

A study on avian biodiversity of Kadamakkudy Wetlands, Ernakulam District, Kerala

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ABSTRACT

Birds are an integral part of nature and constitute one of earth's most important and diverse species, which inhabits various habitats, including forests, grasslands, swamps, shores, agricultural fields, scrubs, lakes, etc. A study on the avian biodiversity of Kadamakkudy wetlands in Ernakulam district, Kerala, was carried out from February 2018 to February 2019. The observations from the study reveals that, the rivers, lakes, marshes and Pokkali rice fields of Kadamakkudy are a suitable habitat for residents and migratory birds. A total of 100 species of birds belonging to 14 orders and 40 families were recorded during the study. Out of the 100 species, 55 were resident species, 37 were transcontinental migrants, five species were local migrants and three species were vagrants. Order Passeriformes represented highest number of species followed by Charadriiformes, Anseriformes, and Pelecaniformes. The total number of species ranged from 58 to 11 in a month with the highest number during February 2018 and lowest during June 2018. Maximum number of individuals were recorded during February 2018 and a minimum during August 2018. Piscivores were dominant in the study area followed by the granivores. Lesser whistling duck (*Dendrocygna javanica*), Garganey (*Spatula querquedula*), Little Cormorant (*Microcarbo niger*), Glossy Ibis (*Plegadis falcinellus*), Pacific Golden Plover (*Pluvialis fulva*) and Lesser Sand Plover (*Charadrius mongolus*) were the bird species observed in greater numbers. The Nesting of Streaked Weaver (*Ploceus manyar*) was observed in the adjacent reeds during March- April. Even though, Kadamakkudy wetlands are a paradise for wetland birds, the habitat faces several threats. Anthropogenic activities like illegal land reclamation, unscientific developmental activities, poaching and tourism create lots of menace.

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1. Introduction

India is one of the twelve megadiverse countries of the world with more than 1300 species of birds of the world. India accounts for more than 13% of the world's avifauna (Grimmett and Inskipp, 2010). The state of Kerala has about 550 bird species including the residents as well as the migrants (eBird, 2023). Geographically, Kerala is mainly divided into highlands, coastal areas and wetlands, including the backwaters, lakes, rivers etc. Wetlands are complex ecosystems with several interacting organisms (Smith and Johnson, 2018). IUCN (1971) defined wetlands as areas of marsh, ponds, or swamps, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh or brackish or salt, including that of marine water, the depth of which at low tide does not exceed six meters. Wetlands are vital worldwide for wildlife protection, recreation, pollution and sediment control, flood prevention, and food production.

Kerala is well known for its diversity on wetlands, which spread all along the coast and inland. Major coastal wetlands in Kerala are Vellayani Kayal, Aakkulam-Veli backwater stretch, Kayamkulam Pozhi, Kumarakom, Mangalavanam, Kole wetlands, Purathur estuary, Manoor Kayal, Chervarpur Kayal, Kadalundy estuary, Azhinjilam, Dharmadom estuary, Kattampalli, Ezhimala, Chempallikundu and Mangrove areas (Kurup,1996). The important freshwater bodies include Sasthamkotta, Pookot and Muriyad.

Birds are considered an integral part of a wetland ecosystem (Custer and Osborn, 1977). Since wetlands serve as ideal ecosystems for birds throughout the year, the wetlands

are declared important bird areas by Birdlife International (Deepak *et al.*, 2017). According to Kumar *et al.*, 2005, 23% of the total bird species found in India depend on the wetlands. The distribution of the birds in a habitat depends on the water depth, type of vegetation, the salinity of the water, pollution, anthropogenic disturbances in the habitat and the relative abundance depends directly on the habitat, habitat structure, vegetation and availability of food resources (Wienes, 1992; Caziani and Derlindate 2000). Kadamakkudy is an important area for Pokkali and shrimp cultivation (Babu and Thomas, 2022). 154 species of birds have been reported from this site (eBird, 2023). In a comparative study (2016- 2019) conducted by Babu and Thomas in the Pokkali fields of Ernakulam district, Valiya Kadamakkudy reported the highest species richness of 83.

2. Materials and Methods

2.1 Study area

Kadamakkudy islands is a group of fourteen islands consisting of Murikkal, Palyam Thuruth, Kandanad, Cheriya Kadamakkudy, Pulikkapuram, Moolampilly, Puthussery, Chariyam Thuruth, Chennur, Kothad, Pizhala, Korambadam, and Karikkad Thuruthu (Fig.1).

The wetland provides a home to a variety of indigenous as well as migratory birds. Kadamakkudy is also an important area of Pokkali cultivation. The wetland is used for Pokkali cultivation for 6 months and the rest 6 months are used for prawn farming. The area is highly influenced by the tides. More number of birds are observed during the low tides. The area is considered one of the birding hot spots in the Ernakulam district. The wetland is under threat due



Fig. 1. Map showing Kadamakkudy, the study location

to recent developmental activities. The District Tourism Promotion Council (DTPC) has initiated plans to facelift Kadamakkudy by setting up mangrove parks, floating restaurants, handicraft markets, and adventure water sports. These activities and an increase in the number of visitors could affect the rich diversity of birds in this area.

2.2 Methodology

The study was conducted from February 2018 to February 2019. Continuous observations were carried out in the study area during these months. The study area was covered on foot and the data were collected fortnightly. The most preferred time for recording bird activity was from 6.00 am to 9.00 am. The line transect and point count method were used to record the birds. Birds were individually counted in the case of small flocks and the block count method was employed in the case of large flocks. Identification of birds were done as per Ali (1969), Ali and Ripely (1969), Grimmet and Inskipp (2005). Website ebird.org and help from expert birders were also availed for bird identification. Binoculars (Nikon Aculon) and a digital camera with a lens of 70-300 mm were used to observe birds. The data collected was analysed. Dominance (D), Simpson index (1-D), Shannon Weiner index (H) and Evenness (e^H/S) were calculated using the PAST Software (PAST version 4.03) (Hammer *et al.*, 2001). The common English names used in this paper follows Chandran *et al.*, (2023).

3. Results

A total of 100 species of birds belonging to 14 orders and 40 families were recorded during the study, out of which, 55 were resident species, 37 were transcontinental migrants, 5 were local migrants and 3 were vagrants (Table 1). River Tern (*Sterna aurantia*), listed as Vulnerable category and Bar-tailed Godwit (*Limosa lapponica*) as well as Black-tailed Godwit (*Limosa limosa*) listed as Near Threatened

category on Red List by IUCN were recorded from Kadamakkudy during the present study.

A greater number of bird species were observed during the months of October, November, February and March which is the migratory season of birds in Kerala. Species richness was highest in the month of February 2018 with 58 species and lowest in the month of June 2018 with 11 species. During the present study, maximum number of individuals were recorded in February 2018 (1548) and the minimum in June 2018 (30) (Table 2).

The Simpson diversity index was maximum in May 2018 (0.95) and minimum in July 2018 (0.25), whereas the. In contrast, the was observed maximum as in the month 3.33) and minimum in the month of July 2018 (0.76) (Table 3). This diversity indices can be compared with other wetlands. Jayson 2005, in a study on ecology of wetland birds in the Kole wetlands of Kerala recorded Shannon diversity index as 3.11.

The waders and waterfowls were present in abundance in the study area. According to the data, most abundant species are Lesser Whistling-duck (*Dendrocygna javanica*), Garganey (*Spatula querquedula*), Little Cormorant (*Microcarbo niger*), Glossy ibis (*Plegadis falcinellus*), Pacific Golden Plover (*Pluvialis fulva*), and Lesser Sand Plover (*Charadrius mongolus*) (Table 1). Species like Little Egret (*Egretta garzetta*), Indian Pond Heron (*Ardeola grayii*), White-throated Kingfisher (*Halcyon smyrnensis*), Stork-billed Kingfisher (*Pelargopsis capensis*), House Crow (*Corvus splendens*), Brahminy Kite (*Haliastur indus*) and Grey Heron (*Ardea cinerea*) were seen in almost every month of a year.

Dominant orders recorded was Passeriformes followed by Charadriiformes. Order Columbiformes, Cuculiformes, Piciformes and Psittaciformes were the least represented orders (Fig. 2).

Table 1. List of birds recorded from the study area

Sl.no	Species	Scientific name	Family	Order	Status	IUCN status	Mean \pm SD
1.	Lesser Whistling Duck	<i>Dendrocygna javanica</i>	Anatidae	Anseriformes	Resident	Least Concern	27.85 \pm 56.19
2.	Ruddy Shelduck	<i>Tadorna ferruginea</i>	Anatidae	Anseriformes	Vagrant	Least Concern	0.08 \pm 0.28
3.	Garganey	<i>Spatula querquedula</i>	Anatidae	Anseriformes	Winter Visitor	Least Concern	20.23 \pm 0.28
4.	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	Anatidae	Anseriformes	Winter Visitor	Least Concern	0.08 \pm 0.28
5.	Northern Pintail	<i>Anas acuta</i>	Anatidae	Anseriformes	Winter Visitor	Least Concern	0.54 \pm 1.45
6.	Rock Pigeon	<i>Columba livia</i>	Columbidae	Columbiformes	Resident	Least Concern	0.54 \pm 1.33
7.	Greater Coucal	<i>Centropus sinensis</i>	Cuculidae	Cuculiformes	Resident	Least Concern	0.23 \pm 0.6
8.	Asian Koel	<i>Eudynamis scolopaceus</i>	Cuculidae	Cuculiformes	Resident	Least Concern	0.46 \pm 0.78
9.	Asian Palm Swift	<i>Cypsiurus balasiensis</i>	Apodidae	Apodiformes	Resident	Least Concern	0.62 \pm 1.71
10.	Common Moorhen	<i>Gallinula chloropus</i>	Rallidae	Gruiformes	Resident	Least Concern	0.07 \pm 0.28
11.	Grey-headed Swampphen	<i>Porphyrio poliocephalus</i>	Rallidae	Gruiformes	Resident	Least Concern	3.77 \pm 4.04
12.	Watercock	<i>Gallix rex cinerea</i>	Rallidae	Gruiformes	Resident	Least Concern	0.08 \pm 0.28
13.	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	Rallidae	Gruiformes	Resident	Least Concern	0.38 \pm 0.51
14.	Ruddy-breasted Crake	<i>Zapornia fusca</i>	Rallidae	Gruiformes	Resident	Least Concern	0.15 \pm 0.38
15.	Baillon's Crake	<i>Zapornia pusilla</i>	Rallidae	Gruiformes	Winter Visitor	Least Concern	0.08 \pm 0.28
16.	Black-winged Stilt	<i>Himantopus himantopus</i>	Recurvirostridae	Charadriiformes	Winter Visitor	Least Concern	9.77 \pm 14.52
17.	Pacific Golden Plover	<i>Pluvialis fulva</i>	Charadriidae	Charadriiformes	Winter Visitor	Least concern	13.46 \pm 36.29
18.	Red-wattled Lapwing	<i>Vanellus indicus</i>	Charadriidae	Charadriiformes	Resident	Least concern	0.92 \pm 1.04
19.	Lesser Sand Plover	<i>Charadrius mongolus</i>	Charadriidae	Charadriiformes	Winter Visitor	Least concern	19.15 \pm 67
20.	Greater Sand Plover	<i>Charadrius leschenaultii</i>	Charadriidae	Charadriiformes	Winter Visitor	Least concern	7.92 \pm 28
21.	Kentish Plover	<i>Charadrius alexandrinus</i>	Charadriidae	Charadriiformes	Winter Visitor	Least concern	0.15 \pm 0.38
22.	Bar-tailed Godwit	<i>Limosa lapponica</i>	Scolopacidae	Charadriiformes	Winter Visitor	Near threatened	0.15 \pm 0.55
23.	Black-tailed Godwit	<i>Limosa limosa</i>	Scolopacidae	Charadriiformes	Winter Visitor	Near threatened	3 \pm 7.64
24.	Terek Sandpiper	<i>Xenus cinereus</i>	Scolopacidae	Charadriiformes	Winter Visitor	Least concern	0.92 \pm 2.4
25.	Common Sandpiper	<i>Actitis hypoleucos</i>	Scolopacidae	Charadriiformes	Winter Visitor	Least concern	0.85 \pm 1.40
26.	Common Greenshank	<i>Tringa nebularia</i>	Scolopacidae	Charadriiformes	Winter Visitor	Least concern	0.85 \pm 0.99
27.	Marsh Sandpiper	<i>Tringa stagnatilis</i>	Scolopacidae	Charadriiformes	Winter Visitor	Least concern	1.92 \pm 6.64
28.	Wood Sandpiper	<i>Tringa glareola</i>	Scolopacidae	Charadriiformes	Winter Visitor	Least concern	0.54 \pm 1.05
29.	Common Redshank	<i>Tringa totanus</i>	Scolopacidae	Charadriiformes	Winter Visitor	Least concern	1.54 \pm 3.13
30.	Black-headed Gull	<i>Chroicocephalus ridibundus</i>	Laridae	Charadriiformes	Winter Visitor	Least concern	0.15 \pm 0.55
31.	Brown-headed Gull	<i>Chroicocephalus brunnicephalus</i>	Laridae	Charadriiformes	Winter Visitor	Least concern	0.15 \pm 0.38
32.	Little Tern	<i>Sternula albifrons</i>	Laridae	Charadriiformes	Winter Visitor	Least concern	1.38 \pm 2.63
33.	Gull-billed Tern	<i>Gelochelidon nilotica</i>	Laridae	Charadriiformes	Winter Visitor	Least concern	0.77 \pm 1.7
34.	Whiskered Tern	<i>Chlidonias hybrida</i>	Laridae	Charadriiformes	Winter Visitor	Least concern	4 \pm 6.72
35.	River Tern	<i>Sterna aurantia</i>	Laridae	Charadriiformes	Resident	Vulnerable	0.46 \pm 0.97
36.	Asian Openbill	<i>Anastomus oscitans</i>	Ciconiidae	Ciconiiformes	Local migrant	Least concern	0.15 \pm 0.55
37.	Oriental Darter	<i>Anhinga melanogaster</i>	Anhingidae	Suliformes	Resident	Near threatened	0.92 \pm 0.95
38.	Little Cormorant	<i>Microcarbo niger</i>	Phalacrocoracidae	Suliformes	Local Migrant	Least concern	11.62 \pm 15.34
39.	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	Phalacrocoracidae	Suliformes	Local migrant	Least concern	6.53 \pm 13
40.	Grey Heron	<i>Ardea cinerea</i>	Ardeidae	Pelecaniformes	Local migrant	Least concern	3.92 \pm 3.17
41.	Purple Heron	<i>Ardea purpurea</i>	Ardeidae	Pelecaniformes	Resident	Least concern	1.46 \pm 1.33
42.	Great Egret	<i>Ardea alba</i>	Ardeidae	Pelecaniformes	Resident	Least concern	4.07 \pm 5.75
43.	Intermediate Egret	<i>Ardea intermedia</i>	Ardeidae	Pelecaniformes	Resident	Least concern	3.46 \pm 9.35
44.	Little Egret	<i>Egretta garzetta</i>	Ardeidae	Pelecaniformes	Resident	Least concern	5.77 \pm 11.63
45.	Western Reef Egret	<i>Egretta gularis</i>	Ardeidae	Pelecaniformes	Resident	Least concern	2.30 \pm 0.6
46.	Cattle Egret	<i>Bubulcus ibis</i>	Ardeidae	Pelecaniformes	Resident	Least concern	0.77 \pm 2.49
47.	Indian Pond Heron	<i>Ardeola Greyii</i>	Ardeidae	Pelecaniformes	Resident	Least concern	4.7 \pm 5.8
48.	Black-crowned Night-Heron	<i>Nycticorax nycticorax</i>	Ardeidae	Pelecaniformes	Resident	Least concern	0.15 \pm 0.38
49.	Glossy Ibis	<i>Plegadis falcinellus</i>	Ardeidae	Pelecaniformes	Vagrant	Least concern	18.77 \pm 45.82
50.	Black-headed Ibis	<i>Threskiornis melanocephalus</i>	Threskiornithidae	Pelecaniformes	Resident	Near threatened	3.23 \pm 7.54
51.	Osprey	<i>Pandion haliaetus</i>	Pandionidae	Accipitriformes	Winter Visitor	Least concern	0.30 \pm 0.48
52.	Western Marsh Harrier	<i>Circus aeruginosus</i>	Accipitridae	Accipitriformes	Winter Visitor	Least concern	0.31 \pm 0.63
53.	Black Kite	<i>Milvus migrans</i>	Accipitridae	Accipitriformes	Resident	Least concern	0.08 \pm 0.28
54.	Brahminy Kite	<i>Haliastur indus</i>	Accipitridae	Accipitriformes	Resident	Least concern	4.23 \pm 4.55
55.	Common Kingfisher	<i>Alcedo atthis</i>	Alcedinidae	Coraciiformes	Resident	Least concern	1.08 \pm 1.03
56.	Stork-billed Kingfisher	<i>Pelargopsis capensis</i>	Alcedinidae	Coraciiformes	Resident	Least concern	1.31 \pm 1.60
57.	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	Alcedinidae	Coraciiformes	Resident	Least concern	1.15 \pm 1.07
58.	Green Bee-eater	<i>Merops orientalis</i>	Meropidae	Coraciiformes	Resident	Least concern	0.54 \pm 1.94
59.	Blue-tailed Bee-eater	<i>Merops philippinus</i>	Meropidae	Coraciiformes	Local migrant	Least concern	2.54 \pm 3.1
60.	White-cheeked Barbet	<i>Psilopogon viridis</i>	Megalaimidae	Piciformes	Resident	Least concern	0.69 \pm 1.70
61.	Black-rumped Flameback	<i>Chrysocolaptes gutta cristatus</i>	Picidae	Coraciiformes	Resident	Least concern	0.54 \pm 1.39
62.	Rose-ringed Parakeet	<i>Psittacula krameria</i>	Psittaculidae	Psittaciformes	Resident	Least concern	2.23 \pm 5.1
63.	Ashy Woodswallow	<i>Artamus fuscus</i>	Artamidae	Passeriformes	Resident	Least concern	0.23 \pm 0.83
64.	Brown Shrike	<i>Lanius cristatus</i>	Laniidae	Passeriformes	Winter Visitor	Least concern	0.08 \pm 0.28
65.	Indian Golden Oriole	<i>Oriolus kundoo</i>	Oriolidae	Passeriformes	Winter Visitor	Least concern	0.15 \pm 0.38
66.	Black Drongo	<i>Dicrurus macrocercus</i>	Dicruridae	Passeriformes	Resident	Least concern	0.08 \pm 0.28
67.	Rufous Treepie	<i>Dendrocitta vagabunda</i>	Corvidae	Passeriformes	Resident	Least concern	0.53 \pm 1.2
68.	House Crow	<i>Corvus splendens</i>	Corvidae	Passeriformes	Resident	Least concern	4.62 \pm 4.15
69.	Large-billed Crow	<i>Corvus macropus</i>	Corvidae	Passeriformes	Resident	Least concern	0.46 \pm 1.4
70.	Barn Swallow	<i>Hirundo rustica</i>	Hirundinidae	Passeriformes	Winter Visitor	Least concern	3.23 \pm 4.04
71.	Red-vented Bulbul	<i>Pycnonotus cafer</i>	Pycnonotidae	Passeriformes	Resident	Least concern	0.15 \pm 0.55
72.	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	Pycnonotidae	Passeriformes	Resident	Least concern	0.08 \pm 0.28

73.	Green Warbler	<i>Phylloscopus nitidus</i>	Phylloscopidae	Passeriformes	Winter Visitor	Least concern	0.23 ± 0.44
74.	Booted Warbler	<i>Iduna caligata</i>	Acrocephalidae	Passeriformes	Winter Visitor	Least concern	0.15 ± 0.38
75.	Paddyfield Warbler	<i>Acrocephalus agricola</i>	Acrocephalidae	Passeriformes	Winter Visitor	Least concern	0.08 ± 0.28
76.	Blyth's Reed Warbler	<i>Acrocephalus dumetorum</i>	Acrocephalidae	Passeriformes	Winter Visitor	Least concern	0.46 ± 0.78
77.	Clamorous Reed Warbler	<i>Acrocephalus stentoreus</i>	Acrocephalidae	Passeriformes	Winter Visitor	Least concern	1.08 ± 1.26
78.	Pallas's Grasshopper Warbler	<i>Helopsaltes certhiola</i>	Locustellidae	Passeriformes	Winter Visitor	Least concern	0.62 ± 1.33
79.	Common Tailorbird	<i>Orthotomus sutorius</i>	Cisticolidae	Passeriformes	Resident	Least concern	0.85 ± 1.21
80.	Grey-breasted Prinia	<i>Prinia hodgsonii</i>	Cisticolidae	Passeriformes	Resident	Least concern	0.08 ± 0.28
81.	Ashy Prinia	<i>Prinia socialis</i>	Cisticolidae	Passeriformes	Resident	Least concern	1.77 ± 1.30
82.	Plain Prinia	<i>Prinia inornata</i>	Cisticolidae	Passeriformes	Resident	Least concern	1.69 ± 1.18
83.	Zitting Cisticola	<i>Cisticola juncidis</i>	Cisticolidae	Passeriformes	Resident	Least concern	1 ± 1.58
84.	Lesser Whitethroat	<i>Curruca curruca</i>	Sylviidae	Passeriformes	Vagrant	Least concern	0.07 ± 0.28
85.	Jungle Babbler	<i>Argya striata</i>	Leiotherichidae	Passeriformes	Resident	Least concern	0.15 ± 0.55
86.	Asian Brown Flycatcher	<i>Muscicapa dauurica</i>	Muscicapidae	Passeriformes	Winter Visitor	Least concern	0.08 ± 0.28
87.	Oriental Magpie Robin	<i>Copsychus saularis</i>	Muscicapidae	Passeriformes	Resident	Least concern	0.54 ± 0.97
88.	Siberian Stonechat	<i>Saxicola maurus</i>	Muscicapidae	Passeriformes	Winter Visitor	Least concern	0.38 ± 0.77
89.	Rosy Starling	<i>Pastor roseus</i>	Sturnidae	Passeriformes	Winter Visitor	Least concern	0.30 ± 1.11
90.	Malabar Starling	<i>Sturnia blythii</i>	Sturnidae	Passeriformes	Resident	Least concern	0.54 ± 1.94
91.	Common Myna	<i>Acridotheres tristis</i>	Sturnidae	Passeriformes	Resident	Least concern	1.31 ± 2.14
92.	Jungle Myna	<i>Acridotheres fuscus</i>	Sturnidae	Passeriformes	Resident	Least concern	0.38 ± 0.96
93.	Purple-rumped Sunbird	<i>Leptocoma zeylonica</i>	Nectariniidae	Passeriformes	Resident	Least concern	0.46 ± 0.97
94.	Purple Sunbird	<i>Cinnyris asiaticus</i>	Nectariniidae	Passeriformes	Resident	Least concern	0.69 ± 1.93
95.	Loten's Sunbird	<i>Cinnyris lotenius</i>	Nectariniidae	Passeriformes	Resident	Least concern	0.31 ± 1.11
96.	Western Yellow Wagtail	<i>Motacilla flava</i>	Motacillidae	Passeriformes	Winter Visitor	Least concern	0.38 ± 0.77
97.	Streaked Weaver	<i>Ploceus manyar</i>	Ploceidae	Passeriformes	Resident	Least concern	1.92 ± 4.03
98.	Baya Weaver	<i>Ploceus philippinus</i>	Ploceidae	Passeriformes	Resident	Least concern	0.23 ± 0.83
99.	Scaly-breasted Munia	<i>Lonchura punctulata</i>	Estrildidae	Passeriformes	Resident	Least concern	0.31 ± 1.1
100.	Tricolored Munia	<i>Lonchura malacca</i>	Estrildidae	Passeriformes	Resident	Least concern	13.46 ± 27.75

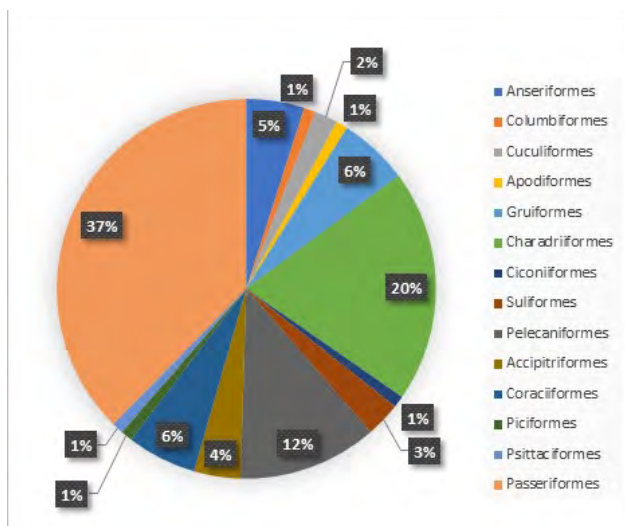


Fig. 2. Orders of birds recorded from the study area

Table 2. Number of bird species and total number of birds recorded during the study period

Month	Number of bird species recorded	Total Number of individuals observed
Feb-18	58	1548
Mar-18	45	637
Apr-18	16	91
May-18	42	602
Jun-18	11	70
Jul-18	20	282
Aug-18	12	30
Sep-18	23	101
Oct-18	46	439
Nov-18	57	489
Dec-18	26	83
Jan-19	24	198
Feb-19	17	172

Table 3. Diversity indices of birds recorded during the study period

	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19
Dominance_D	0.22	0.21	0.16	0.05	0.21	0.75	0.12	0.11	0.17	0.18	0.076	0.14	0.18
Simpson_1-D	0.78	0.79	0.83	0.95	0.79	0.25	0.88	0.88	0.82	0.88	0.92	0.86	0.82
Shannon_H	2.36	2.25	2.11	3.33	1.9	0.76	2.28	2.54	2.5	2.95	2.86	2.35	2.04
Evenness_e^H/S	0.18	0.21	0.55	0.7	0.61	0.11	0.81	0.55	0.26	0.35	0.7	0.44	0.48

4. Discussion

The study reveals that Kadamakudy wetlands support a rich avian biodiversity. The number of species and the total number of birds recorded in each month showed variations. Species richness and diversity is influenced by the presence of migratory species. Monsoon also plays a role. Highest dominance was noted in July 2018 due to the presence of winter visitor Lesser Sand Plover in large numbers. Hence

Simpson diversity index, Shannon index and evenness is low in July 2018. Lowest dominance was noted in May 2018 which correspondingly lead to higher Simpson diversity index and Shannon index.

The tidal phenomena have a significant impact on the variations in bird populations. Large flocks were present during low tides as it favoured the foraging behaviour of birds. Their physical features help to feed them during

the high tide conditions. Larger, longer-legged birds, can withstand higher water levels. The tide cycle has an impact on how birds use intertidal mudflat areas also. It was found that the birds mainly depended on wetlands for their feeding requirement. Both deep-water divers like ducks, cormorants, teals, and shallow water feeders like Pond Heron (*Ardeola grayii*), Cattle egret (*Bubulcus ibis*), Little Egret (*Egretta garzetta*) were spotted from the wetland. There were also granivores like Tri-coloured munia (*Lonchura malacca*), Scaly-breasted munia (*Lonchura punctulata*), Baya weaver (*Ploceus philippinus*), present in large flocks and fed on the paddy. Nests of Munias were sighted in some of the paddy stalks. They were made of dried leaves and grass. The main birds of prey include Brahminy kite (*Haliastur indus*), Black kite (*Milvus migrans*), Western Marsh Harrier (*Circus aeruginosus*) and Osprey (*Pandion haliaetus*). They feed on fishes, rodents, snakes and other smaller birds. It was found that the smaller birds like Munias and weavers, avoided the area inhabited by these birds of prey. Damage to cultivation by birds is a menace faced by the farmers. They were seen roaming around in boats and driving away the birds. Scaring devices, tapes of audio, and video cassettes were also placed as the light reflected from the tape scares the birds. Polythene bags were also used to drive the birds away from the fields.

4.1 Impact of flood on bird diversity

Kadamakkudy, a cluster of islands in the river Periyar was one of the most affected areas in Ernakulam district during 2018 Kerala flood. Damage includes loss of infrastructure, agriculture and livestock.

Interactions with the local farmers and an understanding of the previous avian biodiversity of the area reveals that the impact of Kerala flood 2018 had no pronounced effect on the avian biodiversity of Kadamakkudy. There was no

significant increase in water level in the areas of Pokkali fields where the birds used to get inhabited. It is also a fact that flood occurred during the paddy cultivation period (June to September) when the bird activity is usually low.

5. Conclusion

Kadamakkudy wetlands has high species richness, abundance and diversity of birds. The area provide ample feeding grounds, roosting sites and nesting places for birds. For migratory birds Kadamakkudy is a favourite habitat. Almost throughout the study period bird diversity remained high. This wetland has to be conserved not only owing to the diversity of birds but also for protecting the overall ecosystem.

Various developmental activities have begun to meet the increasing number of both local and international tourists. Reports claim that these wetlands will exist only for a few years if the present trend of exploitation continues. The area should be well protected with the active participation of landowners, residents, NGOs and government authorities. Measures have to be taken to control the poaching of birds. Farmers should be made aware of the significance of wetlands and associated bird species. Illegal reclamation of wetlands has to be mooted. Tourism and infrastructural facilities could be developed only after adopting necessary conservation strategies. For the betterment of both the human race and the ecosystem, conservation and development should go hand in hand.

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6. References

- Ali, S. 1969. The Birds of Kerala. Oxford University Press, Bombay
- Ali, S. and S.D. Ripley 1969. Hand Book of the Birds of India and Pakistan. Oxford University Press, Bombay
- Babu, S. S., & Thomas, K. R. 2022. A Comparative Study on the Wetland Avifauna in the Pokkali Fields of Ernakulam District, Kerala. In Impact of Climate Change on Hydrological Cycle, Ecosystem, Fisheries and Food Security (pp. 219-224). CRC Press.
- Caziani, S.M. & E.J. Derlindati. 2000. Abundance and habitat of High Andean flamingos in northwestern Argentina. Waterbirds 23 (Special Publication 1): 121-133
- Chandran, A., J. Praveen & C. Sashikumar (2023). JoTT Checklist of the birds of Kerala (v3.0), 01 January 2023. <https://threatenedtaxa.org/index.php/JoTT/checklists/birds/kerala>.
- Custer, T.W., Osborn, R.G., 1977. Wading birds as biological indicators: 1975 colony survey. United States fish and wildlife Services. Special Scientific Report-Wildlife No. 206.
- Davis, T., Blasco, D. & Carbonell, M., The Ramsar Convention manual: a guide to the Convention on wetlands (Ramsar, Iran, 1971), IUCN: International Union for Conservation of Nature. Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Ramsar Convention Bureau
- eBird. (2023). eBird: An online database of bird distribution and abundance. Retrieved on 04/09/2023, from <https://ebird.org/region/IN-KL?yr=all>
- eBird. (2023). eBird: An online database of bird distribution and abundance. Retrieved on 04/09/2023, from <https://ebird.org/hotspot/L3154851>
- Jayson. E.A. 2002. Ecology of birds in the Kole lands of Kerala, Research Report No.244.Kerala Forest Research Institute, Peechi.
- Deepak Samuel, V., Krishnan, P., Sreeraj, C.R., Abhilash, K.R., Patro, S., Sankar, R., & Ramesh, R. 2017. Digital repositories for coastal wetland biodiversity in South Asia: a conceptual framework from India. In Wetland Science (pp. 51-65). Springer, New Delhi.
- Grimmet R & Inskipp C. 2005. Birds of Southern India. Om Books.
- Grimmet R, Inskipp T. 2010. Birds of Northern India. Om Books Int
- Kumar, A., J.P. Sati, P.C. Tak and J.R.B. Alfred 2005. Handbook on Indian wetland birds and their conservation. Zoological Survey of India. 472p

- Kurup, D.N. 1996. Ecology of the birds of Bharathapuzha estuary and survey of the coastal wetlands of Kerala. Final report submitted to Kerala Forest Department, Trivandrum 59 p
- Ramsar Convention Bureau. 1997. The Ramsar Convention Manual: a Guide to the Convention on Wetlands (Ramsar, Iran, 1971), 2nd Edition, Ramsar Convention Bureau, Gland Switzerland.
- Smith, J. A., & Johnson, R. B. 2018. Wetlands as Complex Ecosystems: Interactions Among Organisms and Environmental Factors. *Journal of Wetland Ecology*, 10(2), 87-105.
- Wiens, J.A. 1992. *The Ecology of the Bird's Communities*. Cambridge University Press, Cambridge, UK, 336pp.

