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STUDY OF AVIFAUNAL DIVERSITY IN MAN-MADE MANGROVES OF KARAIKAL DISTRICT, PUDUCHERRY, SOUTHERN INDIA

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ABSTRACT

Mangrove is an evergreen, salt tolerant plant community, which grows in inter-tidal coastal zones of tropical and subtropical regions of the world. They act as important habitats for many species of fauna. They are serving as an ideal foraging and nursery grounds for a wide array of aquatic species like aquatic invertebrates, fishes, reptiles, birds and mammals. The use of such mangrove habitats by birds in man-made mangrove is not known. The present study examines this issue by documenting avifaunal diversity in the man-made mangrove of Karaikal district from January 2015 to December 2015. The study revealed the occurrence of 57 bird species comprising 30 families and 10 orders. Among the 57 species, 23 species were water birds and semi-aquatic birds and the remaining 34 species were terrestrial birds. Out of 57 species recorded, Painted Stork is the only bird categorized as 'Near Threatened' and the remaining 56 species were listed under 'Least Concern' by IUCN. The occurrence of bird species along suitable habitats are the highlights of this mangrove area for the welfare of both the local people and birds.

INTRODUCTION

Every ecosystem supports human life by giving direct or indirect benefits and services. Mangrove areas are one among the most productive ecosystems on this planet because they serve as custodians of their juvenile stock and form most valuable biomass (Sandilyan, 2015; Kathiresan *et al*., 2001; Odum, 1971). The mangroves are referred to an ecological group of halophytic plant species, which is known as the salt tolerant forests and provide a wide range of ecological and economic products and services, and also supports a variety of other coastal and marine ecosystems (Sandilyan and Kathiresan, 2012). Mangroves occupy less than 1% of the world's surface (Teneson and Ravichandran, 2015; Saenger, 2002) and are mainly found between the Tropic of Cancer and the Tropic of Capricorn on all continents covering an estimated 75 percent of the tropical coastline worldwide (FAO, 2007). Among them, 39% of mangrove forests are available in Asia followed by 21% in Africa, 15 % in North and Central America, 12.6 % in South America and 12.4 % in Oceania countries like Australia, Papua New Guinea, New Zealand, and South Pacific Islands.

India has contributed 3% of world's mangroves and the largest Sundarbans is a Transboundary forest covering approximately one million hectares in Bangladesh and India. The smallest man-made mangroves of Karaikal also contribute 0.1% in India's contribution. The mangroves of Karaikal fall into two groups according to their habitats in nature: true mangroves and mangrove associates. True mangroves refer to species that specifically grow in intertidal zones, while mangrove associates are capable of occurring in either littoral or terrestrial habitats (Sandilyan and Kathiresan, 2014; Sandilyan *et al*., 2010; Sandilyan, 2010; Kathiresan and Bingham 2001; Nagelkerken *et al*., 2000). Mangrove forests are among the world's most productive ecosystems (Malhotra, 2010; Polidoro *et al*., 2010;Wolanski *et al*., 1992) and they enrich coastal waters, yield commercial forest products, protect coastlines, and support coastal fisheries (Ray and Ramachandra, 2010; Kathiresan and Bingham 2001). The biodiversity of mangroves has also been of increasingly greater interest, firstly because of the convention on biological diversity, and secondly, because the mangrove ecosystems are among the most threatened by the global climate changes, particularly the sea level rise along

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with other anthropogenic pressures (Duraimurugan *et al*., 2017; Jayakumar, 2013).

Indian subcontinent encompasses 1340 species of birds which contribute more than 15% of the world's bird species of 9,900 birds (Anula, 2015; Grimmett *et al*., 2011; Cox, 2010; Ali and Ripley, 1987). The Indian subcontinent is well-known for its rich and diverse bird species whose taxonomy, distribution and habitat characteristics are well documented in India (Jayakumar *et al*., 2014; Jayakumar *et al*., 2013; Grimmett *et al*., 2011; Kazmierczak, 2006; Manakadan and Pittie, 2001). Hence, it is necessary to recognize the diversity and structure of bird communities to portray the importance of regional landscapes for avian conservation. The collected information plays a significant role in providing the baseline information regarding the distribution of a particular bird species in a particular area and also offers useful information for identifying priority areas for conservation (Colin, 2000; Peterson *et al*., 2000; Daniels *et al*., 1991). The diversity of birds is one of the most important ecological indicators to evaluate the habitat quality both qualitatively and quantitatively (Manjunath and Joshi, 2012; Bilgrami, 1995). Birds are a prominent part of mangrove ecosystems and they distributed in large numbers especially in natural mangrove ecosystems in India (Abdul Aziz, 2015; Aditya Ghosh et. al., 2015; Shanij, 2015; Sulphey and Safeer, 2014; Vijaya Kumar and Vijayakumara, 2014; Sandilyan, 2010). Although the occurrences of birds' species in natural Mangrove ecosystems are well studied, studies on birds at man-made mangroves are yet to be addressed. Hence, the present study aimed to assess the avifauna communities in and around Karaikal Mangroves, Pondicherry.

MATERIALS AND METHODS

The present investigation was carried out in Mane-made mangroves at Karaikal (10.93^{o}N and 79.83^{o}E) of Puducherry state, Southern India between January 2015 and December 2015. The area of Karaikal region is 161 sq. km which is about 150 km from the south of Puducherry Union Territory and is surrounded by Nagapattinam district of Tamil Nadu. This district consists of almost entirely coastal alluvial soil which is highly suitable for cultivation of paddy and pulses. The man-made mangrove of Karaikal is situated in the tri junction of River Arasalaru, Bay of Bengal and Beach of Karaikal. This mangrove forests established by M.S. Swaminathan Foundation and funded by the Department of Tourism and, Development, Forest and, Wildlife and Fisheries of Pondicherry during 2009-10 (10 ha). Currently, the area of mangroves is 32. 3 ha, which harbours six species true mangrove plants and 108 species of mangrove associated plants. The mangroves plantation is surrounded by human settlements and opens into fishing areas of Bay of Bengal. The mangroves receive marine water from the Bay of Bengal and fresh water from the River Arasalaru and other small tributaries of river Cauvery. The small channels running across Karaikal town are also bringing the sewage and household wastes into the mangrove ecosystem.

METHODOLOGY

The entire survey was systematically carried out by walking along the fixed paths/ trails, for the documentation of avian species. The abundance of birds species was estimated by direct count method as has been employed by several workers for aquatic and other birds (Weller, 1975; Shah, *et al*., 1983 and Sivasubramanian, 1992). A pair of binoculars (Nikon 7 x 12) was used for counting birds. Care was taken to avoid double count by watching the birds' direction of flight and landing in case they are disturbed by predators or people. The field surveys were performed in the morning from 06.00 to 10.00 hours because these are the peak activity periods of birds in the mangroves and mud flats. Birds were identified using standard field guides (Grimmet *et al*., 2011; Ali, 2002; Ali and Ripley, 1987). Days with unfavourable climatic conditions such as heavy rainy days were avoided for data collection.

Data analysis

The observed number of each species was tabulated and statistical analysis was carried out using Microsoft Excel sheets. Species richness, evenness, Shannon-Wiener Diversity Index and Simpson's diversity index were calculated using the following statistics formulas:

Species Evenness and Richness: Species diversity increases with the complexity of habitat. This diversity considers both the richness and evenness of species. Evenness is a measure of the relative abundance of different species making up the richness of an area. This evenness is an important component of diversity indices (Hill, 1973; Turchi *et al*., 1995; Leinster and Cobbold, 2012) and expresses evenly distribution of the individuals among different species.

Species Richness (d) = S –1 / ln N
where, S = number of species, ln N = natural logarithm of the total number of individuals

Evenness index Species Evenness = H'/ ln (S)
where, H' is Shannon Diversity Index; S is Species Richness (number of species), and ln (S)
is natural logarithm of Species Richness.

Shannon-Weiner Index: Species evenness, richness, and diversity indices as Shannon-Weiner (Shannon and Weaver, 1949) and Simpson Index (Simpson, 1949) were used to evaluate the bird species diversity. Shannon-Weiner Index assumes that individuals are randomly sampled from an independent large population and all the species are represented in the sample. Shannon diversity index is very widely used for comparing diversity between various habitats (Clarke and Warwick, 2001). It was calculated in order to know the species diversity in different habitat (Hutchison, 1970) and different seasons based on the abundance of the species by the following formula:

Shannon-Wiener diversity index (H') H' = - [Σ Pi ln Pi]

Where: Pi is the proportion of species is relative to the total number of species, and ln Pi is
Natural logarithm of this proportion.

The presence of one individual of a species is not necessarily indicative of the species being present in a large number. The value of Shannon Weiner Diversity Index usually falls between 1.5 and 3.5, only rarely it surpasses 4.5. A value near 4.6 would indicate that the numbers of individuals are evenly distributed among all the species.

Simpson Index (D): It measures the probability that two individuals randomly selected from a sample will belong to the same species. Simpson gave the probability of any two

individuals drawn from noticeably large community belonging to different species. It has been measured by the given formula:

Simpson's diversity index $D = 1- \Sigma n(n-1) / N(N-1)$

Where: n is number of individuals of each species; N is the total number individuals of all species

Occurrence Status: For describing frequency of occurrence and comparative abundance, the terms described by Bull (1974) were followed.

The bird species found more than 400 individuals per seasons were termed as very abundant, those between 101 to 300 individuals were termed as abundant, and those found between 51 to 100 individuals termed as common, whereas those found between 11 to 20 individuals were considered as rare species. On the other hand, bird species found below ten individuals having infrequent occurrences were termed as very rare species. The recorded birds were mainly classified into two groups as terrestrial and aquatic.

Table 1 List of bird species at Man-made Mangroves of Karaikal between January 2015 and December 2015.

Sl. No	Common name	Scientific name	Order	Family	IUCN status	Migratory status	Feeding habits
1	Great Egret	*Ardea alba* (Linnaeus, 1758)	Pelecaniformes	Ardeidae	LC	R	P
2	Intermediate Egret	*Ardea intermedia* (Wagler, 1829)	Pelecaniformes	Ardeidae	LC	R	P
3	Cattle Egret	*Bubulcus ibis* (Linnaeus, 1758)	Pelecaniformes	Ardeidae	LC	R	I
4	Little Egret	*Egretta garzetta* (Linnaeus, 1766)	Pelecaniformes	Ardeidae	LC	R	P
5	Indian Pond Heron	*Ardeola grayii* (Sykes, 1832)	Pelecaniformes	Ardeidae	LC	R	P
6	Black-crowned Night Heron	*Nycticorax nycticorax* (Linnaeus, 1758)	Pelecaniformes	Ardeidae	LC	R	P
7	Little Cormorant	*Microcarbo niger* (Vieillot, 1817)	Suliformes	Phalacrocoracidae	LC	LM	P
8	Purple Heron	*Ardea purpurea* (Linnaeus, 1766)	Pelecaniformes	Ardeidae	LC	R	P
9	Grey Heron	*Ardea cinerea* (Linnaeus, 1758)	Pelecaniformes	Ardeidae	LC	R	P
10	Little Green Heron	*Butorides striata* (Linnaeus, 1758)	Pelecaniformes	Ardeidae	LC	LM	P
11	Great Bittern	*Botaurus stellaris* (Linnaeus, 1758)	Pelecaniformes	Ardeidae	LC	LM	P
12	Painted Stork	*Mycteria leucocephala* (Pennant, 1769)	Ciconiiformes	Ciconiidae	NT	WM	P
13	Ruff	*Calidris pugnax* (Linnaeus, 1758)	Charadriiformes	Scolopacidae	LC	WM	P
14	Little-ringed Plover	*Charadrius dubius* (Scopoli, 1786)	Charadriiformes	Charadriidae	LC	WM	I
15	Common-ringed Plover	*Charadrius hiaticula* (Linnaeus, 1758)	Charadriiformes	Charadriidae	LC	WM	I
16	Common Sandpiper	*Actitis hypoleucos* (Linnaeus, 1758)	Charadriiformes	Scolopacidae	LC	WM	I
17	White-breasted Waterhen	*Amaurornis phoenicurus* (Pennant, 1769)	Charadriiformes	Rallidae	LC	R	I
18	Pied Kingfisher	*Ceryle rudis* (Linnaeus, 1758)	Coraciiformes	Alcedinidae	LC	LM	P
19	Small-blue Kingfisher	*Alcedo atthis* (Linnaeus, 1758)	Coraciiformes	Alcedinidae	LC	R	P
20	Little Stint	*Calidris minut* (Leisler, 1812)	Charadriiformes	Scolopacidae	LC	WM	I
21	Black-winged Stilt	*Himantopus himantopus* (Linnaeus, 1758)	Charadriiformes	Recurvirostridae	LC	WM	I
22	Caspian Tern	*Hydroprogne caspia* (Pallas, 1770)	Charadriiformes	Laridae	LC	WM	P
23	White-breasted Kingfisher	*Halcyon smyrnensis* (Linnaeus, 1758)	Coraciiformes	Alcedinidae	LC	R	I
24	Red-wattled Lapwing	*Vanellus indicus* (Boddaert, 1783)	Charadriiformes	Charadriidae	LC	R	I
25	Sykes's Crested Lark	*Galerida cristata* (Linnaeus, 1758)	Passeriformes	Alaudidae	LC	R	I
26	Eastern Skylark	*Alauda arvensis* (Linnaeus, 1758)	Passeriformes	Alaudidae	LC	R	I
27	Yellow-billed Babbler	*Turdoides affinis* (Jerdon, 1845)	Passeriformes	Leiotrichidae	LC	R	I
28	Common Myna	*Acridotheres tristis* (Linnaeus, 1766)	Passeriformes	Sturnidae	LC	R	O
29	Gray Francolin	*Francolinus pondicerianus* (Gmelin,1789)	Galliformes	Phasianidae	LC	R	O
30	Black Drongo	*Dicrurus macrocercus* (Vieillot, 1817)	Passeriformes	Dicruridae	LC	R	I
31	Small Green Bee-Eater	*Merops orientalis* (Latham, 1802)	Coraciiformes	Meropidae	LC	R	I
32	House Crow	*Corvus splendens* (Vieillot, 1817)	Passeriformes	Corvidae	LC	R	O
33	Black-headed Munia	*Lonchura malacca* (Linnaeus, 1766)	Passeriformes	Estrildidae	LC	R	G
34	Red-vented Bulbul	*Pycnonotus cafer* (Linnaeus, 1766)	Passeriformes	Pycnonotidae	LC	R	I
35	Blue Rock Pigeon	*Columba livia* (Gmelin, 1789)	Columbiformes	Columbidae	LC	R	G
36	Spotted Dove	*Spilopelia suratensis* (Gmelin, 1789)	Columbiformes	Columbidae	LC	R	G
37	Common Tailorbird	*Orthotomus sutorius* (Pennant, 1769)	Passeriformes	Cisticolidae	LC	R	I
38	Asian Plam Swift	*Cypsiurus balasiensis* (Gray, 1829)	Caprimulgiformes	Apodidae	LC	R	I
39	Black Kite	*Milvus migrans* (Boddaert, 1783)	Accipitriformes	Accipitridae	LC	R	C
40	Brahminy Kite	*Haliastur indus* (Boddaert, 1783)	Accipitriformes	Accipitridae	LC	LM	C
41	Black-shouldered Kite	*Elanus caeruleus* (Desfontaines, 1789)	Accipitriformes	Accipitridae	LC	LM	C
42	Spotted Owlet	*Athene brama* (Temminck, 1821)	Strigiformes	Strigidae	LC	LM	C
43	House Sparrow	*Passer domesticus* (Linnaeus, 1758)	Passeriformes	Passeridae	LC	R	G
44	Common Swallow	*Hirundo rustica* (Linnaeus, 1758)	Passeriformes	Hirundinidae	LC	R	G
45	Jungle Crow	*Corvus macrorhynchos* (Wagler, 1827)	Passeriformes	Corvidae	LC	R	O
46	Tree Pipit	*Anthus trivialis* (Linnaeus, 1758)	Passeriformes	Motacillidae	LC	R	I
47	White Wagtail	*Motacilla alba* (Linnaeus, 1758)	Passeriformes	Motacillidae	LC	LM	I
48	Yellow Wagtail	*Motacilla flava* (Linnaeus, 1758)	Passeriformes	Motacillidae	LC	LM	I
49	Indian Treepie	*Dendrocitta vagabunda* (Latham, 1790)	Passeriformes	Corvidae	LC	LM	I
50	Lesser Coucal	*Centropus bengalensis* (Gmelin, 1788)	Cuculiformes	Cuculidae	LC	LM	I
51	Asian Paradise Flycatcher	*Terpsiphone paradisi* (Linnaeus, 1758)	Passeriformes	Monarchidae	LC	LM	I
52	Wire-tailed Swallow	*Hirundo smithii* (Leach, 1818)	Passeriformes	Hirundinidae	LC	R	I
53	Asian Koel	*Eudynamys scolopaceus* (Linnaeus, 1758)	Cuculiformes	Cuculidae	LC	LM	F
54	Red-winged Bush Lark	*Mirafra hypermetra* (Reichenow, 1879)	Passeriformes	Alaudidae	LC	LM	I
55	Paddy Field Pipit	*Anthus rufulus* (Vieillot, 1818)	Passeriformes	Motacillidae	LC	R	I
56	Purple-rumped Sunbird	*Leptocoma zeylonica* (Linnaeus, 1766)	Passeriformes	Nectariniidae	LC	LM	N
57	Indian Robin	*Saxicoloides fulicatus* (Linnaeus, 1766)	Passeriformes	Muscicapidae	LC	LM	I

Note: LC-Least Concern; NT-Near Threatened; R-Resident; LM- Local migrants; WM-Winter migrants; I- Insectivore; C-Carnivore; P- Piscivore; N-Nectarivore; F- Frugivore; G- Granivore; O- Omnivore

All the recorded aquatic birds were categorized into various groups on the basis of their diet.

RESULTS

A total of 57 bird species belonging to 30 families were recorded in the study area during the study period (Table 1). Among the 57 species 40% (n=23) of them belonging to water and Semi aquatic birds and the remaining 60% species belonging to terrestrial bird species. Out of the 57 species bird species recorded in the study area, only one species was classified as "Near Threatened"; and the remaining 56 species are "Least Concern", according to the International Union for Conservation of Nature and Natural Resources (IUCN, 2017; BirdLife International 2017). Among the 30 families, Ardeidae had the highest number of species (10 species) followed by Alaudidae, Alcedinidae, Corvidae and Scolopacidae (3 species each). Families, such as Accipitridae, Motacillidae and Charadriidae had two species each, while the remaining families were represented by one species. Out of 57 species, 33 species were Resident (R) birds, 16 species were Local Migrants (LM) and the remaining eight species were Winter Migrants (WM). Birds of diverse food habits were observed, viz., insectivores (27 species; 47%), piscivores (15 species; 26%), granivores (5 species; 9%), omnivores (4 species; 7%), carnivores (4 species; 7%), frugivores (1 species; 2 %) and nectarivores (1 species; 2%) (Figure1).

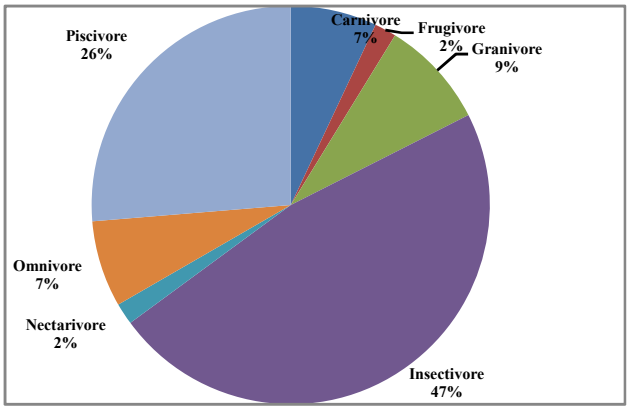

Figure 1 Occurance of avifauna based on their feeding habits.

Shannon Wiener Index and variation, Simpson Index and Evenness Index were also estimated to know the diversity and occurrence bird species in Karikal Mangroves and the results are given in table 2. Among the 12 months surveyed, November had the highest diversity (H′ 2.87) followed by December (H′ 2.79) and October (H′ 2.78), whereas July (H′ 2.14) had the least. There was no variation in Simpson index, which was in the ranges of 0.88- 0.93. The evenness index of the study area falls within 0.57 and 0.71(Table 2). The lowest evenness index (0.57) was recorded in the month of July 2015 and the highest was recorded during November 2015. The month wise variation in species richness was also calculated. Among the 12 months surveyed the highest species richness was recorded during of June 2015, while the lowest was recorded in May 2015 (Table 2). The seasonal occurrence of bird species was also calculated and the information was given in table 3.

DISCUSSION

Karikal Man-made Mangroves attract large a number of both long and short distance migrants, besides harbouring resident bird species which finds similarity with literature (Sampath & Krishnamurthy 1989; 1990, 1993; Nagarajan & Thiyagesan 1996, 2006; Muralidharan *et al*. 2014). Waterbirds, being generally at or near the top of most wetland food chains are highly susceptible to habitat disturbances and are therefore good indicators of the general condition of wetland habitats, particularly mangrove forests (Sandilyan and Kathiresan, 2014; Sandilyan *et al*., 2010; Sandilyan, 2010; Kathiresan and Bingham 2001; Nagelkerken *et al*., 2000; Kushlan 1992). The number of bird species recorded in Man-made mangroves was comparable with earlier reports (Table 4). The season for birds is from September to April. Peak numbers are seen from November to January which is similar to what Nagarajan and Thiyagesan (1996) recorded in Pichavaram Mangrove.

The Near Threatened bird species observed during the study period was Painted Stork *Mycteria leucocephala* and the number of species present (i.e., species richness) in the mangrove forest followed the same pattern almost in all the months.

Table 2 Comparison of different indices for bird species occurrence at the man-made mangrove between January 2015 and December 2015.

Different Indices	January	February	March	April	May	June	July	August	September	October	November	December
Shannon-Weiner Diversity index (H')	2.63	2.52	2.52	2.42	2.23	2.17	2.14	2.38	2.59	2.78	2.87	2.79
Shannon-Weiner Diversity index Variance (H')	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000
Simpson Index	0.92	0.93	0.93	0.92	0.93	0.93	0.93	0.93	0.92	0.89	0.88	0.88
Evenness index	0.65	0.62	0.62	0.65	0.57	0.64	0.53	0.59	0.64	0.69	0.71	0.69
Species Richness	40.86	37.86	39.86	43.86	34.86	56.86	25.86	37.86	35.86	39.87	41.87	38.87

Table 3 Occurrence bird species recorded in the study area based on their distribution.

Occurrence categories	Summer	Pre-monsoon	Monsoon	Post Monsoon
Abundant	7	8	14	8
Common	26	22	22	29
Rare	9	8	4	8
Very rare	7	7	8	2

Furthermore, thousands of terrestrial bird species were found roosting in the dense areas of the mangroves and leaving at dusk. The variations in bird's occurrence indicated that this mangrove was rich in avifauna particularly waterbirds. Although several threats were identified for waterbirds, the most significant was the deprivation of sewage water flow to Karikal man-made mangrove areas (Duraimurugan *et al*., 2017), which completely changed the land use pattern and productivity of the mangroves and the adjoining areas. The availability of diverse habitat types such as channels, mudflats

and sand flats and adjacent seashore offers ideal habitat for different species of birds, which finds similarity with the earlier studies reported from Pichavaram mangroves in Tamil Nadu (Muralidharan *et al*., 2014; Nagarajan and Thiyagesan 1996). Nagarajan and Thiyagesan (1998) found that adjoining croplands played an important role in attracting the birds to the Pichavaram mangroves, which is very well comparable with the present findings. The waterbirds showed preference for different microhabitats for various activities. For example, they used the agricultural lands for foraging and mangroves for roosting, which find similarity with earlier observations (Nagarajan & Thiyagesan 1998). In addition, terrestrial birds roosted in the mangrove vegetations of the margin areas, particularly the Common Myna *Acridotheres tristis* roost with herons and egrets. The Karaikal mangrove biotope, with its peculiar topography and environmental conditions, supports many rare varieties of the economically important shell and fin-fishes, which ultimately attracting more species of fish-eating birds. The information collected is the maiden one and it may of use for future comparison and the occurrence of bird species along suitable habitats are the highlights of this mangrove area for the welfare of both the local people and birds. Long-term monitoring works are highly warranted to understand the situation better.

Table 4 Comparison of bird species occurrence among various mangrove forests of India.

Location	State	Species Richness	Relevant Literature
Sundarbans Mangroves	West Bengal	198	Monirul and Khan, 2003
Sundarbans Mangroves	West Bengal	300	Aditya Ghosh et.al.,2015
Sundarbans Mangroves	West Bengal	315	Abdul Aziz, 2015
Bhitarkanika Mangroves	Orissa	263	Gopi, 2007
Bhitarkanika Mangroves	Orissa	174	Bivash pandav, 1996
Mahanadi Mangroves	Orissa	320	Sulphey and Safeer, 2014
Dhamra Mangroves	Orissa	90	Sushil, 1997
Godavari Mangroves	Andhra Pradesh	119	EGREE, 2016
Mangroves of Andaman & Nicobar	Andaman & Nicobar	217	Salim All Centre for Ornithology & Natural History, 2004
Pichavaram Mangroves	Tamil Nadu	177	Sampath & Krishnamurthy, 1993
Pichavaram Mangroves	Tamil Nadu	100	Sandilyan, 2010
Pichavaram Mangroves	Tamil Nadu	74	Muralidharan *et al*., 2014; Jayakumar, 2013
Muthupet Mangroves	Tamil Nadu	160	Oswin, 1998
Kundapur Mangroves	Karnataka	79	Vijayakumar and Vijayakumara, 2011
Dr Salim Ali Mangrove Sanctuary	Gova	100	Badri Chatterjee , 2017 (*Pers. Comm.*), Hindustan Times
Mahul Creek Mangroves	Maharashtra	134	Verma et. al., 2002
Mumbra-diva Mangroves	Maharashtra	200	Viju B, 2010 (*Pers. Comm.*), The Times Of India Mumbai
Vikhroli Mangroves	Maharashtra	208	Badri Chatterjee , 2017 (*Pers. Comm.*), Hindustan Times
Kunhimangalam Mangroves	Kerala	172	Praveen et. al., 2016
Karaikal Man-made Mangroves	Pondicherry Union Territory	57	Present study

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