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43/2 Varadarajulu Nagar, 5<sup>th</sup> Street West, Ganapathy, Coimbatore, Tamil Nadu 641006, India  
Registered Office: 3A2 Varadarajulu Nagar, FCI Road, Ganapathy, Coimbatore, Tamil Nadu 641006, India  
Ph: +91 9385339863 | [www.threatenedtaxa.org](http://www.threatenedtaxa.org)  
Email: [sanjay@threatenedtaxa.org](mailto:sanjay@threatenedtaxa.org)

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Cover: Green Bee-eater with colour pencils and watercolor wash by Elakshi Mahika Molur.



## An annotated checklist of the avifauna of Karangadu mangrove forest, Ramanathapuram, Tamil Nadu, with notes on the site's importance for waterbird conservation

H. Byju<sup>1</sup> , N. Raveendran<sup>2</sup> , S. Ravichandran<sup>3</sup> & R. Kishore<sup>4</sup>

<sup>1,3</sup> Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai, Tamil Nadu 608502, India.

<sup>2</sup> Iragukal Amritha Nature Trust, 61, Ramachandra Thadaga street, Thirumangalam, Madurai, Tamil Nadu 625706, India.

<sup>4</sup> Sálím Ali Centre for Ornithology and Natural History, Anaikatty, Coimbatore, Tamil Nadu 641108, India.

<sup>1</sup> byjuhi@gmail.com (corresponding author), <sup>2</sup> lant.ravee@gmail.com, <sup>3</sup> sravicas@gmail.com, <sup>4</sup> kishorewfw@gmail.com

**Abstract:** Avifaunal inventories are crucial to the formulation of conservation and management strategies for habitats and species. An annotated checklist of the birds of the Karangadu eco-tourism area located in the Palk Bay in Ramanathapuram district of Tamil Nadu, was prepared. We listed a total of 107 species belonging to 18 orders and 40 families. Orders Charadriiformes, Suliformes, and Pelecaniformes dominated the habitat. Among the families, Scolopacidae (10 species) was dominant, followed by Ardeidae (9), and Laridae (8). In addition, the study also documented three globally 'Near Threatened' species: Painted Stork *Mycteria leucocephala*, Black-tailed Godwit *Limosa limosa*, and Black-headed Ibis *Threskiornis melanocephalus*. The observed frequency of the species was: 57% (61 spp.) common, 32.7% (35 spp.) uncommon, and 10.3% (11 spp.) rare. Categorization based on the residential status of birds revealed that 31% (33 spp.) were winter visitors, and one was a passage migrant (Rosy Starling *Pastor roseus*). These baseline data highlight the importance of Karangadu as an important site on the southeastern coast of India for migratory shorebird conservation priorities.

**Keywords:** Central Asian Flyway, Gulf of Mannar, mangroves, Palk Bay, shorebirds, winter visitors.

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## INTRODUCTION

India is biodiversity rich, with several distinct biogeographical zones and habitats housing 12.5% of world avian diversity (Praveen et al. 2016; Praveen & Jayapal 2022). Birds are indicators of ecosystem health (Bilgrami 1995; Piersma & Lindstrom 2004), and data on their occurrence is important for ecological assessments and management initiatives (Kati & Sekercioglu 2006). The significance of a specific landscape for avifaunal conservation can be recognized by assessing the structure of local bird communities (Kattan & Franco 2004). Information on avifauna is vital for an ecosystem conservation effort, as well as to understand the implications of habitat degradation/loss and climate change (Daniels et al. 1991; Peterson et al. 2000; Llanos et al. 2011).

In Tamil Nadu, several studies have been carried out on the bird diversity of wetlands including Kaliveli (Pieter 1987), Karaivetti (Gokula 2010), Pallikarainai (Raj et al. 2010), Point Calimere (Sugathan 1982), Singanallur Lake (Reginald et al. 2007), and Vaduvor (Gokula & Raj 2011). In the Ramanathapuram District of Tamil Nadu and adjoining areas of the Gulf of Mannar & Palk Bay regions, previous studies have been carried out from Rameswaram Island (Biddulph 1938) and Mandapam & its neighbouring islands (Balachandran 1990). Byju et al. (2023) described the avifaunal distribution on the 21 islands located in the Gulf of Mannar Biosphere Reserve.

In 2022, the Government of India announced the increase of Ramsar sites to 75, which included two wetlands (GOI 2022) from the Ramanathapuram District, prioritizing this area for bird and habitat conservation. Bird survey data provide useful insights for basic and applied ecology, as well as for identifying priority conservation areas (Daniels et al. 1991; Peterson et al. 2000). Some of the recently published records from this district include sighting of Arctic Skua *Stercorarius parasiticus* (Byju & Raveendran 2022a), and the first Asian record of Light-mantled Albatross *Phoebastria palpebrata* (Byju & Raveendran 2022b). Previous findings highlight the importance of this area, and prompted us to undertake a baseline survey based on a need for monitoring in new areas in the rapidly changing landscape. This study of Karangadu on the Palk Bay adjoining the Gulf of Mannar region could act as a base for further research into avian systematics, taxonomy, distribution, assessment, and management. This study also remarks on the regularity of observations, the relevance of birds, especially long-distance migratory shorebirds, and the conservation significance of this mangrove habitat.

## METHODS

### Study Area

Karangadu mangrove forest (9.6479°N & 78.9569°E) is located on the southeastern coast of India, adjoining the Palk Bay in the Ramanathapuram District of Tamil Nadu, India (Figure 1). It is an eco-tourism area run by the forest department with the support of the Eco Development Committee (EDC), involving the local fishermen community providing boating and bird-watching facilities for the public. The predominant vegetation of Karangadu is mangroves, which consists of *Avicennia marina* and *Rhizophora mucronata*. Many of unused areas were planted with mangroves in the last decade, converting the area to a mangrove forest from the estuary to the east coast road. This aids in supporting wading birds. Crabs, prawns, and other invertebrates inhabit the mangroves, regularly attracting a number of birds. Fishing activity and fish landing centres attract fish-eating birds. Small water bodies left over by unused salt pans as well as artificial pools with water released from prawn culture areas aid bird populations. The main habitat types observed in the study area include: Open water habitat and Mangroves (WL = Wetland); Trees (Tr) Palm and Tamarind trees; Shrub habitat (OS = Open Scrub type). The district receives rain from both the south-west and north-east monsoons. The district experiences a tropical climate. The months of May and June are generally hot and dry (Balachandran 1990).

This study on the avifauna of the Karangadu eco-tourism area was carried out between January 2017 and March 2018. A total of 12 field visits (one per month) were conducted to observe the diversity of birds. Field surveys were conducted in the morning (0700–1000 h) and evening (1600–1900 h), depending on the season when birds were most active. Opportunistic sightings were also made to compile the checklist of the birds of the region during the years 2019 to 2021, from September to March. Direct count for individual species and block count methods were employed for flocks for data collection (Howes & Bakewell 1989; Bibby et al. 2000). In the study area, waterbirds were counted at three scanning points (Figure 1), selected on the basis of preliminary surveys done in January 2016. Additional observations recorded while moving from one scanning point to another were treated as incidental records. Birds were observed using Nikon binoculars (10x50) and photographed with Canon 100–400 mm tele-lens, and were identified with the help of a field guide (Grimmett et al. 2011).

The residential status of birds was assessed as

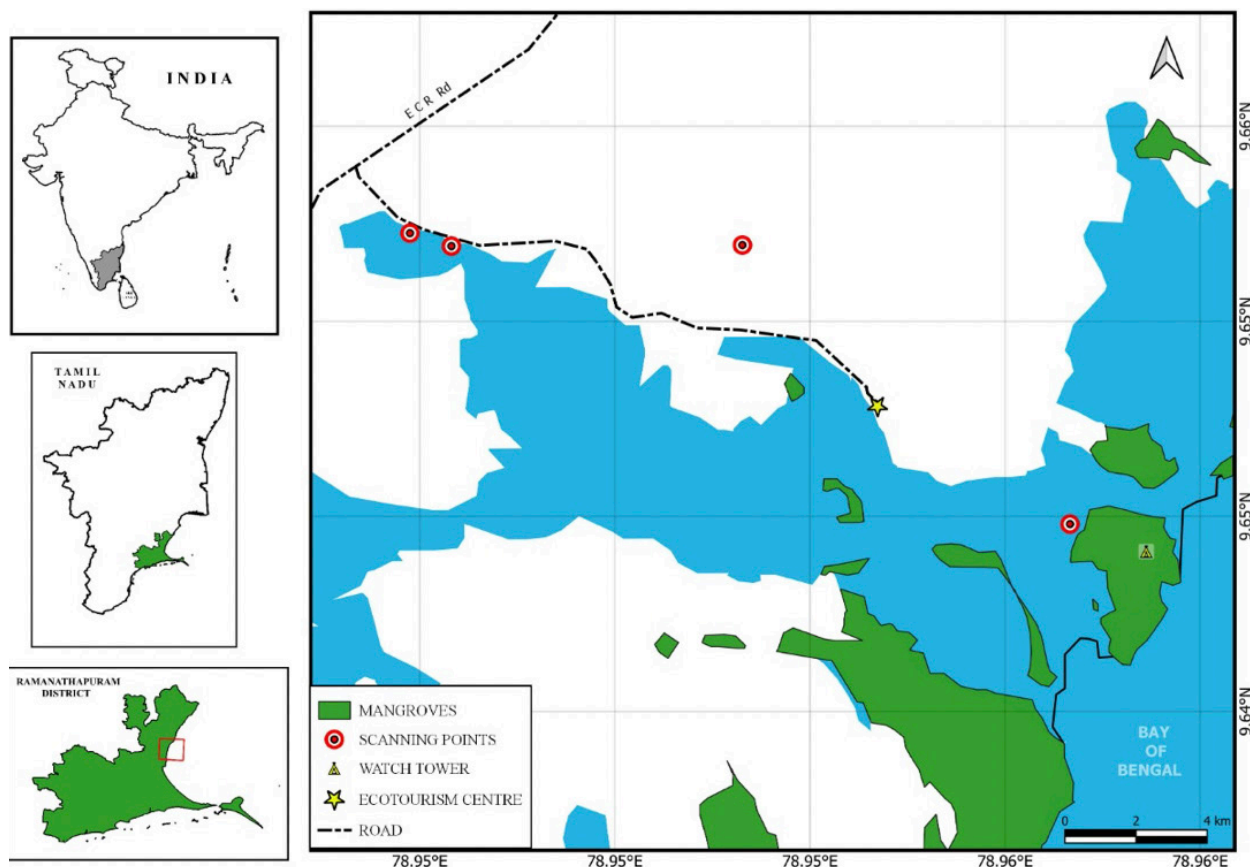


Figure 1. A map of the Karangadu mangrove ecotourism area with bird scanning points.

Resident (R), Passage Migrant (PM), and Winter Visitor (WV) depending on their timing and duration of occurrence (Grimmett et al. 2011). The International Union for the Conservation of Nature (IUCN 2022) status was additionally used to compare the local status with the global status. During the surveys, other information—like the role of EDC or threats to birds were noted. The data recorded in each survey was analyzed for relative abundance based on frequency of bird sightings, categorized as: Common (C), encountered on >60% of visits; Uncommon (UC), encountered 21–60% of visits; Rare (R), encountered on less than 20% of visits (McKinnon & Philips 1993).

## RESULTS AND DISCUSSION

### Avian community structure

A checklist of the Karangadu eco-tourism area in Ramanathapuram, Tamil Nadu, produced in the study includes a total of 107 avian species representing 40 families belonging to 18 orders. Passeriformes, with 17 families and 31 species, was dominant. But waterbirds

(n = 45) belonging to 11 families were abundant in numbers.

Our observations revealed that the families Scolopacidae (10 species) and Ardeidae (nine species) are followed by Laridae (eight species), Accipitridae (seven species), Charadriidae, and Cuculidae (six species each), Columbidae, Threskiornithidae, and Cisticolidae (four species each), and Alcedinidae, Corvidae, Sturnidae, and Alaudidae (three species each). Phasianidae, Meropidae, Strigidae, Phalacrocoracidae, Ciconiidae, Laniidae, Hirundinidae, Muscicapidae, Nectariniidae and Motacillidae (two species each); Podicipedidae, Upupidae, Coraciidae, Apodidae, Rallidae, Recurvirostridae, Falconidae, Phoenicopteridae, Oriolidae, Dicruridae, Monarchidae, Pycnonotidae, Timaliidae, Acrocephalidae, Estrildidae, and Passeridae (one species each) represented the major bird groups of the area. An annotated checklist of birds of the Karangadu mangrove area representing the orders and families is given in Table 1.

Among the total birds documented from the area, water birds were in the majority during all the surveys. We observed that several species of gulls and terns





Image 1. A flock of Marsh Sandpiper *Tringa stagnatilis* in the mangroves of Karangadu.

used the open regions inside the mangroves (Image 1) near the watchtower mainly for roosting. Waterbird abundance and diversity were influenced by factors in wetlands such as wetland area, depth of water and its quality, trophic level, and ideal roosting and breeding locations for birds (Wiens 1989; Mukherjee et al. 2002; Ma et al. 2010). Among the waterbirds, the order Charadriiformes dominated the study area, followed by the Pelecaniformes. Since most of the areas under study were covered with mangroves in the wetland area (Image 2), waterbirds represented the majority in numbers. As a result, we have focused on waterbirds (shorebirds, large wading birds, gulls, and terns) with special focus on shorebirds, both long-distance migrants and resident birds.

We recorded 18 shorebird species, of which 15 were Winter Visitors (WV), including the 'Near Threatened' Black-tailed Godwit *Limosa limosa*. Two species, namely Black-winged Stilt *Himantopus himantopus* and the Red-wattled Lapwing *Vanellus indicus* were Resident. One species, the Kentish Plover, could either be a Resident/Winter Visitor (R/WV), as we have recorded it during the non-breeding season. The most dominant species among the observed shorebirds were Common Sandpiper *Actitis hypoleucos* (peak count at one time:

620 in January), followed by Little Stint *Calidris minuta* (peak count at one time: 245 in January). Another 19 species of waterbirds, including herons, egrets, and ibises, were also recorded from this site, including the 'Near Threatened' Painted Stork *Mycteria leucocephala* and Black-Headed Ibis *Threskiornis melanocephalus*. The most dominant group of birds were the egrets: Great Egret *Ardea alba*, Intermediate Egret *Ardea intermedia*, and Little Egret *Egretta garzetta* (peak counts between 100 and 150 at one time, throughout the year). Moreover, this area also serves as an important foraging place for Greater Flamingo *Phoenicopterus roseus* (peak count at one time was 150 in February).

Six species of terns and two species of gulls were also recorded from the eco-tourism area. This was used as a roosting site by two gull species, namely Brown-headed Gull *Chroicocephalus brunnicephalus* and Black-headed Gull *Chroicocephalus ridibundus*, as well as two tern species, Lesser Crested Tern *Thalasseus bengalensis* and Greater Crested Tern *Thalasseus bergii*. Brown-headed gulls were the most dominant gull species (peak count at one time: 225 in February), and the Lesser Crested Tern represents the most dominant tern species (peak count at one time: 325 in February) among the terns. This observation goes in parallel with the reporting from

Table 1. An annotated checklist of the avifauna recorded from the Karangadu ecotourism area.

Scientific name	Common name	Migration status	IUCN Red List status	Frequency of observation	Habitat type
Order: Galliformes Family: Phasianidae					
<i>Pavo cristatus</i>	Indian Peafowl	R	LC	C	OS
<i>Francolinus pondicerianus</i>	Grey Francolin	R	LC	C	GL/OS
Order: Podicipediformes Family: Podicipedidae					
<i>Tachybaptus ruficollis</i>	Little Grebe	R	LC	C	WL
Order: Bucerotiformes Family: Upupidae					
<i>Upupa epops</i>	Common Hoopoe	R	LC	UC	GL
Order: Coraciiformes Family: Coraciidae					
<i>Coracias benghalensis</i>	Indian Roller	R	LC	C	OS
Family: Alcedinidae					
<i>Ceryle rudis</i>	Pied Kingfisher	R	LC	UC	WL
<i>Halcyon smyrnensis</i>	White-throated Kingfisher	R	LC	C	WL
<i>Alcedo atthis</i>	Common Kingfisher	R	LC	C	WL
Family: Meropidae					
<i>Merops orientalis</i>	Green Bee-eater	R	LC	C	OS
<i>Merops philippinus</i>	Blue-tailed Bee-eater	WV	LC	C	OS
Order: Cuculiformes Family: Cuculidae					
<i>Centropus sinensis</i>	Greater Coucal	R	LC	C	OS
<i>Eudynamis scolopaceus</i>	Asian Koel	R	LC	C	OS
<i>Phaenicophaeus viridirostris</i>	Blue-faced Malkoha	R	LC	C	OS
<i>Hierococcyx varius</i>	Common Hawk Cuckoo	R	LC	UC	OS
<i>Cuculus canorus</i>	Common Cuckoo	WV	LC	UC	OS
<i>Clamator jacobinus</i>	Pied Cuckoo	R	LC	UC	OS
Order: Psittaciformes Family: Psittacidae					
<i>Psittacula krameri</i>	Rose-ringed Parakeet	R	LC	C	Tr
Order: Strigiformes Family: Strigidae					
<i>Asio flammeus</i>	Short-eared Owl	WV	LC	R	GL/OS
<i>Athene brama</i>	Spotted Owlet	R	LC	UC	OS/Tr
Order: Columbiformes Family: Columbidae					
<i>Columba livia</i>	Rock Pigeon	R	LC	C	OS/GL
<i>Streptopelia decaocto</i>	Eurasian Collared-Dove	R	LC	C	OS/GL
<i>Spilopelia senegalensis</i>	Laughing Dove	R	LC	C	OS/GL
<i>Spilopelia chinensis</i>	Spotted Dove	R	LC	C	OS/GL
Order: Apodiformes Family: Apodidae					
<i>Cypsiurus balasiensis</i>	Asian Palm-swift	R	LC	C	Tr
Order: Gruiformes Family: Rallidae					
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	R	LC	C	WL
Order: Charadriiformes Family: Scolopacidae					
<i>Tringa glareola</i>	Wood Sandpiper	WV	LC	UC	WL

Scientific name	Common name	Migration status	IUCN Red List status	Frequency of observation	Habitat type
<i>Actitis hypoleucos</i>	Common Sandpiper	WV	LC	C	WL
<i>Calidris minuta</i>	Little Stint	WV	LC	UC	WL
<i>Calidris temminckii</i>	Temminck's Stint	WV	LC	R	WL
<i>Numenius phaeopus</i>	Whimbrel	WV	LC	UC	WL
<i>Limosa limosa</i>	Black-tailed Godwit	WV	NT	R	WL
<i>Calidris pugnax</i>	Ruff	WV	LC	R	WL
<i>Tringa stagnatilis</i>	Marsh Sandpiper	WV	LC	C	WL
<i>Tringa totanus</i>	Common Redshank	WV	LC	C	WL
<i>Tringa nebularia</i>	Common Greenshank	WV	LC	C	WL
Family: Charadriidae					
<i>Charadrius dubius</i>	Little Ringed Plover	WV	LC	UC	WL
<i>Pluvialis fulva</i>	Pacific Golden Plover	WV	LC	UC	WL
<i>Pluvialis squatarola</i>	Black-bellied Plover	WV	LC	UC	WL
<i>Charadrius mongolus</i>	Lesser Sand Plover	WV	LC	UC	WL
<i>Vanellus indicus</i>	Red-wattled Lapwing	R	LC	C	WL
<i>Charadrius alexandrinus</i>	Kentish Plover	WV/R	LC	C	WL
Family: Recurvirostridae					
<i>Himantopus himantopus</i>	Black-winged Stilt	R	LC	C	WL
Family: Laridae					
<i>Chlidonias hybrida</i>	Whiskered Tern	WV	LC	R	WL
<i>Hydroprogne caspia</i>	Caspian Tern	WV	LC	UC	WL
<i>Gelochelidon nilotica</i>	Gull-billed Tern	WV	LC	UC	WL
<i>Thalasseus bengalensis</i>	Lesser Crested Tern	WV	LC	C	WL
<i>Thalasseus bergii</i>	Greater Crested Tern	WV	LC	C	WL
<i>Sternula albifrons</i>	Little Tern	WV	LC	R	WL
<i>Chroicocephalus ridibundus</i>	Black-headed Gull	WV	LC	C	WL
<i>Chroicocephalus brunnicephalus</i>	Brown-headed Gull	WV	LC	C	WL
Order: Falconiformes					
Family: Falconidae					
<i>Falco tinnunculus</i>	Common Kestrel	WV	LC	R	OS/GL
Order: Accipitriformes					
Family: Accipitridae					
<i>Milvus migrans</i>	Black Kite	R	LC	UC	OS
<i>Elanus caeruleus</i>	Black-winged Kite	R	LC	C	OS
<i>Hieraetus pennatus</i>	Booted Eagle	WV	LC	R	OS/Tr
<i>Accipiter badius</i>	Shikra	R	LC	UC	GL/Tr/OS
<i>Pernis ptilorhynchus</i>	Oriental Honey Buzzard	R	LC	R	Tr
<i>Haliastur indus</i>	Brahminy Kite	R	LC	C	WL/GL
<i>Pandion haliaetus</i>	Osprey	WV	LC	R	WL
Order: Phoenicopteriformes					
Family: Phoenicopteridae					
<i>Phoenicopterus roseus</i>	Greater Flamingo	R	LC	UC	WL
Order: Suliformes					
Family: Phalacrocoracidae					
<i>Microcarbo niger</i>	Little Cormorant	R	LC	C	WL
<i>Phalacrocorax fuscicollis</i>	Indian Cormorant	R	LC	C	WL



Scientific name	Common name	Migration status	IUCN Red List status	Frequency of observation	Habitat type
Order: Pelicaniformes					
Family: Ardeidae					
<i>Ardea cinerea</i>	Grey Heron	R	LC	UC	WL
<i>Ardea purpurea</i>	Purple Heron	R	LC	UC	WL
<i>Egretta garzetta</i>	Little Egret	R	LC	C	WL
<i>Bubulcus ibis</i>	Cattle Egret	R	LC	C	WL
<i>Ardea alba</i>	Great Egret	R	LC	C	WL
<i>Ardea intermedia</i>	Intermediate Egret	R	LC	C	WL
<i>Ardeola grayii</i>	Indian Pond Heron	R	LC	C	WL
<i>Nycticorax nycticorax</i>	Black-crowned Night Heron	R	LC	C	WL
<i>Butorides striata</i>	Striated Heron	R	LC	UC	WL
Family: Threskiornithidae					
<i>Threskiornis melanocephalus</i>	Black-headed Ibis	R	NT	C	WL
<i>Plegadis falcinellus</i>	Glossy Ibis	R	LC	C	WL
<i>Pseudibis papillosa</i>	Red-naped Ibis	R	LC	C	WL
<i>Platalea leucorodia</i>	Eurasian Spoonbill	R	LC	C	WL
Order: Ciconiiformes					
Family: Ciconiidae					
<i>Anastomus oscitans</i>	Asian Openbill	R	LC	C	WL
<i>Mycteria leucocephala</i>	Painted Stork	R	NT	C	WL
Order: Passeriformes					
Family: Oriolidae					
<i>Oriolus kundoo</i>	Indian Golden Oriole	WV	LC	UC	OS
Family: Laniidae					
<i>Lanius vittatus</i>	Bay-backed Shrike	R	LC	C	OS
<i>Lanius cristatus</i>	Brown Shrike	WV	LC	UC	OS
Family: Dicruridae					
<i>Dicrurus macrocercus</i>	Black Drongo	R	LC	C	GL/OS
Family: Monarchidae					
<i>Terpsiphone paradisi</i>	Indian Paradise Flycatcher	R	LC	UC	OS/GL
Family: Corvidae					
<i>Dendrocitta vagabunda</i>	Rufous Treepie	R	LC	UC	OS
<i>Corvus macrorhynchos</i>	Large-billed Crow	R	LC	C	OS/GL/WL
<i>Corvus splendens</i>	House Crow	R	LC	C	OS/WL/GL
Family: Sturnidae					
<i>Acridotheres tristis</i>	Common Myna	R	LC	C	OS/GL
<i>Pastor roseus</i>	Rosy Starling	PM	LC	UC	OS/GL
<i>Sturnia pagodarum</i>	Brahminy Starling	R	LC	UC	OS/GL
Family: Hirundinidae					
<i>Cecropis daurica</i>	Red-rumped Swallow	R	LC	UC	WL
<i>Hirundo rustica</i>	Barn Swallow	WV	LC	UC	WL
Family: Pycnonotidae					
<i>Pycnonotus cafer</i>	Red-vented Bulbul	R	LC	C	OS/GL
Family: Timaliidae					
<i>Turdoides affinis</i>	Yellow-billed Babbler	R	LC	C	OS

Scientific name	Common name	Migration status	IUCN Red List status	Frequency of observation	Habitat type
Family: Cisticolidae					
<i>Prinia socialis</i>	Ashy Prinia	R	LC	C	OS/GL
<i>Prinia inornata</i>	Plain Prinia	R	LC	C	OS/GL
<i>Orthotomus sutorius</i>	Common Tailorbird	R	LC	C	OS/GL
<i>Cisticola juncidis</i>	Zitting Cisticola	R	LC	UC	OS/GL
Family: Acrocephalidae					
<i>Acrocephalus dumetorum</i>	Blyth's Reed Warbler	WV	LC	R	OS
Family: Alaudidae					
<i>Eremopterix griseus</i>	Ashy-crowned Sparrow Lark	R	LC	UC	OS/GL
<i>Galerida cristata</i>	Jerdon's Bushlark	R	LC	UC	OS/GL
<i>Alauda gulgula</i>	Oriental Skylark	R	LC	UC	OS/GL
Family: Muscicapidae					
<i>Copsychus fulcatus</i>	Indian Robin	R	LC	C	OS
<i>Copsychus saularis</i>	Oriental Magpie Robin	R	LC	C	OS
Family: Nectariniidae					
<i>Cinnyris asiaticus</i>	Purple-rumped Sunbird	R	LC	C	OS/GL
<i>Cinnyris asiaticus</i>	Purple Sunbird	R	LC	C	OS/GL
Family: Estrildidae					
<i>Lonchura punctulata</i>	Scaly-breasted Munia	R	LC	UC	OS
Family: Passeridae					
<i>Passer domesticus</i>	House Sparrow	R	LC	C	GL
Family: Motacillidae					
<i>Motacilla maderaspatensis</i>	White-browed Wagtail	R	LC	C	WL
<i>Anthus rufulus</i>	Paddyfield Pipit	R	LC	UC	GL

LC—Least Concern | NT—Near Threatened | EN—Endangered | PM—Passage Migrant | WV—Winter Visitor | LM—Local Migrant | R—Resident | R—Rare | C—Common | UC—Uncommon | WL—Wetland | GL—Grass Land | OS—Open Scrub | Tr—Trees on the peripheries and the village area.



Image 2. A view of the water pools inside the mangrove area from the watch tower at Karangadu.

the west coast site of Kadalundi-Vallikkunnu Community Reserve (Aarif et al. 2017).

In terms of distribution and migratory status, 73 species were found to be Resident, 32 Winter Visitors, one WV/R, and one Passage Migrant (PM) including the Rosy Starling *Pastor roseus* (Table 1). Based on the frequency of sightings, 61 species were Common, 35 were Uncommon, and 11 were Rare. In addition to this, habitat-wise avian richness was also recorded. The wetland had the most species presence (55 spp.), followed by open scrub (OS, 49 spp.) and grassland (GL, 29 spp.). The maximum number of different bird species occupying various habitats, shows their capacity to occupy diversified habitats. Varied feeding niches have enhanced the bird diversity of the study area. Among the land birds documented in Karangadu, eight raptor species were identified: the Black Kite *Milvus migrans*, Black-winged Kite *Elanus caeruleus*, Booted Eagle *Hieraetus pennatus*, Brahminy Kite *Haliastur indus*, Common Kestrel *Falco tinnunculus*, Oriental Honey Buzzard *Pernis ptilorhynchus*, Osprey *Pandion haliaetus* and Shikra *Accipiter badius*. In addition to birds of prey, two nectarivorous birds, the Purple Sunbird *Cinnyris asiaticus* and the Purple-rumped Sunbird *Leptocoma zeylonica* were common in the areas adjacent to the mangroves.

### Conservation Significance

Stop-over sites are critical for long-distance migrant shorebirds migrating between wintering and breeding areas (Boere et al. 2006). Karangadu's proximity to the Important Bird Areas of Sri Lanka and the Gulf of Mannar may provide a link between the country's other major east coast shorebird sites, and other wintering sites along the Central Asian Flyway. Karangadu sandwiches the established shorebird wintering sites of Point Calimere and the Gulf of Mannar. This site serves as an ideal place of roosting for gulls, terns, long-migrant shorebirds, and Greater Flamingos, which makes this wintering site very important for further monitoring and conservation-related activities.

For effective conservation to be implemented, and for future strategies to be adopted, the role, contribution, and participation of the local community are essential (Sinthumule & Netshisaulu 2022). The forest department-initiated EDC-run eco-tourism project in Karangadu is in the right perspective because of the active involvement of the fishermen community in boating and bird watching for the public. This helps in the general upkeep of the mangrove habitat along with avian conservation, as the revenue earned from tourism

is being used by the local community. The newly planted 30-acre areas of mangroves (represented by *Rhizophora apiculata*, *R. mucronata*, and *Avicennia* spp.; developed with the help of the local community in 2015), are serving as an ideal habitat for waterbirds. This might have improved the area's avian diversity and richness. Nevertheless, in the tree habitat (Tr) in the peripheries, the avian richness was quite low, as only six species were recorded (Table 1). The current observations emphasize the value of wetlands and associated areas as avian habitats, as sizable number of species was found in more than one habitat. The inclusion of local communities in conservation has helped in habitat restoration and natural resource conservation programs in recent times (Silori 2007; Nepal & Spiteri 2011; Badola et al. 2012; Scholte et al. 2016; Sinthumule 2021). Controlled seasonal tourism by boating without disturbing habitats through the water channels could boost revenue, and the money raised could be further used for conservation initiatives. Hence, we propose that to check and devise strategies and activities for conservation, Karangadu mangrove areas should be declared a bird sanctuary.

### CONCLUSION

Aside from the established shorebird monitoring sites, regular long-term monitoring, and assessment of the Karangadu eco-tourism area, an important wintering site on the east coast, should be carried out in the future to establish the importance of this area on the flyway. Furthermore, because the community members are engaged in ecotourism activities other than fishing and crab harvesting, they may be effectively educated on the significance and necessity of preserving and sustaining a balanced environment. This study has provided preliminary information on selected shorebirds as well as other waterfowl from the Karangadu eco-tourism area, which will be beneficial for future research in this area as well as demonstrating the importance of designating this as a protected area of conservation importance.

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Dr. George Mathew, Kerala Forest Research Institute, Peechi, India  
Dr. John Noyes, Natural History Museum, London, UK  
Dr. Albert G. Orr, Griffith University, Nathan, Australia  
Dr. Sameer Padhye, Katholieke Universiteit Leuven, Belgium  
Dr. Nancy van der Poorten, Toronto, Canada  
Dr. Kareen Schnabel, NIWA, Wellington, New Zealand  
Dr. R.M. Sharma, (Retd.) Scientist, Zoological Survey of India, Pune, India  
Dr. Manju Siliwal, WILD, Coimbatore, Tamil Nadu, India  
Dr. G.P. Sinha, Botanical Survey of India, Allahabad, India  
Dr. K.A. Subramanian, Zoological Survey of India, New Alipore, Kolkata, India  
Dr. P.M. Sureshan, Zoological Survey of India, Kozhikode, Kerala, India  
Dr. R. Varatharajan, Manipur University, Imphal, Manipur, India  
Dr. Eduard Vives, Museu de Ciències Naturals de Barcelona, Terrassa, Spain  
Dr. James Young, Hong Kong Lepidopterists' Society, Hong Kong  
Dr. R. Sundararaj, Institute of Wood Science & Technology, Bengaluru, India  
Dr. M. Nithyanandan, Environmental Department, La Ala Al Kuwait Real Estate. Co. K.S.C., Kuwait  
Dr. Himender Bharti, Punjabi University, Punjab, India  
Mr. Purnendu Roy, London, UK  
Dr. Saito Motoki, The Butterfly Society of Japan, Tokyo, Japan  
Dr. Sanjay Sondhi, TITLI TRUST, Kalpavriksh, Dehradun, India  
Dr. Nguyen Thi Phuong Lien, Vietnam Academy of Science and Technology, Hanoi, Vietnam  
Dr. Nitin Kulkarni, Tropical Research Institute, Jabalpur, India  
Dr. Robin Wen Jiang Ngiam, National Parks Board, Singapore  
Dr. Lionel Monod, Natural History Museum of Geneva, Genève, Switzerland.  
Dr. Asheesh Shivam, Nehru Gram Bharti University, Allahabad, India  
Dr. Rosana Moreira da Rocha, Universidade Federal do Paraná, Curitiba, Brasil  
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Dr. James M. Carpenter, American Museum of Natural History, New York, USA  
Dr. David M. Claborn, Missouri State University, Springfield, USA  
Dr. Kareen Schnabel, Marine Biologist, Wellington, New Zealand  
Dr. Amazonas Chagas Júnior, Universidade Federal de Mato Grosso, Cuiabá, Brasil  
Mr. Monsoon Jyoti Gogoi, Assam University, Silchar, Assam, India  
Dr. Heo Chong Chin, Universiti Teknologi MARA (UiTM), Selangor, Malaysia  
Dr. R.J. Shiel, University of Adelaide, SA 5005, Australia  
Dr. Siddharth Kulkarni, The George Washington University, Washington, USA  
Dr. Priyadarsanan Dharma Rajan, ATREE, Bengaluru, India  
Dr. Phil Alderslade, CSIRO Marine And Atmospheric Research, Hobart, Australia  
Dr. John E.N. Veron, Coral Reef Research, Townsville, Australia  
Dr. Daniel Whitmore, State Museum of Natural History Stuttgart, Rosenstein, Germany.  
Dr. Yu-Feng Hsu, National Taiwan Normal University, Taipei City, Taiwan  
Dr. Keith V. Wolfe, Antioch, California, USA  
Dr. Siddharth Kulkarni, The Hormiga Lab, The George Washington University, Washington, D.C., USA  
Dr. Tomas Ditrich, Faculty of Education, University of South Bohemia in Ceske Budejovice, Czech Republic  
Dr. Mihaly Foldvari, Natural History Museum, University of Oslo, Norway  
Dr. V.P. Uniyal, Wildlife Institute of India, Dehradun, Uttarakhand 248001, India  
Dr. John T.D. Caleb, Zoological Survey of India, Kolkata, West Bengal, India  
Dr. Priyadarsanan Dharma Rajan, Ashoka Trust for Research in Ecology and the Environment (ATREE), Royal Enclave, Bangalore, Karnataka, India

Fishes

Dr. Neelesh Dahanukar, IISER, Pune, Maharashtra, India  
Dr. Topiltzin Contreras MacBeath, Universidad Autónoma del estado de Morelos, México  
Dr. Heok Hee Ng, National University of Singapore, Science Drive, Singapore  
Dr. Rajeev Raghavan, St. Albert's College, Kochi, Kerala, India  
Dr. Robert D. Sluka, Chiltern Gateway Project, A Rocha UK, Southall, Middlesex, UK  
Dr. E. Vivekanandan, Central Marine Fisheries Research Institute, Chennai, India  
Dr. Davor Zanella, University of Zagreb, Zagreb, Croatia  
Dr. A. Biju Kumar, University of Kerala, Thiruvananthapuram, Kerala, India  
Dr. Akhilesh K.V., ICAR-Central Marine Fisheries Research Institute, Mumbai Research Centre, Mumbai, Maharashtra, India  
Dr. J.A. Johnson, Wildlife Institute of India, Dehradun, Uttarakhand, India  
Dr. R. Ravinesh, Gujarat Institute of Desert Ecology, Gujarat, India

Amphibians

Dr. Sushil K. Dutta, Indian Institute of Science, Bengaluru, Karnataka, India  
Dr. Annemarie Ohler, Muséum national d'Histoire naturelle, Paris, France

Reptiles

Dr. Gernot Vogel, Heidelberg, Germany  
Dr. Raju Vyas, Vadodara, Gujarat, India  
Dr. Pritpal S. Soorae, Environment Agency, Abu Dubai, UAE.  
Prof. Dr. Wayne J. Fuller, Near East University, Mersin, Turkey  
Prof. Chandrashekher U. Rivonker, Goa University, Taleigao Plateau, Goa. India  
Dr. S.R. Ganesh, Chennai Snake Park, Chennai, Tamil Nadu, India  
Dr. Himansu Sekhar Das, Terrestrial & Marine Biodiversity, Abu Dhabi, UAE

Birds

Dr. Hem Sagar Baral, Charles Sturt University, NSW Australia  
Mr. H. Byju, Coimbatore, Tamil Nadu, India  
Dr. Chris Bowden, Royal Society for the Protection of Birds, Sandy, UK  
Dr. Priya Davidar, Pondicherry University, Kalapet, Puducherry, India  
Dr. J.W. Duckworth, IUCN SSC, Bath, UK  
Dr. Rajah Jayapal, SACON, Coimbatore, Tamil Nadu, India  
Dr. Rajiv S. Kalsi, M.L.N. College, Yamuna Nagar, Haryana, India  
Dr. V. Santharam, Rishi Valley Education Centre, Chittoor Dt., Andhra Pradesh, India  
Dr. S. Balachandran, Bombay Natural History Society, Mumbai, India  
Mr. J. Praveen, Bengaluru, India  
Dr. C. Srinivasulu, Osmania University, Hyderabad, India  
Dr. K.S. Gopi Sundar, International Crane Foundation, Baraboo, USA  
Dr. Gombobaatar Sunde, Professor of Ornithology, Ulaanbaatar, Mongolia  
Prof. Reuven Yosef, International Birding & Research Centre, Eilat, Israel  
Dr. Taej Mundkur, Wetlands International, Wageningen, The Netherlands  
Dr. Carol Inskipp, Bishop Auckland Co., Durham, UK  
Dr. Tim Inskipp, Bishop Auckland Co., Durham, UK  
Dr. V. Gokula, National College, Tiruchirappalli, Tamil Nadu, India  
Dr. Arkady Lelej, Russian Academy of Sciences, Vladivostok, Russia  
Dr. Simon Dowell, Science Director, Chester Zoo, UK  
Dr. Mário Gabriel Santiago dos Santos, Universidade de Trás-os-Montes e Alto Douro, Quinta de Prados, Vila Real, Portugal  
Dr. Grant Connette, Smithsonian Institution, Royal, VA, USA  
Dr. M. Zafar-ul Islam, Prince Saud Al Faisal Wildlife Research Center, Taif, Saudi Arabia

Mammals

Dr. Giovanni Amori, CNR - Institute of Ecosystem Studies, Rome, Italy  
Dr. Anwaruddin Chowdhury, Guwahati, India  
Dr. David Mallon, Zoological Society of London, UK  
Dr. Shomita Mukherjee, SACON, Coimbatore, Tamil Nadu, India  
Dr. Angie Appel, Wild Cat Network, Germany  
Dr. P.O. Nameer, Kerala Agricultural University, Thrissur, Kerala, India  
Dr. Ian Redmond, UNEP Convention on Migratory Species, Lansdown, UK  
Dr. Heidi S. Riddle, Riddle's Elephant and Wildlife Sanctuary, Arkansas, USA  
Dr. Karin Schwartz, George Mason University, Fairfax, Virginia.  
Dr. Lala A.K. Singh, Bhubaneswar, Orissa, India  
Dr. Mewa Singh, Mysore University, Mysore, India  
Dr. Paul Racey, University of Exeter, Devon, UK  
Dr. Honnavalli N. Kumara, SACON, Anaikatty P.O., Coimbatore, Tamil Nadu, India  
Dr. Nishith Dharaia, HNG University, Patan, Gujarat, India  
Dr. Spartaco Gippoliti, Socio Onorario Società Italiana per la Storia della Fauna "Giuseppe Altobello", Rome, Italy  
Dr. Justus Joshua, Green Future Foundation, Tiruchirappalli, Tamil Nadu, India  
Dr. H. Raghuram, The American College, Madurai, Tamil Nadu, India  
Dr. Paul Bates, Harison Institute, Kent, UK  
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Dr. Dan Challender, University of Kent, Canterbury, UK  
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Tamil Nadu 641006, India  
ravi@threatenedtaxa.org

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