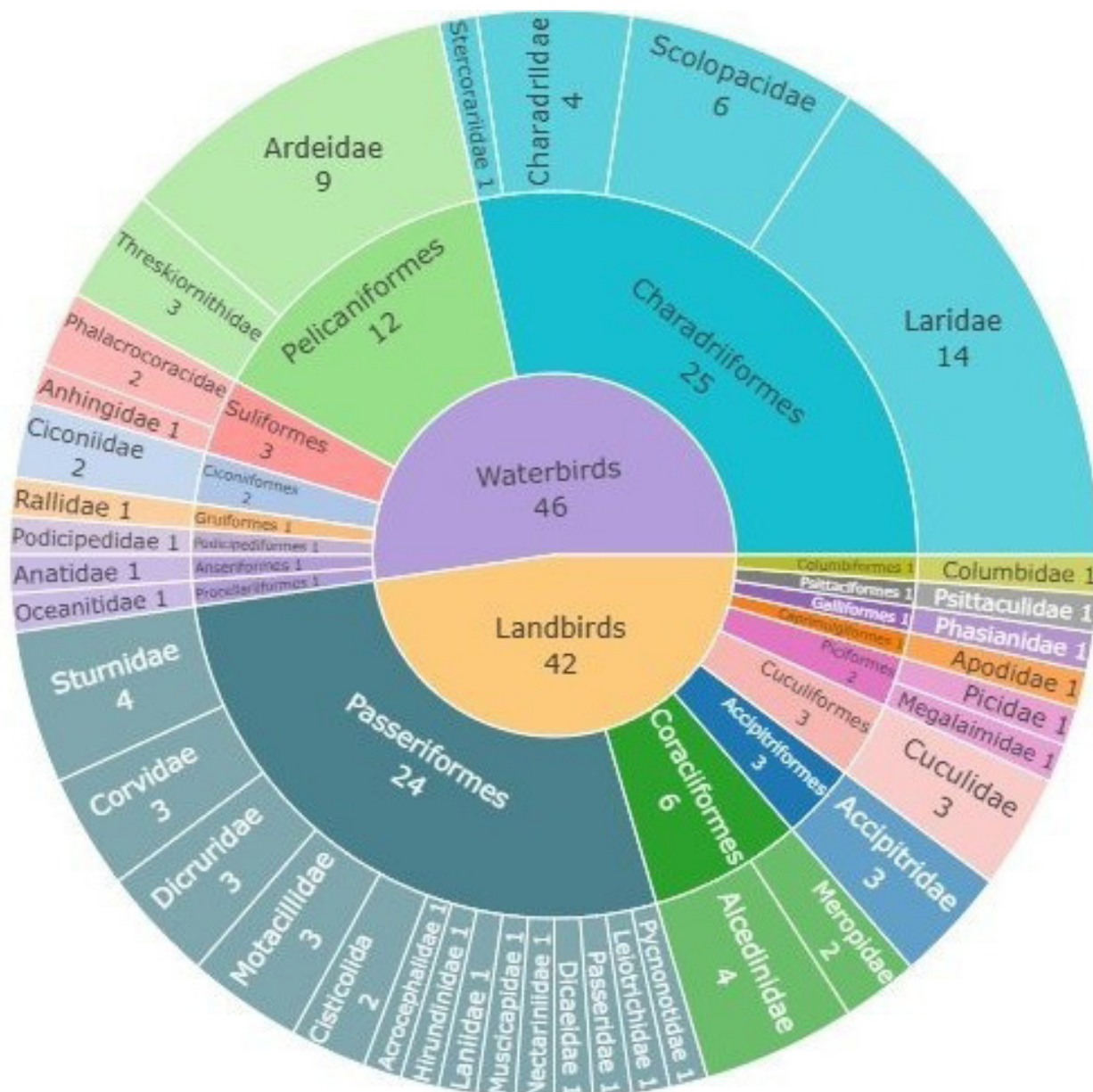


Image 2. Orders and families of waterbirds and landbirds, with the respective number of species recorded in Poovar.

recorded was Rose-ringed Parakeet *Psittacula krameri* (Image 4). According to migratory status, resident birds constituted 64% (56 species) of species, while winter visitors accounted for the rest.

Of the species documented, 86 were categorized as 'Least Concern', the Oriental Darter *Anhinga melanogaster* as 'Near Threatened', and the River Tern *Sterna aurantia* as 'Vulnerable'. As per the Indian Wildlife Protection Act (IWPA) 2022, eight species were under Schedule I, 79 species under Schedule II, and one species, House Crow *Corvus splendens*, is Not Scheduled (Table 1).

The peak counts of most of the birds recorded during the study period were from October to February. Black Kite *Milvus migrans* was the most abundant landbird species ($n = 450$ in December), followed by House Crow ($n = 200$ in July) and Brahminy Kite *Haliastur indus* ($n = 156$ in September). Both the kite species were recorded in all kinds of habitats - backwater, mangrove, urban and beach area, typical of their scavenging nature. One individual of another raptor, Shikra *Accipiter badius*, was recorded in November in the backwater and mangrove area. Among the waterbirds, the most abundant species were Glossy Ibis *Plegadis falcinellus* ($n = 60$ in

Table 1. Species list with IUCN Red List status, migration status, WPA status, along with feeding guilds and habitats.

Orders	Families	Common name	Scientific name	WPA Schedule	IUCN Red List status	Migratory status	Feeding guild	Major habitats
Accipitriformes	Accipitridae	Black Kite	<i>Milvus migrans</i> (Boddaert, 1783)	I	LC	R	C	BW, MG, BC, UA
		Brahminy Kite	<i>Haliastur indus</i> (Boddaert, 1783)	I	LC	R	C	BW, MG, BC, UA
		Shikra	<i>Accipiter badius</i> (Gmelin, 1788)	I	LC	R	C	BW, MG
Caprimulgiformes	Apodidae	Asian Palm Swift	<i>Cypsiurus balasienis</i> (Gray, JE, 1829)	II	LC	R	I	UA, FL
Columbiformes	Columbidae	Rock Pigeon	<i>Columba livia</i> (Gmelin, JF, 1789)	II	LC	R	O	UA
Coraciiformes	Alcedinidae	Common Kingfisher	<i>Alcedo atthis</i> (Linnaeus, 1758)	II	LC	R	P	BC, BW, MG
		Pied Kingfisher	<i>Ceryle rudis</i> (Linnaeus, 1758)	II	LC	R	P	BW, MG
		Stork-billed Kingfisher	<i>Pelargopsis capensis</i> (Linnaeus, 1766)	II	LC	R	C	BW, MG
		White-throated Kingfisher	<i>Halcyon smyrnensis</i> (Linnaeus, 1758)	II	LC	R	C	BW, MG
	Meropidae	Asian Green Bee-eater	<i>Merops orientalis</i> (Latham, 1801)	II	LC	R	I	BW, MG
		Blue-tailed Bee-eater	<i>Merops philippinus</i> (Linnaeus, 1767)	II	LC	WV	I	BW, MG
Cuculiformes	Cuculidae	Asian Koel	<i>Eudynamis scolopaceus</i> (Linnaeus, 1758)	II	LC	R	O	UA
		Greater Coucal	<i>Centropus sinensis</i> (Stephens, 1815)	II	LC	R	O	UA
		Pied Cuckoo	<i>Clamator jacobinus</i> (Boddaert, 1783)	II	LC	WV	I	FL
Galliformes	Phasianidae	Peregrine Falcon	<i>Falco peregrinus</i> (Tunstall, 1771)	I	LC	WV	C	BC, UA
Passeriformes	Acrocephalidae	Blyth's Reed Warbler	<i>Acrocephalus dumetorum</i> (Blyth, 1849)	II	LC	WV	I	BW
	Cisticolidae	Ashy Prinia	<i>Prinia socialis</i> (Sykes, 1832)	II	LC	R	I	BW, UA
		Common Tailorbird	<i>Orthotomus sutorius</i> (Pennant, 1769)	II	LC	R	I	UA
	Corvidae	House Crow	<i>Corvus splendens</i> (Vieillot, 1817)	Not scheduled	LC	R	O	UA
		Large-billed Crow	<i>Corvus macrorhynchos</i> (Wagler, 1827)	II	LC	R	O	UA, BC
		Rufous Treepie	<i>Dendrocitta vagabunda</i> (Latham, 1790)	II	LC	R	O	BW
	Dicruridae	Ashy Drongo	<i>Dicrurus leucophaeus</i> (Vieillot, 1817)	II	LC	R	I	BW, FL
		Greater Racket-tailed Drongo	<i>Dicrurus paradiseus</i> (Linnaeus, 1766)	II	LC	R	I	BW, FL
		Black Drongo	<i>Dicrurus macrocercus</i> (Vieillot, 1817)	II	LC	R	I	BW, FL
	Hirundinidae	Barn Swallow	<i>Hirundo rustica</i> (Linnaeus, 1758)	II	LC	WV	I	BW, FL
	Laniidae	Brown Shrike	<i>Lanius cristatus</i> (Linnaeus, 1758)	II	LC	WV	I	BW, FL
	Motacillidae	Paddyfield Pipit	<i>Anthus rufulus</i> (Vieillot, 1818)	II	LC	R	I	BW, FL
		White-browed Wagtail	<i>Motacilla maderaspatensis</i> (Gmelin, JF, 1789)	II	LC	R	I	BW
		Grey Wagtail	<i>Motacilla cinerea</i> (Tunstall, 1771)	II	LC	WV	I	BW
	Muscicapidae	Oriental Magpie-Robin	<i>Copsychus saularis</i> (Linnaeus, 1758)	II	LC	R	I	BW, FL, UA
	Nectariniidae	Purple-rumped Sunbird	<i>Leptocoma zeylonica</i> (Linnaeus, 1766)	II	LC	R	N	BW, FL, UA
	Dicaeidae	Pale-billed Flowerpecker	<i>Dicaeum erythrorhynchos</i> (Latham, 1790)	II	LC	R	F/N	BW, FL, UA

Orders	Families	Common name	Scientific name	WPA Schedule	IUCN Red List status	Migratory status	Feeding guild	Major habitats
Passeriformes	Passeridae	House Sparrow	<i>Passer domesticus</i> (Linnaeus, 1758)	II	LC	R	O	FL, UA
	Sturnidae	Brahminy Starling	<i>Sturnia pagodarum</i> (Gmelin, JF, 1789)	II	LC	R	O	FL, UA
		Common Myna	<i>Acridotheres tristis</i> (Linnaeus, 1766)	II	LC	R	O	FL, UA
		Jungle Myna	<i>Acridotheres fuscus</i> (Wagler, 1827)	II	LC	R	O	FL, UA
		Rosy Starling	<i>Pastor roseus</i> (Linnaeus, 1758)	II	LC	WV	O	BW, FL, UA
	Leiotrichidae	Yellow-billed Babbler	<i>Argya affinis</i> (Jerdon, 1845)	II	LC	R	O	BW, FL, UA
	Pycnonotidae	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i> (Linnaeus, 1758)	II	LC	R	O	BW, FL, UA
Piciformes	Megalaimidae	White-cheeked Barbet	<i>Psilopogon viridis</i> (Boddaert, 1783)	II	LC	R	O	BW, MG
	Picidae	Black-rumped Flameback	<i>Dinopium benghalense</i> (Linnaeus, 1758)	II	LC	R	I	BW, FL
Psittaciformes	Psittaculidae	Rose-ringed Parakeet	<i>Psittacula krameri</i> (Scopoli, 1769)	II	LC	R	F	FL, UA
Charadriiformes	Charadriidae	Greater Sand Plover	<i>Anarhynchus leschenaultii</i> (Lesson, RP, 1826)	II	LC	WV	I	BC
		Kentish Plover	<i>Anarhynchus alexandrinus</i> (Linnaeus, 1758)	II	LC	WV	I	BC
		Tibetan Sand Plover	<i>Anarhynchus atrifrons</i> (Wagler, 1829)	II	LC	WV	I	BC, BW
		Red-wattled Lapwing	<i>Vanellus indicus</i> (Boddaert, 1783)	II	LC	R	I	BW, FL
	Laridae	Bridled Tern	<i>Onychoprion anaethetus</i> (Scopoli, 1786)	II	LC	WV	P	BC
		Little Tern	<i>Sternula albifrons</i> (Pallas, 1764)	II	LC	WV	P	BC, BW, MG
		Common Tern	<i>Sterna hirundo</i> (Linnaeus, 1758)	II	LC	WV	P	BC, BW, MG
		River Tern	<i>Sterna aurantia</i> (Gray, JE, 1831)	I	VU	R	P	BC, BW
		Greater Crested Tern	<i>Thalasseus bergii</i> (Lichtenstein, MHC, 1823)	II	LC	WV	P	BC, BW, MG
		Lesser Crested Tern	<i>Thalasseus bengalensis</i> (Lesson, RP, 1831)	II	LC	WV	P	BC
		Sandwich Tern	<i>Thalasseus sandvicensis</i> (Latham, 1787)	II	LC	WV	P	BC
		Gull-billed Tern	<i>Gelochelidon nilotica</i> (Gmelin, JF, 1789)	I	LC	WV	O	BC, BW, MG
		Whiskered Tern	<i>Chlidonias hybrida</i> (Pallas, 1811)	II	LC	WV	P	BC, BW, MG
		Caspian Tern	<i>Hydroprogne caspia</i> (Pallas, 1770)	II	LC	WV	P	BC, BW, MG
		Lesser Black-backed Gull	<i>Larus fuscus</i> (Linnaeus, 1758)	II	LC	WV	C	BC, BW, MG
		Black-headed Gull	<i>Larus ridibundus</i> (Linnaeus, 1766)	II	LC	WV	C	BC, BW, MG
		Brown-headed Gull	<i>Chroicocephalus brunnicephalus</i> (Jerdon, 1840)	II	LC	WV	C	BC, BW, MG
		Pallas's Gull	<i>Ichthyophaga ichthyophaga</i> (Pallas, 1773)	II	LC	WV	C	BC, BW, MG
	Scolopacidae	Common Sandpiper	<i>Actitis hypoleucos</i> (Linnaeus, 1758)	II	LC	WV	I	BC, BW, MG, FL
		Sanderling	<i>Calidris alba</i> (Pallas, 1764)	II	LC	WV	I	BC
		Temminck's Stint	<i>Calidris temminckii</i> (Leisler, 1812)	II	LC	WV	I	BC
		Common Greenshank	<i>Tringa nebularia</i> (Gunnerus, 1767)	I	LC	WV	I	BC
		Wood Sandpiper	<i>Tringa glareola</i> (Linnaeus, 1758)	II	LC	WV	I	BC, FL
		Whimbrel	<i>Numenius phaeopus</i> (Linnaeus, 1758)	II	LC	WV	I	BC

Orders	Families	Common name	Scientific name	WPA Schedule	IUCN Red List status	Migratory status	Feeding guild	Major habitats
	Stercorariidae	Parasitic Jaeger	<i>Stercorarius parasiticus</i> (Linnaeus, 1758)	II	LC	WV	C	BC
Ciconiiformes	Ciconiidae	Asian Openbill	<i>Anastomus oscitan</i> (Boddaert, 1783)	II	LC	R	C	BC, FL
		Painted Stork	<i>Mycteria leucocephala</i> (Pennant, 1769)	II	LC	R	C	BC, FL
Gruiformes	Rallidae	White-breasted Waterhen	<i>Amaurornis phoenicurus</i> (Pennant, 1769)	II	LC	R	O	BW
Pelicaniformes	Ardeidae	Eastern Cattle Egret	<i>Bubulcus coromandus</i> (Boddaert, 1783)	II	LC	R	C	BC, FL
		Great Egret	<i>Ardea alba</i> (Linnaeus, 1758)	II	LC	R	C	BC, FL, MG
		Medium Egret	<i>Ardea intermedia</i> (Wagler, 1829)	II	LC	R	C	BC, FL, MG
		Grey Heron	<i>Ardea cinerea</i> (Linnaeus, 1758)	II	LC	R	C	BW, FL
		Purple Heron	<i>Ardea purpurea</i> (Linnaeus, 1766)	II	LC	R	C	BW, FL
		Indian Pond Heron	<i>Ardeola grayii</i> (Sykes, 1832)	II	LC	R	C	BW, FL
		Little Egret	<i>Egretta garzetta</i> (Linnaeus, 1766)	II	LC	R	C	BC, FL, MG
		Western Reef Heron	<i>Egretta gularis</i> (Bosc, 1792)	II	LC	R	C	BC, FL, MG
		Black-crowned Night Heron	<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	II	LC	R	C	BW, FL
	Threskiornithidae	Black-headed Ibis	<i>Threskiornis melanocephalus</i> (Latham, 1790)	II	LC	R	I	BW, FL
		Eurasian Spoonbill	<i>Platalea leucorodia</i> (Linnaeus, 1758)	I	LC	R	I	BW, FL
		Glossy Ibis	<i>Plegadis falcinellus</i> (Linnaeus, 1766)	II	LC	R	I	BW, FL
Procellariiformes	Oceanitidae	Wilson's Storm Petrel	<i>Oceanites oceanicus</i> (Kuhl, 1820)	II	LC	WV	P	BC
Suliformes	Anhingidae	Oriental Darter	<i>Anhinga melanogaster</i> (Pennant, 1769)	II	NT	R	P	BW, FL
	Phalacrocoracidae	Indian Cormorant	<i>Phalacrocorax fuscicollis</i> (Stephens, 1826)	II	LC	R	P	BW, MG
		Little Cormorant	<i>Microcarbo niger</i> (Vieillot, 1817)	II	LC	R	P	BW, MG
Podicipediformes	Podicipedidae	Little Grebe	<i>Tachybaptus ruficollis</i> (Pallas, 1764)	II	LC	R	O	BW, MG
Anseriformes	Anatidae	Lesser Whistling Duck	<i>Dendrocygna javanica</i> (Horsfield, 1821)	II	LC	R	O	BW, MG

WPA status: I—Schedule I | II—Schedule II. IUCN Red List status: LC—Least Concern | VU—Vulnerable | NT—Near Threatened. Migration status: WV—Winter visitor | R—Resident. Feeding guild: C—Carnivore | I—Insectivore | O—Omnivore | P—Piscivore | F—Frugivore | N—Nectarivore. Habitats: BW—Backwater | BC—Beach | MG—Mangrove | FL—Farmlands.

November), Lesser Black-backed Gull *Larus fuscus* (n = 56 in January), Greater Crested Tern *Thalasseus bergii* and Brown-headed Gull *Chroicocephalus brunnicephalus* (n = 34 each in March and February, respectively), and Tibetan Sand Plover *Anarhynchus atrifrons* (n = 30 in December) (Image 5).

The Multiple correspondence analysis (MCA) showed clear habitat-associated assemblages of bird species across the study area (Image 6). The first two dimensions (dim) explained 38.7% of the total variance (dim.1: 22.14%, eigenvalue 0.4059; dim.2: 16.55%, eigenvalue 0.3034), indicating that these axes

captured the most significant patterns in species-habitat relationships (Table 2). Although subsequent dimensions each explained smaller proportions of variance, their contribution declined gradually, and interpretation was therefore focused on the first two axes for visualization. Species characteristic of beaches and sandbars, such as terns, plovers, and jaegers, clustered distinctly with the beach vector. While other species like Gulls, Tibetan Sand Plover, few species of terns like Common Tern *Sterna hirundo*, Little Tern *Sternula albifrons*, and Greater Crested Tern show overlapping habitat preferences of beaches, backwater, and mangroves. Backwater habitats

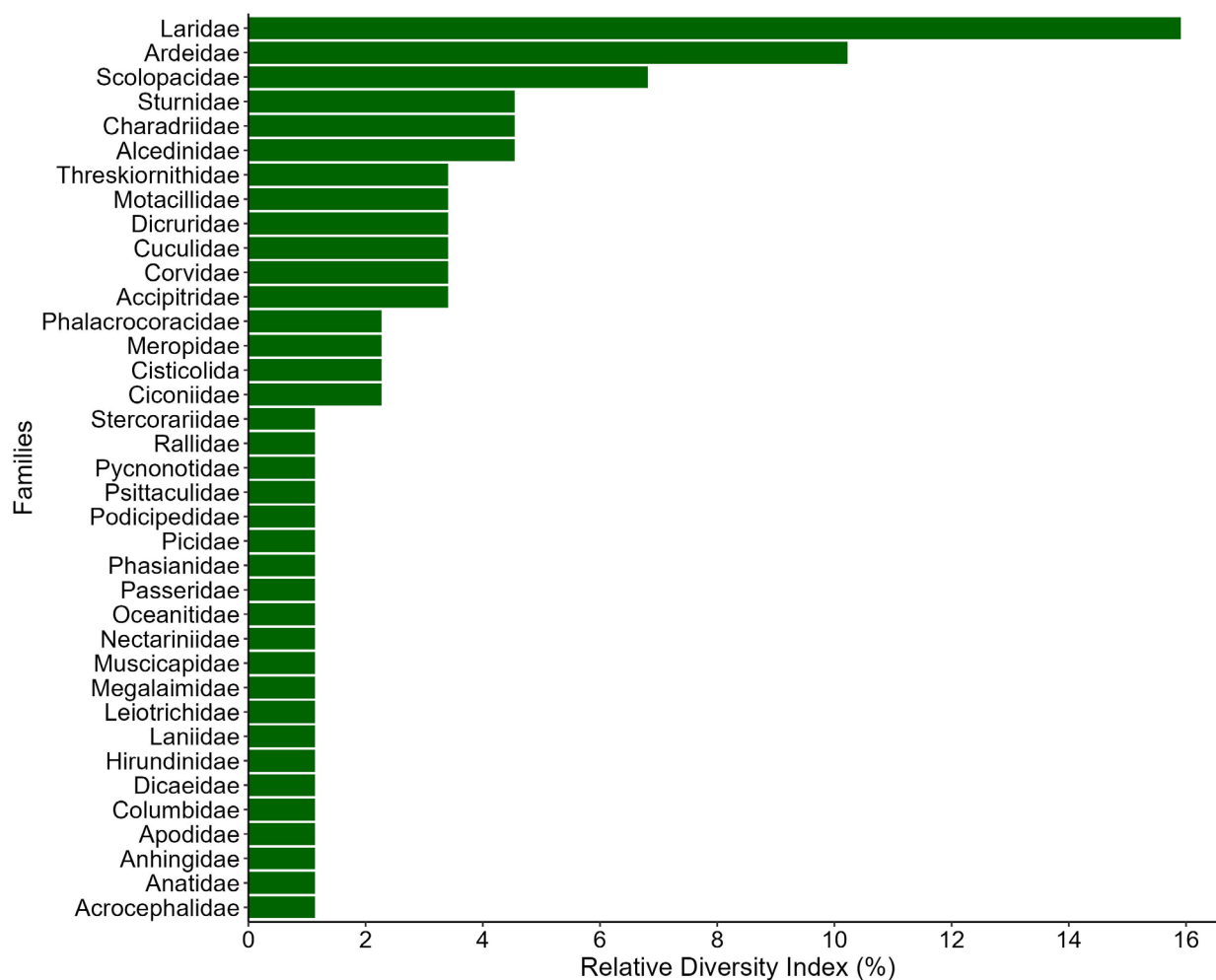


Image 3. Relative diversity index (%) of various families of avifauna recorded in Poovar.

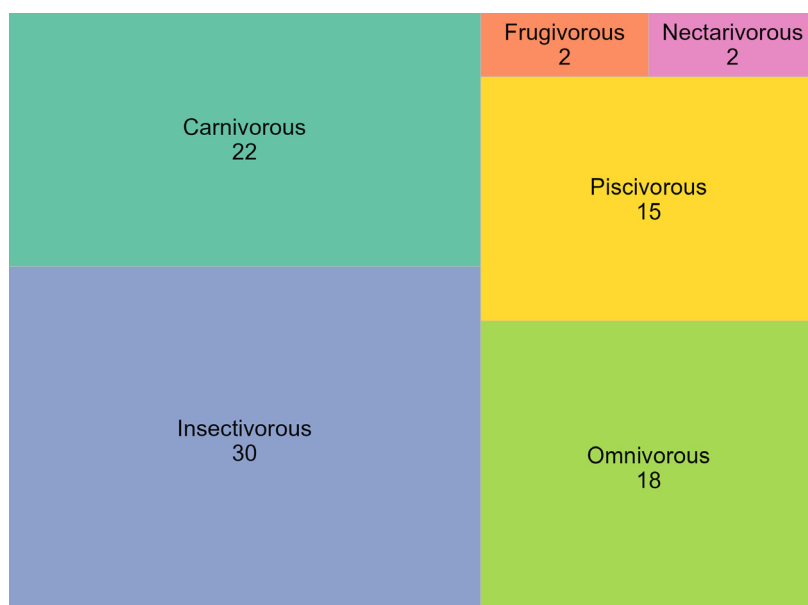


Image 4. Feeding guild composition of the avifauna in Poovar.

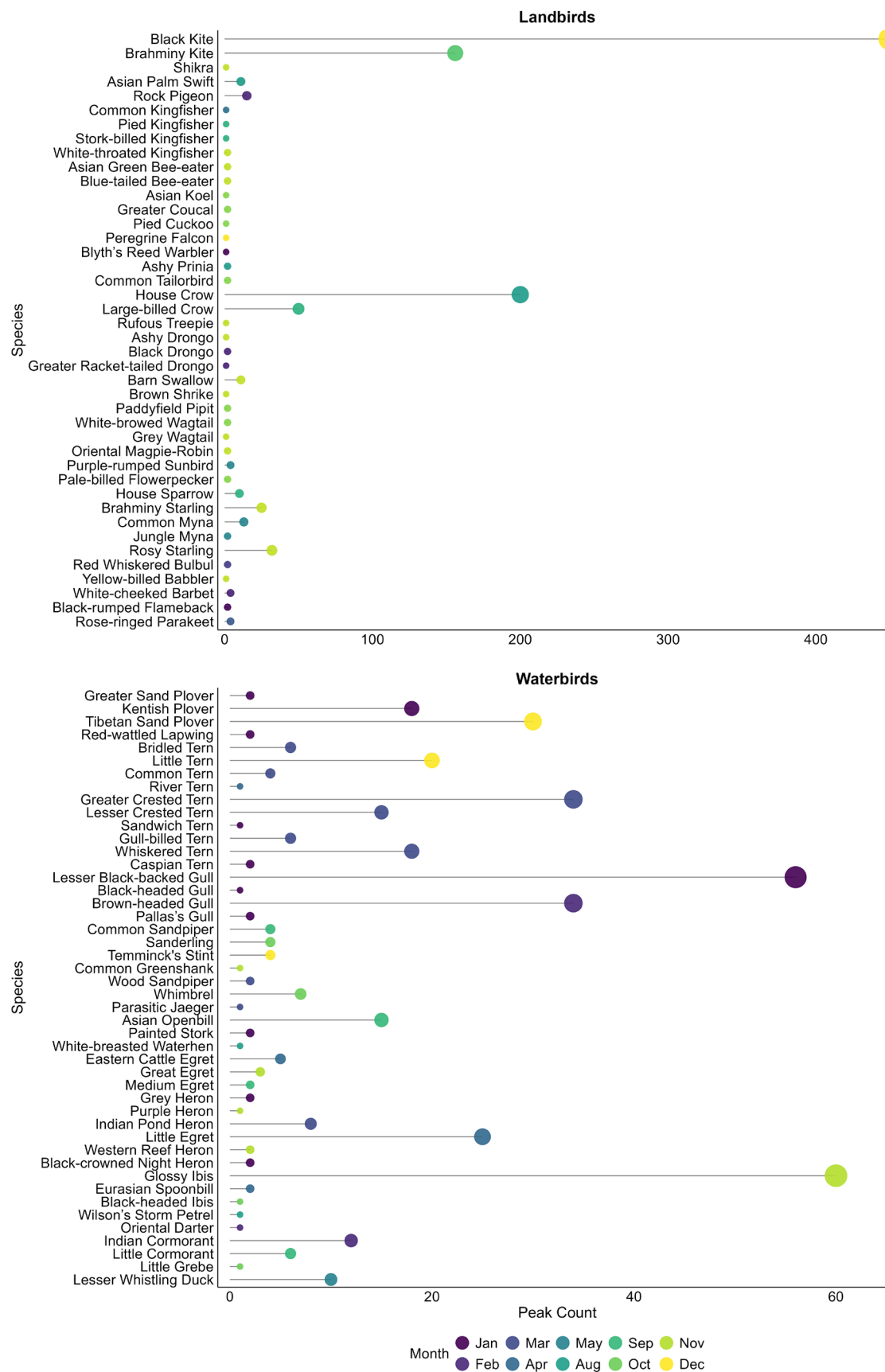


Image 5. Peak counts (one time) and the respective months of record of landbirds and waterbirds in Poovar.

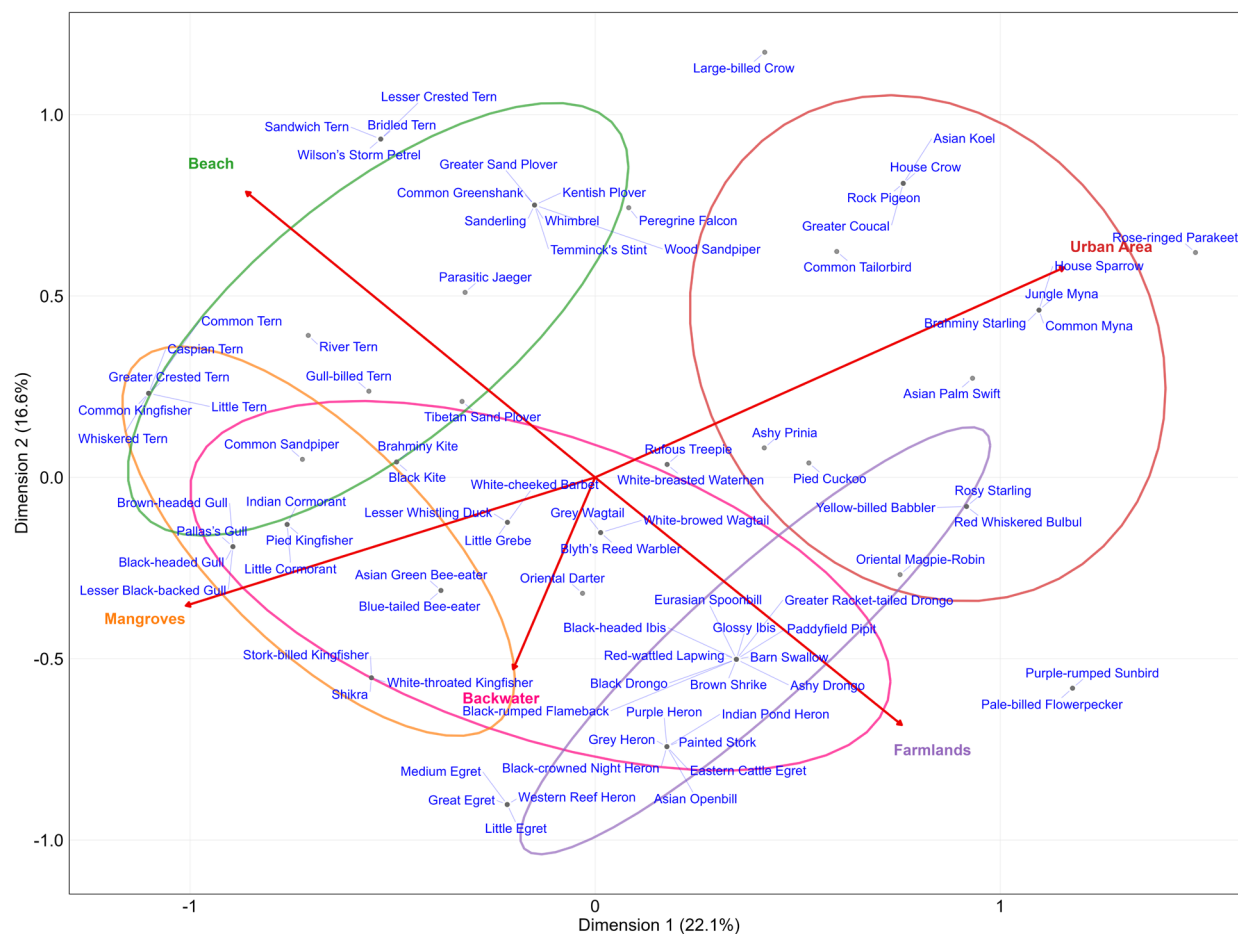


Image 6. Multiple correspondence analysis of the waterbirds and landbird species with diverse habitats in Poovar.

Table 2. Eigenvalues and percent variance explained by each multiple correspondence analysis dimension.

Dimensions	Eigenvalue	Variance percent
Dim.1	0.4059	22.14
Dim.2	0.3034	16.55
Dim.3	0.2198	11.99
Dim.4	0.1719	9.37
Dim.5	0.1711	9.33
Dim.6	0.1666	9.09
Dim.7	0.1411	7.69
Dim.8	0.1067	5.82
Dim.9	0.0581	3.17
Dim.10	0.0484	2.64
Dim.11	0.0397	2.16

showed a mixed assemblage of herons, egrets, storks, and ibises, with the majority of them overlapping with farmland habitats. Specific habitats, such as agricultural lands, were found to support the highest species richness of the insectivorous birds, whereas the wetland habitats

were strongly associated with birds in the piscivorous and carnivorous guild (Panda et al. 2021). Agricultural fields supporting wetland birds are well documented in recent studies (Byju et al. 2024c).

Urban habitats or the human settlement areas formed a discrete group in Poovar, primarily occupied by Passeriformes such as mynas, sparrows, coucal, koel, Common Tailor-bird *Orthotomus sutorius*, and pigeons. Very few landbird species, like Oriental Magpie Robin *Copsychus saularis*, Red-whiskered Bulbul *Pycnonotus jocosus*, among others, showed overlapping habitat preferences with both urban areas and farmlands. The size of each ellipse in the MCA plot represents the dispersion of species within that habitat category; larger ellipses indicate greater variability in species composition, just like composition, particularly in the backwater habitat (Image 7). In the MCA biplot, habitats represented by longer vectors, such as beach and urban areas, show species assemblages that are more distinct from the overall community, whereas shorter vectors

indicate less exclusive species associations and greater compositional overlap, as observed for backwater and mangrove habitats. Along dimension 1, beach and mangrove habitats are positioned on the negative axis, while urban and farmland habitats occur on the positive axis, reflecting contrasting assemblages. Backwater habitat occupies an intermediate position and overlap with other habitats, highlighting their transitional species composition.

Diversity, abundance, and distribution of waterbirds are determined by the distinctive characteristics of habitats and factors such as food availability, vegetation characteristics, water availability, water quality, among others (Ma et al. 2010). Waterbirds comprised the majority of the avifauna community in Poovar, with the order Charadriiformes being the dominant order. This aligned with the trend in other coastal ecosystems (Byju et al. 2025e), where species of Charadriidae and Laridae were the most abundant because of suitable feeding and roosting grounds, especially in heterogeneous habitats like estuaries, backwater, mangroves, and sandy beaches (Manikannan et al. 2012; Byju et al. 2024b). Such habitat mosaics offer diverse foraging substrates and water regimes, enabling partitioning of resources between different bird groups. Some bird species are associated with more than one habitat (Lorenzón et al. 2016). The occurrence of the same species in multiple habitat types indicates that the ecological and resource requirements of those species are fulfilled in both environments (Sharma et al. 2024). Similar patterns have been recorded in the Ashtamudi and Vembanad estuarine complexes of Kerala (Narayanan et al. 2011) and Perungulam wetland in Tamil Nadu (Mathibalan et al. 2026), where structurally complex wetlands supported higher bird diversities.

CONCLUSION

By sustaining diverse avian assemblages and facilitating breeding and seasonal occupancy, Poovar functions as a key node within the broader wetland network used by resident and migratory birds.

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