

VOLUME 9

ISSUE 1

2023

ISSN 2454 – 3055



**INTERNATIONAL
JOURNAL OF
ZOOLOGICAL
INVESTIGATIONS**

*Forum for Biological and
Environmental Sciences*

Published by Saran Publications, India



International Journal of Zoological Investigations

Contents available at Journals Home Page: www.ijzi.net

Editor-in-Chief: Prof. Ajai Kumar Srivastav

Published by: Saran Publications, Gorakhpur, India



ISSN: 2454-3055

Diversity and Distribution of Avifauna in Seashores of Tharangambadi Taluk, Mayiladuthurai District, Tamil Nadu, India

Sivakumar S. and Thomas Nithiyanandam G.*

Department of Zoology, T.B.M.L. College (Affiliated to Bharathidasan University, Thiruchirappalli), Porayar 609 307, Tamil Nadu, India

**Corresponding Author*

Received: 10th December, 2022; **Accepted:** 8th January, 2023; **Published online:** 28th January, 2023

<https://doi.org/10.33745/ijzi.2023.v09i01.017>

Abstract: Birds use wetland as a main source for feeding, resting, shelter and social interactions. Wetland refers to lowland covered with shallow and sometimes temporary or intermittent water. The study revealed diversity and distribution of birds in Tharangambadi Sea shores, Mayiladuthurai District, Tamil Nadu during January 2016 to December 2016. The total count method was employed for observation of birds. The results showed 56 species of birds from 14 orders. Among the 14 orders of birds Passeriformes has 36% of species followed by Charadriiformes (14%), Pelecaniformes (12%), Coraciiformes (9%) and so on. The encountered birds were tabulated as food habits and which recorded insectivores (41%) followed by carnivore (20%), piscivore (14%), omnivore (11%), granivore (9%), frugivore (3%) and nectivores (2%). The study also showed that 35 species are resident and 21 species are migrants including local migrant. The Painted Stork alone is Near Threatened category as IUCN. Species richness was high during the month of December 2016 (55) and least was during the month of April 2016 (32). The abundance was high during the month of December (632) and least was in the month of May (197) ($F=21.58$; $p<0.01$). But the dominance index was high in the month of June (0.052), May (0.051) and least was in the month of February (0.036) and September (0.036). Simpson diversity index was high during the month of February (0.9641) and least was in May (0.7415). Shannon H' index was high in January (3.571) and least was in April (3.192). Evenness index was high in April (0.7607) and least was in the month of October (0.6631). It is concluded that avian diversity is an indication of habitat heterogeneity and the number of species and individuals in an area which implies its importance. Each habitat has a specific set of microenvironment that is suitable for a species.

Keywords: Diversity, Passeriformes, Insectivores, Simpson diversity index, Shannon H' index, Evenness index, Avifauna

Citation: Sivakumar S. and Thomas Nithiyanandam G.: Diversity and distribution of avifauna in seashores of Tharangambadi Taluk, Mayiladuthurai district, Tamil Nadu, India. Intern. J. Zool. Invest. 9(1): 154-163, 2023.

<https://doi.org/10.33745/ijzi.2023.v09i01.017>



This is an Open Access Article licensed under a Creative Commons License: Attribution 4.0 International (CC-BY). It allows unrestricted use of articles in any medium, reproduction and distribution by providing adequate credit to the author (s) and the source of publication.

Introduction

Birds are feathered biped, warm-blooded vertebrate animals, whose temperature remains stable and independent of the surrounding

temperature (Ali 2002). Birds are commonly used as an agency of biodiversity owing to the wide availability of pertinent data on their distribution

and status (Gregory *et al.*, 2003; Gregory 2006; Eglinton *et al.*, 2012). Birds use wetland as a main source for feeding, resting, shelter, and social interactions (Rajpar and Zakaria, 2011; Pandiyan *et al.*, 2014). Wetlands and water birds are always together elements; the water birds occupy several trophic levels in the food web of wetland nutrient cycles (Rajashekara and Venkatesha, 2010). The term wetland refers to lowlands covered with shallow and sometimes temporary or intermittent waters. They are referred to by such names as marshes, swamps, bogs, wet meadows, potholes, sloughs and river. Overflow lands, shallow, lakes, and ponds usually with emergent vegetation as a conspicuous feature are included in the definition. "Wetlands" have been defined as swamps and other damp areas of land but in common parlance the word is used interchangeably with "Lakes", which denotes a large body of water surrounded by land. However, internationally accepted term of wetlands describes them (Ramsar convention) as "area of marsh, fen, peat land or water whether natural or artificial, permanent or temporary with water, that is static or flowing, fresh, brackish or salt including areas of marine water, the depth of which does not exceed six meters" (Chatrath, 1992). The pressure of abiotic factors on the waterbird congregations in wetlands has long been studied by many authors (Nagarajan and Thiyagesan, 1996; Malik and Joshi, 2013). Water quality acts as an imperative factor to estimate the health of the wetland, since the same is dependable for the prey availability and productivity of an ecosystem (Manikannan *et al.*, 2012). This directly or indirectly influences the distribution and habitat use of waterbirds (Manikannan *et al.*, 2012; Elafri *et al.*, 2017).

In India, 69% of the area consists of inland wetlands (Bassi *et al.*, 2014), of which many wetlands are threatened and many are already degraded (Central Pollution Control Board, 2008). To overcome this rapid loss of wetlands, it is highly essential to afford an alternate habitat to support waterbirds (Elphick and Oring, 2003). Rice fields can act as an alternate habitat for waterbirds during winter (Sundar and Subramanya, 2010;

Acosta *et al.*, 2010; Strum *et al.*, 2013).

Many waterbird species are declining worldwide (BirdLife International, 2017). Southern India is a globally important wintering site for waterbirds migrating along the Central Asian and South Asian Flyway, where waterbird abundance has decreased by 40% in the Pichavaram mangroves of Tamil Nadu on the east coast (Sandilyan *et al.*, 2010) and by 44% in the Kadalundi Vallikunnu Community Reserve on the west coast (Aarif *et al.*, 2014, 2020). The present investigation was designed to study diversity and abundance of water birds and land birds in sea shores of Tharagambadi Taluk, Mayiladuthurai District due to lack of avifaunal studies in the above mentioned study area.

Materials and Methods

Study area:

The study area is located in the Tharangambadi Taluk of Mayiladuthurai District. The district lies between 10°25' and 11°40' North Longitude and 79° 49' and 80° 01' East Latitude of Tamil Nadu, India. It is a semi-urban and characterized by various habitats such as sea shores, agricultural area, shrub land, channel, human habitation, riverine bed, waste land etc. The river Cauvery runs through the study area which ends in Poombukar (Fig. 1). The river Cauvery is the chief water source for agricultural activities in this area. This area receives north east monsoon during October to December. In the study area, number of natural water bodies existed viz., Wells, Ponds, Puddles. The villagers pump out water through motor for their agriculture activities also. People in the study area depend more upon the fishing and agricultural activities. Paddy, banana, coconut, ground nut, sugar cane, cereals, pulses are grown here.

Assessment of Birds:

Direct count method was used for counting birds at fortnightly in each month (Pandiyan *et al.*, 2006). For direct counting a suitable vantage point was chosen and all visible birds were counted. This counting was made without any bias and to

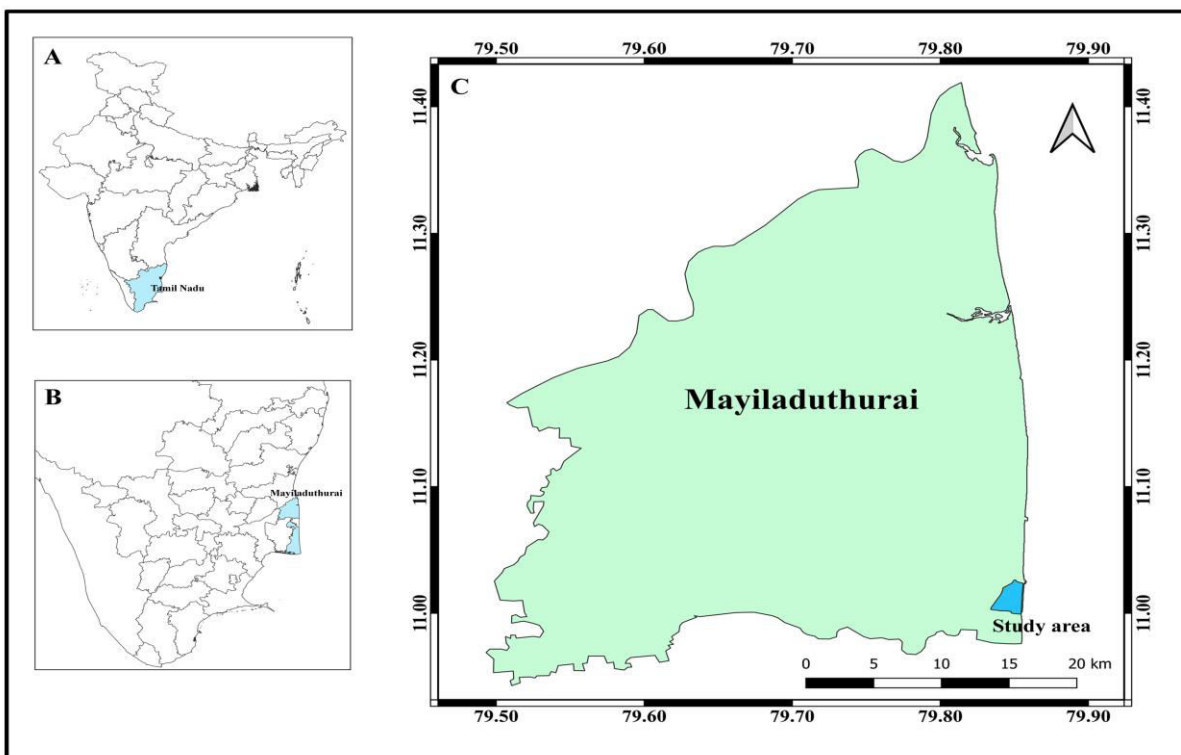


Fig. 1: Map shows the study area in Mayiladuthurai District.

ensure accuracy. 'Total count' method was followed for bird census wherever possible, and it was made walking in and around the wetlands or from specific vantage points (Nagarajan and Thiyagesan, 1996). Systematic birds count was carried out at different sites (three random sites were selected), each during January 2016 to December 2016. During counts, each site was divided into many sections in each section the birds were counted. All the birds on the ground or in the water were counted using binocular and any bird flying across the observer also included in the counting. Birds flying behind the observer were not counted. Migratory, wintering, breeding/summering and resident water birds were commonly encountered in the wetlands during the monsoon season. The birds were counted by using binocular (7x50) and spotting scope (20x60).

Diversity indices:

The diversity indices of birds were also calculated. Species richness, abundance, Simpson diversity

index, Sahnnon H' index and Evenness calculated by using PAST software. Univariate statistical analysis was conducted for data analysis by using SPSS version 16.0. Kruskal-Wallis One-Way ANOVA was used to test variation in abundance among the birds.

Results

Total 4416 birds were encountered which belongs to 56 species from 14 orders of Class Aves during January 2016 to December 2016 in Tharangambadi sea shore habitat (Table 1). Among the 14 orders of birds Passeriformes has 36% of species followed by Charadriiformes (14%), Pelecaniformes (12%), Coraciiformes (9%) and so on (Fig. 2). The encountered birds were tabulated as food habits and it showed insectivores (41%) followed by carnivore (20%), piscivore (14%), omnivore (11%), granivore (9%), frugivore (3%) and nectivores (2%) (Fig. 3). The study also showed that 35 species are resident and 21 species are migrants including local migrant.

Table 1: List of birds were encountered with IUCN and migratory status during the study period

S. No.	Common Name	Scientific Name	Order	Family	IUCN Category	WPA Sch	Foraging Guild	Migratory Status
1	Black Kite	<i>Milvus migrans</i> (Boddaert, 1783)	Accipitriformes	Accipitridae	LC	Sch I	C	R
2	Brahminy Kite	<i>Haliastur indus</i> (Boddaert, 1783)	Accipitriformes	Accipitridae	LC	Sch I	C	LM
3	Black shouldered Kite	<i>Elanus caeruleus</i> (Desfontaines, 1789)	Accipitriformes	Accipitridae	LC	Sch IV	C	LM
4	Shikra	<i>Accipiter badius</i> (Gmelin, 1788)	Accipitriformes	Accipitridae	LC	Sch I	C	R
5	Asian Palm Swift	<i>Cypsiurus balasiensis</i> (Gray, 1829)	Caprimulgiformes	Apodidae	LC	Sch IV	I	R
6	Little-ringed Plover	<i>Charadrius dubius</i> (Scopoli, 1786)	Charadriiformes	Charadriidae	LC	Sch IV	I	WM
7	Common-ringed Plover	<i>Charadrius hiaticula</i> (Linnaeus, 1758)	Charadriiformes	Charadriidae	LC	Sch IV	I	WM
8	Red-wattled Lapwing	<i>Vanellus indicus</i> (Boddaert, 1783)	Charadriiformes	Charadriidae	LC	Sch IV	I	R
9	Common Sandpiper	<i>Actitis hypoleucos</i> (Linnaeus, 1758)	Charadriiformes	Scolopacidae	LC	Sch IV	I	WM
10	Little Stint	<i>Calidris minut</i> (Leisler, 1812)	Charadriiformes	Scolopacidae	LC	Sch IV	I	WM
11	Black winged Stilt	<i>Himantopus himantopus</i> (Linnaeus, 1758)	Charadriiformes	Recurvirostridae	LC	Sch IV	I	WM
12	Caspian Tern	<i>Hydroprogne caspia</i> (Pallas, 1770)	Charadriiformes	Laridae	LC	Sch IV	P	WM
13	Painted Stork	<i>Mycteria leucocephala</i> (Pennant, 1769)	Ciconiiformes	Ciconiidae	NT	Sch IV	P	WM
14	Blue Rock Pigeon	<i>Columba livia</i> (Gmelin, 1789)	Columbiformes	Columbidae	LC	Sch IV	G	R
15	Spotted Dove	<i>Spilopelia suratensis</i> (Gmelin, 1789)	Columbiformes	Columbidae	LC	Sch IV	G	R
16	Pied Kingfisher	<i>Ceryle rudis</i> (Linnaeus, 1758)	Coraciiformes	Alcedinidae	LC	Sch IV	P	LM
17	Small Blue Kingfisher	<i>Alcedo atthis</i> (Linnaeus, 1758)	Coraciiformes	Alcedinidae	LC	Sch IV	P	R
18	White breasted Kingfisher	<i>Halcyon smyrnensis</i> (Linnaeus, 1758)	Coraciiformes	Alcedinidae	LC	Sch IV	P	R
19	Small Green Bee-Eater	<i>Merops orientalis</i> (Latham, 1802)	Coraciiformes	Meropidae	LC	Sch IV	I	R
20	Indian Roller	<i>Coracias benghalensis</i> (Linnaeus, 1758)	Coraciiformes	Coraciidae	LC	Sch IV	C	R
21	Lesser Coucal	<i>Centropus bengalensis</i> (Gmelin, 1788)	Cuculiformes	Cuculidae	LC	Sch IV	I	LM
22	Asian Koel	<i>Eudynamys scolopaceus</i> (Linnaeus, 1758)	Cuculiformes	Cuculidae	LC	Sch IV	F	LM

23	Grey Francolin	<i>Francolinus pondicerianus</i> (Gmelin, 1789)	Galliformes	Phasianidae	LC	Sch IV	O	R
24	Indian Peafowl	<i>Pavo cristatus</i> (Linnaeus, 1758)	Galliformes	Phasianidae	LC	Sch I	O	R
25	White-breasted Waterhen	<i>Amaurornis phoenicurus</i> (Pennant, 1769)	Gruiformes	Rallidae	LC	Sch IV	I	R
26	Common Moorhen	<i>Gallinula chloropus</i> (Linnaeus, 1758)	Gruiformes	Rallidae	LC	Sch IV	O	R
27	Yellow billed Babbler	<i>Turdoides affinis</i> (Jerdon, 1845)	Passeriformes	Leiotrichidae	LC	Sch IV	I	R
28	Common Myna	<i>Acridotheres tristis</i> (Linnaeus, 1766)	Passeriformes	Sturnidae	LC	Sch IV	O	R
29	Black Drongo	<i>Dicrurus macrocercus</i> (Vieillot, 1817)	Passeriformes	Dicruridae	LC	Sch IV	I	R
30	House Crow	<i>Corvus splendens</i> (Vieillot, 1817)	Passeriformes	Corvidae	LC	Sch V	O	R
31	Jungle Crow	<i>Corvus macrorhynchos</i> (Wagler, 1827)	Passeriformes	Corvidae	LC	Sch IV	O	R
32	Indian Treepie	<i>Dendrocitta vagabunda</i> (Latham, 1790)	Passeriformes	Corvidae	LC	Sch IV	I	LM
33	Black headed Munia	<i>Lonchura malacca</i> (Linnaeus, 1766)	Passeriformes	Estrildidae	LC	Sch IV	G	R
34	Red vented Bulbul	<i>Pycnonotus cafer</i> (Linnaeus, 1766)	Passeriformes	Pycnonotidae	LC	Sch IV	I	R
35	Common Tailorbird	<i>Orthotomus sutorius</i> (Pennant, 1769)	Passeriformes	Cisticolidae	LC	Sch IV	I	R
36	House Sparrow	<i>Passer domesticus</i> (Linnaeus, 1758)	Passeriformes	Passeridae	LC	Sch IV	G	R
37	Common Swallow	<i>Hirundo rustica</i> (Linnaeus, 1758)	Passeriformes	Hirundinidae	LC	Sch IV	G	R
38	Wire-tailed Swallow	<i>Hirundo smithii</i> (Leach, 1818)	Passeriformes	Hirundinidae	LC	Sch IV	I	R
39	Tree Pipit	<i>Anthus trivialis</i> (Linnaeus, 1758)	Passeriformes	Motacillidae	LC	Sch IV	I	R
40	White Wagtail	<i>Motacilla alba</i> (Linnaeus, 1758)	Passeriformes	Motacillidae	LC	Sch IV	I	LM
41	Yellow Wagtail	<i>Motacilla flava</i> (Linnaeus, 1758)	Passeriformes	Motacillidae	LC	Sch IV	I	LM
42	Paddy Field Pipit	<i>Anthus rufulus</i> (Vieillot, 1818)	Passeriformes	Motacillidae	LC	Sch IV	I	R
43	Asian Paradise Flycatcher	<i>Terpsiphone paradisi</i> (Linnaeus, 1758)	Passeriformes	Monarchidae	LC	Sch IV	I	LM
44	Red winged Bush Lark	<i>Mirafra hypermetra</i> (Reichenow, 1879)	Passeriformes	Alaudidae	LC	Sch IV	I	LM
45	Purple rumped Sunbird	<i>Leptocoma zeylonica</i> (Linnaeus, 1766)	Passeriformes	Nectariniidae	LC	Sch IV	N	LM
46	Indian Robin	<i>Saxicoloides fulicatus</i> (Linnaeus, 1766)	Passeriformes	Muscicapidae	LC	Sch IV	I	LM
47	Great Egret	<i>Ardea alba</i> (Linnaeus, 1758)	Pelecaniformes	Ardeidae	LC	Sch IV	C	R
48	Intermediate Egret	<i>Ardea intermedia</i> (Wagler, 1829)	Pelecaniformes	Ardeidae	LC	Sch IV	C	R

49	Cattle Egret	<i>Bubulcus ibis</i> (Linnaeus, 1758)	Pelecaniformes	Ardeidae	LC	Sch IV	C	R
50	Little Egret	<i>Egretta garzetta</i> (Linnaeus, 1766)	Pelecaniformes	Ardeidae	LC	Sch IV	C	R
51	Indian Pond Heron	<i>Ardeola grayii</i> (Sykes, 1832)	Pelecaniformes	Ardeidae	LC	Sch IV	C	R
52	Purple Heron	<i>Ardea purpurea</i> (Linnaeus, 1766)	Pelecaniformes	Ardeidae	LC	Sch IV	P	R
53	Little Green Heron	<i>Ardea cinerea</i> (Linnaeus, 1758)	Pelecaniformes	Ardeidae	LC	Sch IV	P	R
54	Rose ringed Parakeet	<i>Psittacula krameri</i> (Scopoli, 1769)	Psittaciformes	Psittaculidae	LC	Sch IV	F	R
55	Spotted Owlet	<i>Athene brama</i> (Temminck, 1821)	Strigiformes	Strigidae	LC	Sch IV	C	LM
56	Little Cormorant	<i>Microcarbo niger</i> (Vieillot, 1817)	Suliformes	Phalacrocoracidae	LC	Sch IV	P	LM

C- Carnivore; I- Insectivore; P-Piscivore; G- Granivore; F- Frugivore; O- Omnivore; N- Nectivore; R- Resident; LM- Local migrant; WM- Winter migrant

Table 2: Diversity indices of birds recorded in Sea shores of Tharangambadi Taluk, Mayiladuthurai District during from January 2016 to December 2016

Indices	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Species richness	52	48	37	32	33	38	40	45	50	51	51	55
Abundance	487	357	263	215	197	228	243	330	415	498	551	632
Dominance index	0.037	0.036	0.048	0.050	0.051	0.052	0.048	0.039	0.036	0.040	0.041	0.039
Simpson diversity index	0.9633	0.9641	0.9518	0.9501	0.9491	0.9479	0.9524	0.961	0.9639	0.9605	0.9588	0.9609
Shannon H' index	3.571	3.532	3.254	3.192	3.197	3.227	3.319	3.474	3.566	3.518	3.494	3.565
Evenness index	0.6836	0.712	0.6998	0.7607	0.7415	0.6631	0.691	0.7167	0.7075	0.6611	0.6451	0.6422

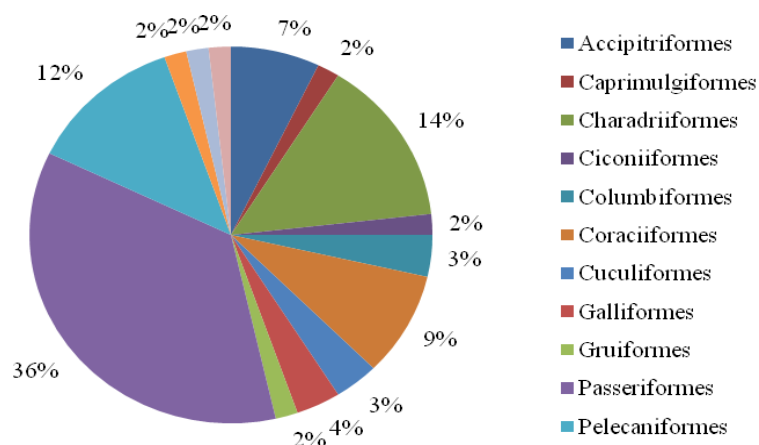


Fig. 2: Birds (Order wise) encountered in the study area.

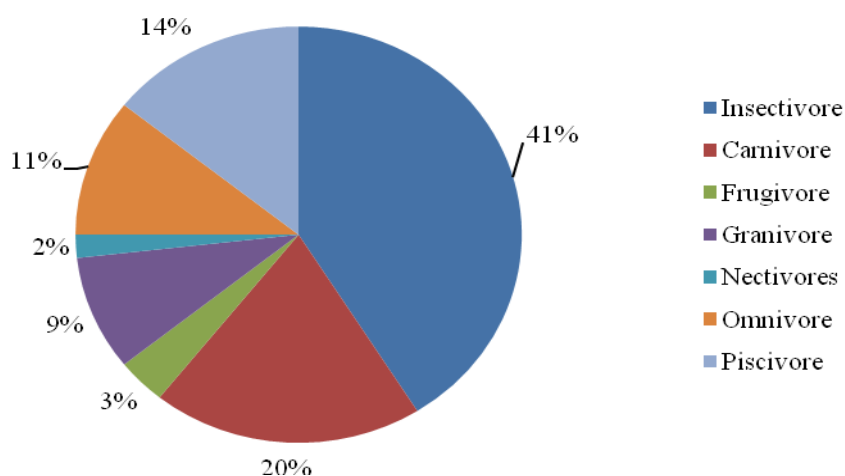


Fig. 3: Food habits of birds recorded in Sea Shores of Tharangambadi Taluk.

The Painted Stork alone is Near Threatened (NT) category as IUCN.

The diversity indices showed that species richness was high during the month of December 2016 (55) followed by January (52), October and November (51) and least richness was recorded during the month of April 2016 (32). The abundance was high during the month of December (632) followed by November (551) and October (498) and least was in the month of May (197) ($F= 21.58$; $p<0.01$). But the dominance index was high in the month of June (0.052), May (0.051) and April (0.050) and least was in the month of February (0.036) and September

(0.036). Simpson diversity index was high during the month of February (0.9641) and least was in May (0.7415). Shannon H' index was high in January (3.571) and least was in April (3.192). Evenness index was high in April (0.7607) and least was in the month of October (0.6631) (Table 2).

Discussion

The study encountered 56 species of birds in sea shores of Tharangambadi Taluk, Mayiladuthurai District during January 2016 to December 2016. As per IUCN categories, all the birds are under the Least concern (LC) except Painted stork (NT).

Painted stork frequently visited many places of Cauvery deltaic regions sea shores and around places (Point Calimere- Jagadeesan and Pandiyan, 2021; Manmade mangrove forest of Kariakal- Gupta *et al.*, 2022; Adjacent agricultural lands of Pichavaram mangroves- Sandilyan, 2014). Family Passeriforms alone recorded 36%. It may be due to the associated agricultural lands which enhance the diversity of Passeriformes (Sandilyan, 2014; Tanalgo *et al.*, 2015; Singh *et al.*, 2018). As classified the birds as per food habits, the insectivores were dominated followed by carnivores and omnivores. Due to the availability of insects in the study area from different habitats like agricultural lands, channel, open water bodies which enhance the insectivore birds. Most bird species are insectivores that depend for the most part on insects as prey (Losey and Vaughan, 2006; Şekercioğlu, 2006). Species richness of bird was during the month of December 2016 and least was in the April 2016. Abundance of birds which was high during the month of December and least was in the month of May. It may be due to the water level and seasonal climatic features (Yardi *et al.*, 2019). Dominance index was high during the month of May-June 2016 and least was in the month of February and September 2016. The availability of food makes some birds with a feeding guild of a highly abundant food to dominate the area (Welsh, 1987). Simpson diversity index was high during the month of February 2016 and least in the May 2016. Shannon H' index was in high during the month of January 2016 and least was in the month of April 2016. The evenness index showed high in the month of April 2016 and least was in the month of October 2016. Avian diversity is an indication of habitat heterogeneity and the number of species and individuals in an area implies the importance of the area. Each habitat has a specific set of microenvironment that is suitable for a species. Bibi and Ali (2013) stated that the values of Shannon-Weiner Diversity Index usually falls between 1.5 and 3.5. Kiros *et al.* (2018) mentioned that the variation in bird species diversity, richness, and abundance is associated with the

vegetation composition that make changes in food sources, nesting, and protection based on birds' habitat preference and feeding.

Conclusion

It is concluded from the present study that bird species varied among the studied months. Bird species (resident and migratory) numbers and abundance were higher in the month of December 2016 according to the habitat suitability, which support free water and abundant food supply (insects, grasses, and aquatic fauna) as well as nesting and resting sites. Also, most migratory birds feed on insects. During the winter season, the migratory birds are visiting nearby bird sanctuaries (Point Calimere) and territorial forest (Pichavaram mangroves) agricultural areas (Cauvery deltaic regions).

Acknowledgements

Authors thanks to Management and the Principal, T.B.M.L College, Porayar, Mayiladuthurai District, Tamil Nadu, for providing necessary facilities to perform this research work. We thank Professor and Head, Post Graduate and Research Department of Zoology for providing logistic support for this research.

References

- Aarif KM, Kaiser SA, Nefla A and Almaroofi S. (2020) Over-summering abundance, species composition, and habitat use patterns at a globally important site for migratory shorebirds. *Wilson J Ornithol.* 132(1): 165-172.
- Aarif KM, Muzaffar SB, Babu S and Prasadani PK. (2014) Shorebird assemblages respond to anthropogenic stress by altering habitat use in a wetland in India. *Biodiver Conserv.* 23: 727-740.
- Acosta M, Mugica L, Blanco D, Lopez-Lanus B, Dias AR, Doodnath LW and Hurtado J. (2010) Birds of rice fields in the Americas. *Waterbirds* 33(Suppl.): 105-122.
- Ali S. (2002) *The Book of Indian Birds* (13th ed.). Mumbai: Bombay Natural History Society, pp. 326.
- Bassi N, Kumar MD, Sharma A and Pardha-Saradhi P. \ (2014) Status of wetlands in India: a review of extend ecosystem benefits, threats and management

- strategies. *Journal of Hydrology: Regional Studies* 2: 1–19.
- Bibi F and Ali Z. (2013) Measurement of diversity indices of avian communities at Taunsa Barrage Wildlife Sanctuary, Pakistan. *J Animal Plant Sci.* 23(2): 469-474.
- BirdLife International (2017) Waterbirds are showing widespread declines, particularly in Asia. <http://www.birdlife.org>.
- Central Pollution Control Board (CPCB) (2008) Status of water quality in India 2007. New Delhi: Central Pollution Control Board, Ministry of Environment and Forests, Government of India.
- Chatrath KJS. (1992) *Wetland of India*. Ashish Publishing House, New Delhi.
- Eglington SM, Noble DG and Fuller RJ. (2012) A meta analysis of spatial relationships in species richness across taxa: Birds as indicators of wider biodiversity in temperate regions, *J Nat Conserv.* 20: 301-309.
- Elafri A, Belhamra M and Houhamdi M. (2017) Comparing habitat preferences of a set of waterbird species wintering in the coastal wetlands of North Africa: implication for management. *Ekológia (Bratislava)* 36(2): 158-171.
- Elphick CS and Oring LW. (2003) Conservation implications of flooding rice fields on winter waterbird communities. *Agricult Ecosys Environ.* 94(1): 17-29.
- Gregory R. (2006) Birds as biodiversity indicators for Europe. <https://doi.org/10.1111/j.1740-9713.2006.00178.x>.
- Gregory RD, Noble D, Field R, Marchant J, Raven M and Gibbons DW. (2003) Using birds as indicators of biodiversity. *Ornis Hungarica* 12-13: 11-24.
- Gupta BM, Jayakumar S, Duraimurugan V, Krishnappa K and Paramanandham J. (2021) Biodiversity assessment in the Mangrove Forest of Karaikal District, Puducherry Union Territory. Project Report Phase I submitted to Government of Puducherry, Department of Science, Technology and Environment, Puducherry Pollution Control Committee- 5, pp. 1-43.
- Jagadheesan R and Pandiyan J. (2021) Temporal variations of large wading birds in the Point Calimere Wildlife Sanctuary, Tamil Nadu, India. *Indian J Sci Technol.* 14(1): 1-7.
- Kiros S, Afework B and Legese K. (2018) A preliminary study on bird diversity and abundance from Wabe fragmented forests around Gubre subcity and Wolkite town, southwestern Ethiopia. *Int J Avian Wildlife Biol.* 3(5): 333-340.
- Losey JE and Vaughan M. (2006) The economic value of ecological services provided by insects. *Biosci.* 56: 311-323.
- Malik DS and Joshi N. (2013) Habitat selection pattern of migratory avifauna in relation to nutrients in Asan wetland at Doon valley (Garhwal Himalaya), India. *Int J Recent Scientific Res.* 4(10): 1470-1475.
- Manikannan R, Ashokan S and Ali AMS. (2012) Abundance and factors affecting population characteristics of Waders (Charadriiformes) in Great Vedaranyam Swamp of Point Calimere Wildlife Sanctuary, South- East coast of India. *Int J Ecosystem* 2(1): 6-14.
- Nagarajan R and Thiyagesan K. (1996) Waterbirds and substrate quality of Pichavaram wetlands, Southern India. *Ibis* 138(4): 710-721.
- Pandiyan J, Asokan S, Thiyagesan K and Nagarajan R. (2006) Use of tidal flats in the Cauvery Delta region of SE India by shorebirds, gulls and terns. *Wader Study Group Bull.* 109: 105-111.
- Pandiyan J, Naresh B and Nagarajan R. (2014) Temporal variations of shorebirds and benthic community, traditional salt pans of east coast of southern India. *Int J Pure Appl Zool.* 2(1): 14-25.
- Rajashekara S and Venkatesha MG. (2010) The diversity and abundance of waterbirds in lakes of Bangalore city, Karnataka, India. *Biosystematica* 4(2): 63-73.
- Rajpar MN and Zakaria M. (2011) Bird species abundance and their correlation ship with microclimate and habitat variables at Natural Wetland Reserve, Peninsular Malaysia. *Int J Zool* 2011: 758573.
- Sandilyan S, Thiyagesan K and Nagarajan R. (2010) Major decline in species-richness of waterbirds in the Pichavaram mangrove wetlands, southern India. *Wader Study Group Bull.* 117(2): 91-98.
- Sandilyan S. (2014) Adjacent agricultural lands of Pichavaram Mangroves- Vital alternative habitat for waterbirds in Southern India. *Global J Environ Res.* 8(2): 21-25.
- Şekercioğlu CH. (2006) Ecological significance of bird populations. *Handbook of the birds of the world Lynx Edicions, Barcelona.*
- Singh K, Maheshwari A and Dwivedi SV. (2018) Studies on avian diversity of Banda university of agriculture and technology campus, Banda, Uttar Pradesh, India. *Int J Avian Wildlife Biol.* 3(2):177-180.
- Strum KM, Reiter ME, Hartman CA, Iglecia MN, Kelsey TR and Hickey CM. (2013) Winter management of California's rice fields to maximize waterbird habitat and minimize water use. *Agricult Ecosystem*

- Environ. 179: 116-124.
- Sundar KSG and Subramanya SS. (2010) Bird use of rice fields in the Indian subcontinent. *Waterbirds*, 33(Suppl): 44-70.
- Tanalgo KC, Pineda JA, Agravante ME and Amerol ZM. (2015) Bird diversity and structure in different land-use types in lowland South-Central Mindanao, Philippines. *Trop Life Sci Res*. 26(2): 85-103.
- Welsh DA. (1987) Birds as indicators of forest stand condition in boreal forest of eastern Canada. In: *The value of birds*. International council for Bird preservation, (eds.) Diamond A.W. and Filion F.L., Cambridge, England. pp. 259-266.
- Yardi K, Bharucha E and Girade S. (2019) Post-restoration monitoring of water quality and avifaunal diversity of Pashan Lake, Pune, India using a citizen science approaches. *Freshwater Sci*. 38(2). <https://doi.org/10.1086/703440>.