



Ornithofauna and its conservation in the Kuttanad wetlands, southern portion of Vembanad-Kole Ramsar site, India

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Abstract: The avifauna of Kuttanad was studied from January 1995 to June 2007. Two-hundred-and-twenty-five taxa of birds belonging to 15 orders and 59 families were recorded. Among the birds recorded, 38% were migrants. Fifty-five species were found to breed in the area. Family Scolopaceidae showed maximum species diversity. European Roller *Coracias garrulus* recorded during this study is the first report of this species from Kerala. Ten globally threatened species were recorded. Kuttanad wetland shows greater species diversity, especially in the wetland birds, than the Kole wetlands of Kerala. Kumarakom heronry holds 8% of the biogeographical population of the Near Threatened Oriental Darter. Landscape alteration, hunting, felling of nesting trees and pesticides are the major detrimental factors for the survival of birds. Conservation aspects of birds of this region are discussed.

Keywords: Avifauna, conservation, Kuttanad, Ramsar site, threats.

INTRODUCTION

Wetlands are complex and productive ecosystems (Maltby 1986; Unni 2002) that occupy about six percent of the Earth's land surface (Maltby & Turner 1983). Wetlands are known as "biological supermarkets" because of the extensive food chains and rich biodiversity they support, providing unique habitats for a wide range of flora and fauna (Mitsch & Gosselink 2000). Wetlands are important habitats for birds, which use them for feeding, roosting, nesting and rearing young (Weller 1999; Stewart 2001). The use of wetlands by birds during the breeding cycle ranges widely, with some depending almost totally on wetlands for breeding, feeding or shelter during their breeding cycles.

Kuttanad wetland is located at the southern portion of India's largest Ramsar site the Vembanad-Kole wetland. Ali (1984), Ali & Ripley (1987), Neelakantan (1996), Chandy (2003), Narayanan (2004), Sreekumar & Narayanan (2004), Rakesh et al. (2004), Narayanan et al. (2005a,b) reported various aspects of the avifauna of this wetland. The only detailed study regarding birds in this region is the midwinter water bird count. Nature Education Society, Thrissur, organized the first water bird survey in the Vembanad Lake (NEST 1993). Since 2001, regular Midwinter Waterbird Count is being carried out at different parts of Kuttanad wetlands by Kottayam Nature Society (KNS) in association with Kerala Forest and Wildlife Department (Sreekumar 2001, 2002, 2003, 2004, 2005), but most of the surveys were concentrated in and around the premises of Vembanad Lake. Existing information available on the avifauna of

this region is based on surveys conducted by KNS and mainly in view to the wetland birds. Hence this work was taken with the following objectives (i) to make an inventory of the avifauna of Kuttanad wetlands with breeding birds, status, occurrence, (ii) to find and list the major factors which threatens the bird fauna, and (iii) to propose the action plan for the conservation of birds and wetlands of Kuttanad.

STUDY AREA

Kuttanad is primarily a deltaic formation of five river systems: Meenachil, Pamba, Manimala, Muvattupuzha and Achencovil, located in the fertile low-lying areas of Vembanad Lake (Fig. 1) (Shari & Chitra 2005). It spreads over Alappuzha, Kottayam and Pathanamthitta districts of Kerala and forms an integral part of the Vembanad-Kole Ramsar site. This region lies between 9°17'–9°40'N & 76°19'–76°33'E and is separated from

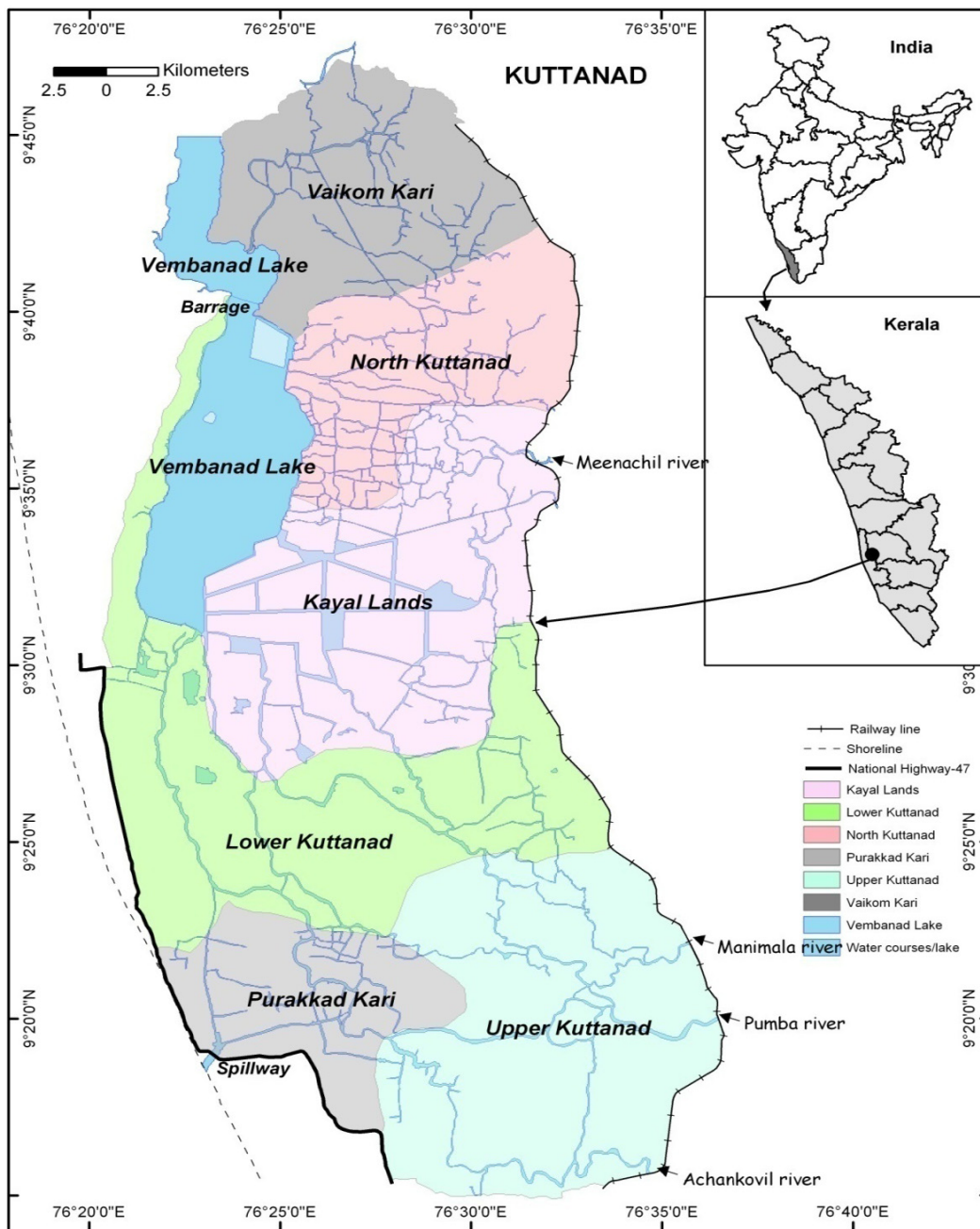


Figure 1. Six divisions of Kuttanad wetlands

the Arabian Sea by a narrow strip of land. Much of this region lies 0.6 to 2.2 m below mean sea level, hence the area remains water-logged almost throughout the year and is subjected to continued flood submergence during the monsoon and saline water ingress during the summer months. Kuttanad is rightly called the “Rice Bowl of Kerala”, contributing nearly 20% of the total state rice production. It consists of 53,639 hectares distributed among 1086 units where rice is cultivated (Sudhikumar & Sebastian 2005). Most of these fields are inundated during the non-crop season and water has to be pumped out to the canal systems and backwaters before the commencement of the cultivating season (Sashikumar & Palot 2002). Based on the soils, geomorphology and salinity intrusion, Kuttanad is subdivided into six agro-ecological zones viz., (i) Upper Kuttanad (ii) Kayal lands (iii) Vaikom Kari (iv) Lower Kuttanad (v) North Kuttanad and (vi) Purakkad Kari (Indo-Dutch Mission 1989). Major portion of the Vembanad estuary is situated in Kuttanad Wetland, which is the biggest estuary in the southwest coast of India. It experiences warm climate with fairly uniform temperature throughout the year ranging from 21–36 °C. Humidity in general is very high all through the year (Shari & Chitra 2005). The average annual rainfall received is around 3000mm (Shari & Chitra 2005) of which about 83% is received during south west monsoon months.

MATERIAL AND METHODS

This study was carried out from January 1995 to June 2007. Observations were carried out during the weekdays mainly from 0700 to 1100 hr and occasional sightings of birds during non-birding trips were also included. Birds were identified with the help of different field guides (Ali 1984; Ali & Ripley 1987; Neelakantan 1996; Grimmet et al. 2000; Grewal et al. 2002) using Bushnell (7x35mm) binoculars. The species list (Table 1) includes those that were recorded in the present study and also from various other works, compiled from published and unpublished materials and personal communications. As per the occurrence in the Kuttanad wetlands, species were classified as: resident (R) - found in all suitable habitats throughout the year; migrant (M) - found only during a specific season (this includes birds from Central

Asian countries and northern areas of the Indian sub-continent); local migrant (LM) - resident to the state but found in Kuttanad region only during a specific season; straggler from the hill (SH) - species usually found in the hilly areas of the state but recorded from this area; and vagrant (V) - birds which accidentally came to the region from its normal range, which is hundreds of miles away. The status of many birds observed in Kuttanad Wetland is different from their Kerala State status. Abundance of each species was derived following Nameer et al. (2000). According to the feeding habits, birds were divided as aquatic herbivores, aquatic insectivore, aquatic omnivores, piscivores, carnivores, insectivores, omnivores, granivores, frugivores, nectarivores. The taxonomical classification and common names follow Manakadan & Pittie (2002).

RESULTS AND DISCUSSION

Total 225 taxa of birds belonged to 15 orders 59 families were identified from Kuttanad wetlands (Table 1). Neelakantan (1996) listed out 483 species from Kerala out of which around 47% of bird species were recorded during this study. Order Passeriformes possess the most diversified families (26) and species (78). Maximum number of species was recorded from the families Scolopaceidae and Ardeidae (Table 1). Though a wetland-dominated area, 52.5% birds belong to non-wetland category. Most of the land birds were seen at the eastern boundaries of Kuttanad, where Kuttanad wetlands meet midland areas of Kerala. Hence high number of species reported from that area could be due to edge effect. Among the birds recorded, 38% constitute migrants and 38% residents (Fig. 2). Wetland and wetland dependent birds formed major portion of these migrants. The composition of birds in major feeding guilds in the study area showed that the insectivore guild was the most common with 37.33% species, followed by piscivores (Fig. 3).

Ten globally threatened species were recorded. Among these Greater Spotted Eagle *Aquila clanga* is listed under Vulnerable category. Species, such as Ferruginous Pochard *Aythya nyroca*, Painted Stork *Mycteria leucocephala*, Oriental White Ibis *Threskiornis melanocephalus*, Spot-billed Pelican *Pelecanus philippensis*, Oriental Darter *Anhinga*

Table 1. Checklist of the birds of Kuttanad wetlands with its status

	Scientific name	Common name	Status	Breeding
	Podicipedidae			
1	<i>Tachybaptus ruficollis</i> (Pallas, 1764)	Little Grebe	C, R	√
	Pelecanidae			
2	<i>Pelecanus philippensis</i> Gmelin, 1789	Spot-billed Pelican	O, M	
	Phalacrocoracidae			
3	<i>Phalacrocorax niger</i> (Vieillot, 1817)	Little Cormorant	A, R	√
4	<i>Phalacrocorax fuscicollis</i> Stephens, 1826	Indian Shag	C, R	√
5	<i>Phalacrocorax carbo</i> (Linnaeus, 1758)	Great Cormorant	U, R	√
	Anhingidae			
6	<i>Anhinga melanogaster</i> Pennant, 1769	Darter	C, R	√
	Ardeidae			
7	<i>Egretta garzetta</i> (Linnaeus, 1766)	Little Egret	A, R	√
8	<i>Egretta gularis</i> (Bosc, 1792)	Western Reef-Egret	U, M	
9	<i>Ardea cinerea</i> Linnaeus, 1758	Grey Heron	U, LM	
10	<i>Ardea purpurea</i> Linnaeus, 1766	Purple Heron	C, R	√
11	<i>Casmerodius albus</i> (Linnaeus, 1758)	Large Egret	C, R	√
12	<i>Mesophoyx intermedia</i> (Wagler, 1829)	Median Egret	C, R	√
13	<i>Bubulcus ibis</i> (Linnaeus, 1758)	Cattle Egret	A, M	
14	<i>Ardeola grayii</i> (Sykes, 1832)	Indian Pond-Heron	A, R	√
15	<i>Butorides striatus</i> (Linnaeus, 1758)	Little Green Heron	U, R	
16	<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	Black-crowned Night-Heron	C, R	√
17	<i>Ixobrychus sinensis</i> (Gmelin, 1789)	Yellow Bittern	U, R	
18	<i>Ixobrychus cinnamomeus</i> (Gmelin, 1789)	Chestnut Bittern	U, R	√
19	<i>Dupetor flavicollis</i> (Latham, 1790)	Black Bittern	U, R	√
	Ciconiidae			
20	<i>Mycteria leucocephala</i> (Pennant, 1769)	Painted Stork	O, M	
21	<i>Anastomus oscitans</i> (Boddaert, 1783)	Asian Openbill-Stork	U, M	
22	<i>Ciconia episcopus</i> (Boddaert, 1783)	White-necked Stork	U, LM	
	Threskiornidae			
23	<i>Plegadis falcinellus</i> (Linnaeus, 1766)	Glossy Ibis	C, M	
24	<i>Threskiornis melanocephalus</i> (Latham, 1790)	Oriental White Ibis	C, R	√
25	<i>Platalea leucorodia</i> Linnaeus, 1758	Eurasian Spoonbill	U, M	
	Anatidae			
26	<i>Dendrocygna javanica</i> (Horsfield, 1821)	Lesser Whistling-Duck	C, R	√
27	<i>Tadorna ferruginea</i> (Pallas, 1764) #	Brahminy Shelduck #	V	
28	<i>Nettapus coromandelianus</i> (Gmelin, 1789)	Cotton Teal	C, R	√
29	<i>Anas poecilorhyncha</i> J.R. Forester, 1781	Spot-billed Duck	U, LM?	
30	<i>Anas clypeata</i> Linnaeus, 1758	Northern Shoveller	O, M	
31	<i>Anas acuta</i> Linnaeus, 1758	Northern Pintail	C, M	
32	<i>Anas querquedula</i> Linnaeus, 1758	Garganey	C, M	
33	<i>Anas crecca</i> Linnaeus, 1758	Common Teal	U, M	
34	<i>Aythya nyroca</i> (Guldenstadt, 1770)	Ferruginous Pochard	O, M	
	Accipitridae			
35	<i>Elanus caeruleus</i> (Desfontaines, 1789)	Black-shouldered Kite	U, LM	
36	<i>Milvus migrans</i> (Boddaert, 1783)	Black Kite	U, R	√
37	<i>Haliastur indus</i> (Boddaert, 1783)	Brahminy Kite	C, R	√
38	<i>Circus aeruginosus</i> (Linnaeus, 1758)	Western Marsh-Harrier	C, M	
39	<i>Circus pygargus</i> (Linnaeus, 1758) #	Montagu's Harrier #	O, M	
40	<i>Ichthyophaga ichthyaetus</i> (Horsfield, 1821) #	Greater Grey-headed Fish-Eagle #	O, SH	
41	<i>Accipiter badius</i> (Gmelin, 1788)	Shikra	C, R	√
42	<i>Accipiter nisus</i> (Linnaeus, 1758)	Eurasian Sparrowhawk	O, M, a	
43	<i>Aquila nipalensis</i> Hodgson, 1833	Steppe Eagle	U, M	
44	<i>Aquila clanga</i> Pallas, 1811 #	Greater Spotted Eagle	U, M	
45	<i>Hieraaetus pennatus</i> (Gmelin, 1788) #	Booted Eagle	U, M	
	Pandionidae			
46	<i>Pandion haliaetus</i> (Linnaeus, 1758)	Osprey	C, M	
	Falconidae			
47	<i>Falco tinnunculus</i> Linnaeus, 1758 #	Common Kestrel	O, SH	
48	<i>Falco peregrinus</i> Tunstall, 1771 #	Peregrine Falcon	U, M	

	Scientific name	Common name	Status	Breeding
	Rallidae			
49	<i>Amaurornis phoenicurus</i> (Pennant, 1769)	White-breasted Waterhen	C, R	√
50	<i>Rallina eurizonoides</i> (Lafresnaye, 1845)	Slaty-legged Crake	U, M	
51	<i>Galliarallus striatus</i> Linnaeus, 1766 #	Blue-breasted Rail #	O, M	
52	<i>Porzana pusilla</i> (Pallas, 1776) #	Baillon's Crake #	O, M	
53	<i>Porzana fusca</i> (Linnaeus, 1766)	Ruddy-breasted Crake	U, M	
54	<i>Gallix rex cinerea</i> (Gmelin, 1789)	Watercock	C, R	
55	<i>Porphyrio porphyrio</i> (Linnaeus, 1758)	Purple Moorhen	C, R	
56	<i>Gallinula chloropus</i> (Linnaeus, 1758)	Common Moorhen	U, M	
57	<i>Fulica atra</i> Linnaeus, 1758	Common Coot	U, M?	
	Jacanidae			
58	<i>Hydrophasianus chirurgus</i> (Scopoli, 1786)	Pheasant-tailed Jacana	C, R	
59	<i>Metopidius indicus</i> (Latham, 1790)	Bronze-winged Jacana	C, R	
	Rostratulidae			
60	<i>Rostratula benghalensis</i> (Linnaeus, 1758)	Greater Painted-Snipe	U, R	
	Charadriidae			
61	<i>Pluvialis fulva</i> (Gmelin, 1789)	Pacific Golden-Plover	C, M	
62	<i>Pluvialis squatarola</i> (Linnaeus, 1758)	Grey Plover	U, M	
63	<i>Charadrius dubius</i> Scopoli, 1786	Little Ringed Plover	U, M	
64	<i>Charadrius alexandrinus</i> Linnaeus, 1758	Kentish Plover	U, M	
65	<i>Charadrius mongolus</i> Pallas, 1776	Lesser Sand Plover	C, M	
66	<i>Charadrius leschermaultii</i> Lesson, 1826	Greater Sand Plover	O, M	
67	<i>Vanellus malabaricus</i> (Boddaert, 1783)	Yellow-wattled Lapwing	O, LM	
68	<i>Vanellus indicus</i> (Boddaert, 1783)	Red-wattled Lapwing	C, R	
	Scolopacidae			
69	<i>Gallinago gallinago</i> (Linnaeus, 1758)	Common Snipe	C, M	
70	<i>Limosa limosa</i> (Linnaeus, 1758)	Black-tailed Godwit	C, M	
71	<i>Numenius phaeopus</i> (Linnaeus, 1758)	Whimbrel	U, M	
72	<i>Numenius arquata</i> (Linnaeus, 1758)	Eurasian Curlew	U, M	
73	<i>Tringa totanus</i> (Linnaeus, 1758)	Common Redshank	C, M	
74	<i>Tringa erythropus</i> (Pallas, 1764)	Spotted Redshank	O, M	

	Scientific name	Common name	Status	Breeding
75	<i>Tringa stagnatilis</i> (Bechstein, 1803)	Marsh Sandpiper	U, M	
76	<i>Tringa nebularia</i> (Gunner, 1767)	Common Greenshank	C, M	
77	<i>Tringa ochropus</i> Linnaeus, 1758	Green Sandpiper	C, M	
78	<i>Tringa glareola</i> Linnaeus, 1758	Wood Sandpiper	C, M	
79	<i>Actitis hypoleucos</i> Linnaeus, 1758	Common Sandpiper	C, M	
80	<i>Calidris temminckii</i> (Leisler, 1812)	Temminck's Stint	C, M	
81	<i>Calidris minuta</i> (Leisler, 1812)	Little Stint	U, M	
82	<i>Calidris ferruginea</i> (Pontoppidan, 1813)	Curlew Sandpiper	O, M	
83	<i>Calidris subminuta</i> (Midendorff, 1853) #	Long-toed Stint #	O, M, a	
84	<i>Phuillomachus pugnax</i> (Linnaeus, 1758)	Ruff	O, M	
	Recurvirostridae			
85	<i>Himantopus himantopus</i> (Linnaeus, 1758)	Black-winged Stilt	U, R	√
	Glareolidae			
86	<i>Glareola lactea</i> Temminck, 1820	Small Pratincole	U, LM	
	Laridae			
87	<i>Larus ichthyaetus</i> Pallas, 1773 #	Pallas's Gull #	O, M	
88	<i>Larus brunnicephalus</i> Jerdon, 1840	Brown-headed Gull	U, M	
89	<i>Larus ridibundus</i> Linnaeus, 1766	Black-headed Gull	C, M	
90	<i>Gelochelidon nilotica</i> (Gmelin, 1789)	Gull-billed Tern	C, M	
91	<i>Sterna caspia</i> Pallas, 1770	Caspian Tern	O, M	
92	<i>Sterna bengalensis</i> Lesson, 1831 #	Lesser Crested Tern #	O, M	
93	<i>Sterna bergii</i> Lichtenstein, 1823 #	Large Crested Tern #	O, M	
94	<i>Sterna albifrons</i> Pallas, 1764 #	Little/Saunders's Tern	O, M	
95	<i>Sterna aurantia</i> J.E. Gray, 1831	River Tern	O, LM	
96	<i>Sterna fuscata</i> Linnaeus, 1766 #	Sooty Tern #	V	
97	<i>Chlidonias hybridus</i> (Pallas, 1811)	Whiskered Tern	C, M	
98	<i>Chlidonias leucopterus</i> (Temminck, 1815)	White-winged Black Tern	O, M	
	Columbidae			
99	<i>Columba livia</i> Gmelin, 1789	Blue Rock Pigeon	C, R	√
100	<i>Streptopelia chinensis</i> (Scopoli, 1786)	Spotted Dove	O, LM	

	Scientific name	Common name	Status	Breeding
101	<i>Chalcophaps indica</i> (Linnaeus, 1758)	Emerald Dove	U, LM	
102	<i>Ducula badia</i> (Raffles, 1822)	Mountain Imperial-Pigeon	U, SH	
103	<i>Treron pompadora</i> (Gmelin, 1789)	Pompadour Green-Pigeon	U, LM	
	Psittacidae			
104	<i>Loriculus vernalis</i> (Sparman, 1787)	Indian Hanging-Parrot	U, LM	
105	<i>Psittacula krameri</i> (Scopoli, 1769)	Rose-ringed Parakeet	C, R	√
106	<i>Psittacula cyanocephala</i> (Linnaeus, 1766)	Plum-headed Parakeet	C, R	
	Cuculidae			
107	<i>Clamator jacobinus</i> (Boddaert, 1783)	Pied Crested Cuckoo	O, M, a	
108	<i>Clamator coromandus</i> (Linnaeus, 1766) #	Red-winged Crested Cuckoo #	O, M, a	
109	<i>Hierococcyx varius</i> (Vahl, 1797)	Brainfever Bird	C, LM	
110	<i>Cuculus micropterus</i> Gould, 1838	Indian Cuckoo	O, M	
111	<i>Cacomantis passerinus</i> (Vahl, 1797) #	Indian Plaintive Cuckoo #	U, M	
112	<i>Eudynamis scolopacea</i> (Linnaeus, 1758)	Asian Koel	C, R	√
113	<i>Centropus sinensis</i> (Stephens, 1815)	Greater Coucal	C, R	√
	Tytonidae			
114	<i>Tyto alba</i> (Scopoli, 1769)	Barn Owl	C, R	√
	Strigidae			
115	<i>Otus bakkamoena</i> Pennant, 1769	Collared Scops-Owl	U, R	
116	<i>Ketupa zeylonensis</i> (Gmelin, 1788) #	Brown Fish-Owl #	U, R?	
117	<i>Strix ocellata</i> (Lesson, 1839)	Mottled Wood-Owl	U, R?	
118	<i>Glaucidium radiatum</i> (Tickell, 1833)	Jungle Owlet	C, R	
119	<i>Athene brama</i> (Temminck, 1821)	Spotted Owlet	U, R?	
120	<i>Ninox scutulata</i> (Raffles, 1822)	Brown Hawk-Owl	U, R	√
	Caprimulgidae			
121	<i>Caprimulgus atripennis</i> Jerdon, 1845 #	Jerdon's Nightjar #	SH, a	
	Apodidae			
122	<i>Apus affinis</i> (J.E. Gray, 1830)	House Swift	C, LM	
123	<i>Apus pacificus</i> (Latham, 1801)	Pacific Swift	SH	
124	<i>Tachymarptis melba</i> (Linnaeus, 1758)	Alpine Swift	U, LM	
125	<i>Hirundapus giganteus</i> (Temminck, 1846)	Brown-backed Needletail-Swift	U, SH	

	Scientific name	Common name	Status	Breeding
126	<i>Cypsiurus balasiensis</i> (J.E. Gray, 1829)	Asian Palm-Swift	C, R	√
	Alcedinidae			
127	<i>Alcedo atthis</i> (Linnaeus, 1758)	Small Blue Kingfisher	C, R	√
128	<i>Ceyx erithaca</i> (Linnaeus, 1758) #	Oriental Dwarf Kingfisher #	O, SH, a	
129	<i>Halcyon capensis</i> (Linnaeus, 1766)	Stork-billed Kingfisher	C, R	
130	<i>Halcyon smymensis</i> (Linnaeus, 1758)	White-breasted Kingfisher	C, R	√
131	<i>Halcyon pileata</i> (Boddaert, 1783)	Black-capped Kingfisher	U, M	
132	<i>Ceryle rudis</i> (Linnaeus, 1758)	Pied Kingfisher	C, R	√
	Meropidae			
133	<i>Merops philippinus</i> Linnaeus, 1766	Blue-tailed Bee-eater	C, M	
134	<i>Merops orientalis</i> Latham, 1801	Small Bee-eater	C, R	
135	<i>Merops leschenaulti</i> Vieillot, 1817 #	Chestnut-headed Bee-eater #	RR, LM	
	Coraciidae			
136	<i>Coracias benghalensis</i> (Linnaeus, 1758)	Indian Roller	C, R	√
137	<i>Coracias garrulus</i> Linnaeus, 1758 #	European Roller #	V	
	Bucerotidae			
138	<i>Ocyrceros griseus</i> (Latham, 1790) #	Malabar Grey Hornbill #	O, SH, a	
	Upupidae			
139	<i>Upupa epops</i> Linnaeus, 1758	Common Hoopoe	U, LM	
	Capitonidae			
140	<i>Megalaima viridis</i> (Boddaert, 1783)	White-cheeked Barbet	C, R	√
141	<i>Megalaima haemacephala</i> (P.L.S. Müller, 1776) #	Coppersmith Barbet	C, R	
	Picidae			
142	<i>Dendrocopos nanus</i> (Vigors, 1832) #	Brown-capped Pigmy Woodpecker #	U, LM	
143	<i>Dendrocopos maharattensis</i> (Latham, 1801) #	Yellow-fronted Pied Woodpecker #	O, R	
144	<i>Dinopium benghalense</i> (Linnaeus, 1758)	Lesser Golden-backed Woodpecker	C, R	√
145	<i>Celeus brachyurus</i> (Vieillot, 1818) #	Rufous Woodpecker #	O, SH	
	Pittidae			
146	<i>Pitta brachyura</i> (Linnaeus, 1766)	Indian Pitta	UN, M	
	Alaudidae			
147	<i>Eremopterix grisea</i> (Scopoli, 1786)	Ashy-crowned Sparrow-Lark	O, LM	

	Scientific name	Common name	Status	Breeding
148	<i>Galerida malabarica</i> (Scopoli, 1786)	Malabar Crested Lark	O, LM	
149	<i>Alauda gulgula</i> Franklin, 1831	Eastern Sky Lark	U, LM	
	Hirundinidae			
150	<i>Hirundo rustica</i> Linnaeus, 1758	Common Swallow	C, M	
151	<i>Hirundo daurica</i> Linnaeus, 1771	Red-rumped Swallow	C, LM	
152	<i>Hirundo smithii</i> Leach, 1818 #	Wire-tailed Swallow #	U, LM	
153	<i>Hirundo fluvicola</i> Blyth, 1855 #	Streak-throated Swallow	U, LM, a	
154	<i>Hirundo tahitica</i> Gmelin, 1789	House Swallow	O, SH, a	
155	<i>Riparia diluta</i> (Sharpe & Wyatt, 1893)	Pale Martin	V, a	
	Motacillidae			
156	<i>Dendronanthus indica</i> (Gmelin, 1789) #	Forest Wagtail #	C, M	
157	<i>Motacilla alba</i> Linnaeus, 1758	White Wagtail	C, M	
158	<i>Motacilla cinerea</i> Tunstall, 1771	Grey Wagtail	C, M	
159	<i>Motacilla flava</i> Linnaeus, 1758	Yellow Wagtail	A, M	
160	<i>Motacilla citriola</i> Pallas, 1776	Citrine Wagtail	U, M	
161	<i>Motacilla maderaspatensis</i> Gmelin, 1789	Large Pied Wagtail	C, R	√
162	<i>Anthus rufulus</i> Vieillot, 1818	Paddyfield Pipit	C, LM	
	Campephagidae			
163	<i>Coracina macei</i> (Lesson, 1830) #	Large Cuckoo-shrike #	U?, LM	
164	<i>Coracina melanoptera</i> (Rüppell, 1839) #	Black-headed Cuckoo-shrike #	U?, LM	
165	<i>Pericrocotus cinnamomeus</i>	Small Minivet	U?, LM	
166	<i>Pericrocotus flammeus</i> (Forster, 1781) #	Scarlet Minivet #	U?, LM	
167	<i>Tephrodornis pondicerianus</i> (Gmelin, 1789) #	Common Woodshrike #	U?, LM	
	Pycnonotidae			
168	<i>Pycnonotus jocosus</i> (Linnaeus, 1758)	Red-whiskered Bulbul	U, R	
169	<i>Pycnonotus cafer</i> (Linnaeus, 1766)	Red-vented Bulbul	C, R	√
	Irenidae			
170	<i>Chloropsis cochinchinensis</i> (Gmelin, 1788)	Jerdon's Chloropsis	U, R	√
171	<i>Chloropsis aurifrons</i> (Temminck, 1829)	Gold-fronted Chloropsis	O, LM	
172	<i>Aegithina tiphia</i> (Linnaeus, 1758)	Common Iora	C, R	√

	Scientific name	Common name	Status	Breeding
	Laniidae			
173	<i>Lanius cristatus</i> Linnaeus, 1758	Brown Shrike	U, M	
174	<i>Lanius schach</i> Linnaeus, 1758 #	Rufous-backed Shrike	O, LM	
	Turdinae			
175	<i>Zoothera citrina cyanotus</i>	Orange-headed Thrush	O, LM	
176	<i>Copsychus saularis</i> (Linnaeus, 1758)	Oriental Magpie-Robin	C, R	√
177	<i>Saxicoloides fulicata</i> (Linnaeus, 1776)	Indian Robin	O, LM	
178	<i>Saxicola torquata</i> (Linnaeus, 1766) #	Common Stonechat #	O, M	
179	<i>Saxicola caprata</i> (Linnaeus, 1766)	Pied Bushchat	O, LM	
180	<i>Luscinia svecica</i> (Linnaeus, 1758) #	Bluethroat #	O, M	
	Timalinae			
181	<i>Turdoides affinis</i> (Jerdon, 1847)	White-headed Babbler	U, R	
182	<i>Turdoides striatus</i> (Dumont, 1823)	Jungle Babbler	C, R	
	Sylviinae			
183	<i>Prinia hodgsonii</i> Blyth, 1844	Franklin's Prinia	U, R	
184	<i>Cisticola juncidis</i> (Rafinesque, 1810)	Streaked Fantail-Warbler	C, R	√
185	<i>Prinia socialis</i> Sykes, 1832	Ashy Prinia	C, R	
186	<i>Prinia inornata</i> Sykes, 1832	Plain Prinia	C, R	√
187	<i>Acrocephalus dumetorum</i> Blyth, 1849	Blyth's Reed-Warbler	C, M	
188	<i>Acrocephalus stentoreus</i> (Hemprich & Ehrenberg, 1833)	Indian Great Reed-Warbler	C, R	√
189	<i>Orthotomus sutorius</i> (Pennant, 1769)	Common Tailorbird	C, R	
190	<i>Phyoscopus trochiloides</i> (Sundevall, 1837)	Greenish Leaf-Warbler	C, M	
191	<i>Phyoscopus magnirostris</i> Blyth, 1843 #	Large-billed Leaf-Warbler #	O, M	
	Muscicapinae			
192	<i>Muscicapa dauurica</i> Pallas, 1811 #	Asian Brown Flycatcher #	U, M	
	Monarchinae			
193	<i>Terpsiphone paradisi</i> (Linnaeus, 1758)	Asian Paradise-Flycatcher	C, M	
194	<i>Hypothymis azurea</i> (Boddaert, 1783)	Black-naped Monarch-Flycatcher	O, SH	
	Rhipidurinae			
195	<i>Rhipidura aureola</i> Lesson, 1830 #	White-browed Fantail-Flycatcher #	O, LM?	

	Scientific name	Common name	Status	Breeding
	Paridae			
196	<i>Parus major</i> Linnaeus, 1758 #	Great Tit #	C, R	√
	Dicaeidae			
197	<i>Dicaeum erythrorh-ynchos</i> (Latham, 1790)	Tickell's Flowerpecker	C, R	
	Nectarinidae			
198	<i>Nectarinia zeylonica</i> (Linnaeus, 1766)	Purple-rumped Sunbird	C, R	
199	<i>Nectarinia asiatica</i> (Latham, 1790)	Purple Sunbird	U, R	
200	<i>Nectarinia lotenia</i> (Linnaeus, 1766)	Loten's Sunbird	C, R	
	Zosteropidae			
201	<i>Zosterops palpebrosus</i> (Temminck, 1824) #	Oriental White-eye #	O, SH	
	Estrilidae			
202	<i>Lonchura striata</i> (Linnaeus, 1766)	White-rumped Munia	C, R	
203	<i>Lonchura punctulata</i> (Linnaeus, 1758)	Spotted Munia	U, R	
204	<i>Lonchura malacca</i> (Linnaeus, 1766)	Black-headed Munia	U, LM	
	Passeridae			
205	<i>Passer domesticus</i> (Linnaeus, 1758) #	House Sparrow	U, R	√
206	<i>Petronia xanthocollis</i> (Burton, 1838) #	Yellow-throated Sparrow	U, M (BV)	√
	Ploceinae			
207	<i>Ploceus philippinus</i> (Linnaeus, 1766)	Baya Weaver	C, R	√
208	<i>Ploceus manyar</i> (Horsfield, 1821)	Streaked Weaver	U, R	√
	Sturnidae			
209	<i>Sturnus malabaricus malabaricus</i> (Gmelin, 1789)	Grey-headed Starling	C, M	
210	<i>Sturnus malabaricus blythi</i>	Blyth's Myna	O, SH	
211	<i>Acridotheres tristis</i> (Linnaeus, 1766)	Common Myna	C, R	√
212	<i>Acridotheres fuscus</i> (Wagler, 1827)	Jungle Myna	C, R	√
213	<i>Sturnus roseus</i> (Linnaeus, 1758) #	Rosy Starling	U, M	
214	<i>Sturnus pagodarum</i> (Gmelin, 1789) #	Brahminy Starling	O, M	
	Oriolidae			
215	<i>Oriolus oriolus</i> (Linnaeus, 1758)	Eurasian Golden Oriole	C, M	
216	<i>Oriolus chinensis</i> Linnaeus, 1766 #	Black-naped Oriole #	O, M	
217	<i>Oriolus xanthornus</i> (Linnaeus, 1758)	Black-headed Oriole	C, R	√

	Scientific name	Common name	Status	Breeding
	Dicruridae			
218	<i>Dicrurus macrocercus</i> Vieillot, 1817	Black Drongo	C, R	√
219	<i>Dicrurus leucophaeus</i> Vieillot, 1817	Ashy Drongo	O, M	
220	<i>Dicrurus aeneus</i> Vieillot, 1817 #	Bronzed Drongo #	U, LM	
221	<i>Dicrurus paradiseus</i> (Linnaeus, 1766) #	Greater Racket-tailed Drongo #	C, R	
	Artamidae			
222	<i>Artamus fuscus</i> Vieillot, 1817	Ashy Woodswallow	C, R	√
	Corvidae			
223	<i>Dendrocitta vagabunda</i> (Latham, 1790)	Indian Tree Pie	C, R	√
224	<i>Corvus splendens</i> Vieillot, 1817	House Crow	C, R	√
225	<i>Corvus macrorhynchos</i> Wagler, 1827	Jungle Crow	C, R	

R - Resident; M - Migrant; LM - Local Migrant; SH - Straggler from hill; V - Vagrant; A - abundant; C - Common; UN - Uncommon; O - Occasional; BV - Breeding visitor; a - Sightings made by others but validated by author(s); # - Not recorded from Kole wetlands;

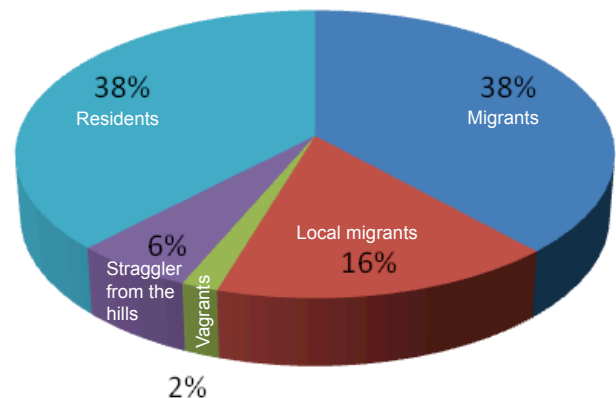


Figure 2. Status of the birds recorded from the Kuttanad wetlands

melanogaster, Greater Grey-headed Fish-Eagle *Ichthyophaga ichthyaetus*, Black-tailed Godwit *Limosa limosa*, Eurasian Curlew *Numenius arquata* and European Roller *Coracias garrulus* are listed in the Near Threatened category (IUCN 2010).

Among the 225 species of birds recorded, 55 species are found to breed in the Kuttanad wetlands. Kumarakom heronry is the biggest of all heronries reported from Kuttanad and so far 12 species of wetland birds were found to breed in this heronry. The Near Threatened Oriental Darter and Oriental

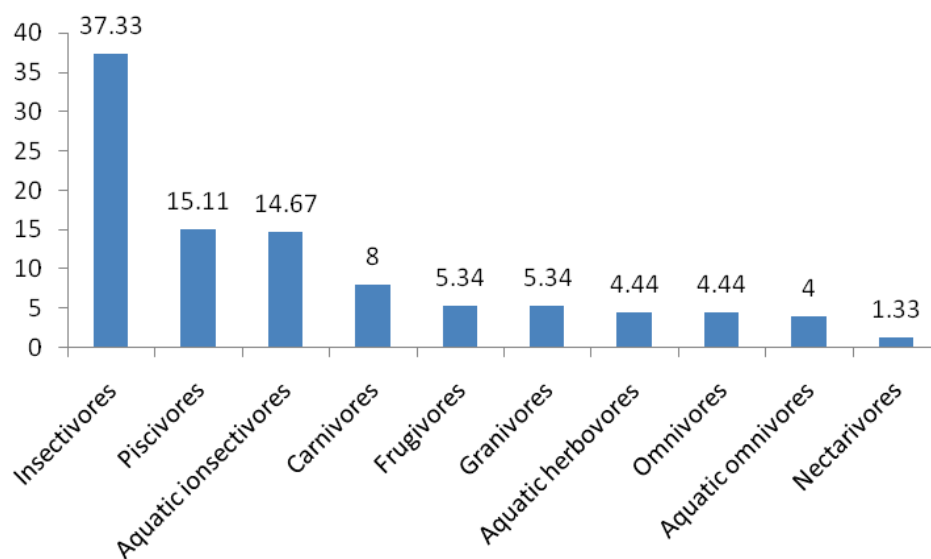


Figure 3. Percentage distribution of feeding guilds of birds in Kuttanad wetland

White Ibis were found to breed during monsoon. Among the colonial nesting waterbirds Oriental White Ibis, Indian Shag *Phalacrocorax fuscicollis*, Large Egret *Casmerodius albus*, Median Egret *Mesophoyx intermedia* were found to breed only in the Kumarakom heronry, and Little Cormorants *Phalacrocorax niger* and Indian Pond Heron *Ardeola grayii* were found to nest in more than two areas. Kuttanad wetland support relatively large flocks of Egret spp., Oriental White Ibis, Little Cormorants, Indian Shag, Darter, Glossy Ibis *Plegadis falcinellus*.

The birds that are of interest owing to their rarity as far as Kerala is concerned, and which were sighted during the period of the study period from Kuttanad region are given below.

Sightings of special interest

Oriental Darter *Anhinga melanogaster* - Zacharias & Gaston (2003) reported that the Oriental Darter population had declined in Kerala during last three decades. But it is one among the common species of wetland bird of this wetland. Narayanan & Vijayan (2007) recorded about 8% of the South Asian population of Oriental Darter during the breeding season of 2004.

Painted Stork *Mycteria leucocephala* - A flock of six birds were sighted at Parippu in the Kayal Kuttanad region on 05 January 2000. There were only a handful of sightings of this species from Kerala during the period of study.

Eurasian Spoonbill *Platelia leucorodia* - four

sightings from Kayal and Lower Kuttanad. Solitary bird in a paddy field close to the Moncompu-Champakkulam road near Moncompu on 29 November 1996; one at Judgy Aarayiram paddy fields on 13 April 2003 (K.M. Sajith pers. comm. 2003); one individual on flight at Ramankary on 21 September 2003 and on the same day Dipu Sasi (pers. obs.) saw a flock of seven individuals on flight at Kumarakom.

Spotted Redshank *Tringa erythropus* - A loose flock of 10 birds were located (04 November 2001) on the mud flats of Erupathinaalayiram paddy field at Kayal Kuttanad. This formed the second sight record of this species from Kerala State.

Long-toed Stint *Calidris subminuta* - Sighted and photographed by Sathyan Meppayur, Tim Inskipp and Carol Inskipp from Pathinaalayiram paddy fields on 04 December 2006 (Sathyan Meppayur pers. comm. 2008). This could be the first report of this species from Kerala.

Ferruginous Pochard *Aythya nyroca* - One male individual of this species has been sighted by the second author on December 1976 along with a Brahminy Shelduck *Tadorna ferruginea* between Pathiramanal Island and Thannermukkom Bund. This is a very rare duck species and has very few records so far from Kerala State.

Sooty Tern *Sterna fuscata* - A dead specimen with a ring on the tarsi, having the ring number DB26299 was found on 03 July 1998 at Puthenchantha, near Vaakathanam, Kottayam (9°30'N & 76°32'E). The same was ringed at Bird Island, Seychelles (3°41'N

& 55°13'E) by British Museum on 08 September 1997 and this bird has moved 2800km in 328 days (Dave Anning in litt. 17 August 2001).

White-winged Black Tern *Chidonias leucopterus* - Total three sightings of this species from Kuttanad. Eight individuals of these birds were seen on Vembanad Lake on 11 April 2003, a loose flock of 12 individuals on 13 April 2003 and two individuals at Chama paddy field near Neelamperoor on 02 October 2003.

Steppe Eagle *Aquila nipalensis* - Recorded from Vembanad Lake on 19th January 2003 and Kavanattinkara on 21 January 2007. Mainly a winter visitor to the northern areas of the country.

Greater Spotted Eagle *Aquila clanga* - Four individuals were recorded on three occasions. Two individuals were recorded from Pallathuruthy in the Lower Kuttanad region on 19 January 2003; one individual at Kaippuzhamuttu on 18 January 2004 and the last one was from Thollayiram Kayal (16 January 2005). Mainly a winter visitor to the northern areas of the country.

Greater Grey-headed Fish-Eagle *Icthyophaga icthyaetus* - This species has been recorded from Pathiramanal Island in the Vembanad Lake by Sethumadhavan C.P. and Saju Vasana on 20 January 2002. This is the only record of this species from the Kuttanad part of Vembanad Lake, even though Saju Vasana has another sighting of the same from the Chithrappuzha, Ernakulam District.

Mountain Imperial Pigeon *Ducula badia* - These are mainly a birds of the forest biotope and it seldom seen on the wetlands. An uncommon bird - first record of this was in 05 August 2003. After the first record, regular sightings during monsoon seasons from the Kayal Kuttanad and North Kuttanad.

Malabar Grey Hornbill *Ocyrceros griseus* - An endemic species of Western Ghats. One individual recorded on 15 January 2005 by P. Manoj (pers. comm. 2005) at Kumarakom heronry. A small relict population of this species is still surviving at Ponthanpuzha forest in the midlands of Kottayam District. Individual sighted from Kumarakom would be from the Ponthanpuzha population.

European Roller *Coracias garrulus* - One individual was seen at Erupathinaalayiram paddy fields of Kayal Kuttanad, 29 September 2002. This was the first report of this species from Kerala State.

Oriental Dwarf Kingfisher *Ceyx erithaca* - One

individual of this forest species were recorded from Kumarakom heronry on 16 February 2005 by P. Manoj (pers. comm. 2005).

Rufous Woodpecker *Celeus brachyurus* - The species was recorded only once from Chennithala in the Upper Kuttanad region on 23 February 1997.

Large-billed Leaf-Warbler *Phylloscopus magnirostris* - Once heard on 10 January 2004 from the tree-dominated area of Ayamanam. This is essentially a bird of the evergreen forests of the hills.

Pacific Swift *Apus pacificus* - A huge flock of around 2000 individuals from Kumarakom and adjacent areas (north Kuttanad and Vaikomkari divisions) by David V. Raju (pers. comm. 2006) and various visiting birders to this area on 24–26 December 2006 and a flock of more than 500 individuals on 29 December 2006.

Pale Martin *Riparia diluta* - Sighted and photographed by Sathyan Meppayur, Tim Inskipp and Carol Inskipp from Pathinaalayiram paddy fields on 04 December 2006 (Sathyan Meppayur pers. comm. 2008). This is the first report of this species from Kerala.

Major threats to the avifauna of this region

Thanneermukkom salt-water barrage (1250m long) commissioned in 1975 was constructed across the narrow portion of the Vembanad Lake to prevent the saltwater intrusion during summer from sea and to spill out floodwater during monsoon. The Thanneermukkom barrage has greatly influenced the ecology of the region. When this regulator is closed, there is virtually no flow of water beyond it on the southern side making the entire Kuttanad a static pool. At present the barrage is open from 22 December to 22 March. Water with heavy loads of pesticides and fertilizers from the paddy fields were drained into this stagnant water body. Persistence of these kinds of situations triggered several ecological backlashes like proliferation of weed growth, deterioration of the water quality, increased morbidity among the local fish population and destruction of subsistence fishery on which the local fishermen depended (Abhilash et al. unpublished). Barrage also impaired the migration of marine and estuarine fauna. Horizontal and vertical shrinkage of Vembanad Lake, vanishing mangroves, eutrophication, increased interventions in the area by tourism, Thottappally spillway, sewage and industrial pollution etc. are the major problems of Kuttanad

wetlands (Abhilash et al. unpublished). The loss of habitat through direct and indirect anthropogenic activities causes immense threat to the birds especially the migratory birds of Kuttanad. The most important threats to the wetland birds are the following.

Landscape alteration: The key threat factor is the landscape alteration in Kuttanad. Encroachment of the wetlands for the construction of new buildings and settlements are very common in Kuttanad, even though it is legally banned. Before and after the year 1947, huge area of the Vembanad Lake has been converted to paddy fields to enhance the rising demand for food. This adversely affected the migratory birds such as ducks and teals by reducing available roosting place, foraging areas and food in the lake. Thus the formation of mudflats in the reclaimed areas provided ideal foraging areas for the wintering waders.

Hunting: Hunting pressure is intense in some areas of Kuttanad, Sashikumar & Palot (2002) have earlier reported heavy poaching of the birds from this area. The main hunting methods involve a combination of shooting, with hooks and line using fishes as bait, picking of nestlings from nests, especially from heronries. The main species caught by shooting is winter migrants like ducks, godwits and the species belonging to the ardeidae family. Black-crowned Night-Herons and egrets are the species heavily trapped by hook and line method (S. Dipu pers. comm. 2004). Heavy poaching of nestlings of Purple Heron from the nests situated in the thickets of *Phragmites karka* is prevailing in the “R Block” area.

Overgrowth of exotic vegetation: Infestation of the exotic waterweeds like *Eichhornia crassipes*, *Slavinia molesta* are causing serious harms to the water birds (Sashikumar & Palot 2002), but at the same time this provides foraging areas for the species like Jacanas and Moorhens. Exotic vegetation also poses immense threats to the native flora and fauna of this region. Vembanad Lake is covered by *Eichhornia crassipes* which is drastically affecting the life of fishermen and local people, who are dependent on this lake for their basic needs.

Pesticides: Intensive use of chemical fertilizers and pesticide as a part of the agriculture activities have played havoc on the traditional farming system and life style of Kuttanad, affecting birds, other wildlife as well as human beings (Sashikumar & Palot 2002). Organochlorine and organophosphate pesticides

are widely used in paddy cultivation all over the state. Studies conducted in the Kuttanad ecosystem show that these chemicals are present well above the permissible limits. Seedikkoya & Shukkur (2004) reported the presence of organochlorines such as DDT, DDE, Dieldrin, Aldrin and heavy metals such as zinc (Zn) and copper (Cu) in the Indian Pond Heron, Little Egret *Egretta garzetta* and Cattle Egret *Bubulcus ibis* from northern Kerala. But such studies on birds are not yet conducted in Kuttanad.

Felling of nesting and roosting trees: Cutting down of tall trees used by colonial nesting waterbirds is rampant in Kuttanad, and small heronries in Kerala face similar threats from local people. Loss of local flora is huge in Kuttanad wetland. The reduction in size or the total felling of sacred groves has also created trouble in the form habitat loss for land birds and wetland birds; which uses tiny patches for feeding, roosting and nesting. The extent of mangrove trees in the Kumarakom heronry, Pathiramanal has drastically reduced. After the taking over of Kumarakom heronry by KTDC, 13 hectares of the land was given to a venture company by KTDC. They cleared the mangrove belt along the lake and converted them into a lawn and constructed a tourist jetty. With this, a species of mangrove *Kandelia candel* was totally wiped out from the Kumarakom heronry (Ramachandran & Mohanan 1990; Sreekumar 2001).

Tourism: Ali (1984) reported that large flocks of wintering ducks roost in the calm waters of Vembanad Lake. At present, amplified promotion of tourism by using boats and speedboats force migratory ducks to desert roosting place in the lake. Most of the tourist resorts in and around the Vembanad Lake and Kuttanad do not have any proper solid waste and waste-water treatment facilities, therefore all waste materials are dumped into the lake during night hours. This activity adversely affects self-sustaining capacity of the Lake. House boats discharge effluents and wastes directly into the lake and large amount of oil are spilled into the system. In the name of tourism the authorities, which owns the Kumarakom heronry clear pure stands of *Phragmites karka*, where Black-crowned Night-Heron *Nycticorax nycticorax*, Median Egret *Mesophoyx intermedia*, and Large Egret *Casemerodius albus* nests. This activity has drastically affected nesting habitats of the breeding birds.

Kuttanad wetlands show high diversity in terms of

number of species especially the wetland birds; this is higher than the total terrestrial species and total wetland species recorded from the Kole wetland of Kerala (Sivaperuman & Jayson 2000). Thirty-eight species from the Kuttanad wetlands are not recorded from the Kole wetlands (Table 1). According to Kumar et al. (2005), 128 wetland birds were included in the revised Indo-Russian agreement on the migratory birds list; of this 50 species were recorded from different parts of Kuttanad wetlands during the present study. In Upper Kuttanad region and the eastern boundary of Kuttanad, tree diversity is high compared to the main wetland. Hence most of the land birds were recorded from this area, some were restricted this area alone.

Indian Shag, Large Egret, Median Egret were found to breed only in the Kumarakom heronry; loss of nesting habitat and the disturbance caused by increased anthropogenic activities throughout the Kuttanad wetlands may be reason for this situation. Little Cormorants and Indian Pond-Heron were found to nest in more than two nesting areas. Little Cormorants and Indian Pond Heron may have the capacity to withstand the disturbance caused by human beings; this could be the possible explanation for the use of more than two nesting sites compared to the other colonial nesting water birds, but most of the other colonial nesting water bird species are congregating at Kumarakom Heronry for breeding. During the 2004 breeding season 157 nests of Darter were reported and 276 birds were counted in a single count (Narayanan 2004). According to Rahmani et al. (2002) world population of Darter was estimated as 10,000. Kumarakom heronry holds about 8% of the South Asian biogeographical population of Darter (Narayanan & Vijayan 2007), which qualifies *Criterion 6* of the Convention on Wetlands of International Importance (Ramsar Convention). Kumarakom heronry has the biggest known breeding birds of Oriental White Ibis from Kerala (Narayanan 2004). Although the Ramsar site designated in 2002 includes both Vembanad Lake and Kole wetlands, there is no definite connection between Vembanad and the Kole wetlands, and both have the potential to become independent Ramsar sites (Narayanan & Vijayan 2007). Hence, we propose that Vembanad Lake should be declared as a Ramsar site in its own right.

During the winter months massive flocks of Glossy Ibis, which contains 500 or more birds visit the mud

fields in the paddy fields and the 1% threshold of Glossy Ibis is 250 (Kumar et al. 2005). Other than Darter, species such as Oriental White Ibis, Indian Shag, Black-crowned Night Heron, and Little Cormorant in the Kumarakom heronry during the breeding season is well above the limit of 1% biogeographic population (Narayanan 2004).

Conservation action plan

The following action plan is proposed for the conservation of birds and wetlands of Kuttanad.

a. Active patrolling should be carried out by the forest department, at least five groups with four forest guards are recommended for patrolling at different parts of the Vembanad area to stop poaching.

b. Nature awareness programmes regarding birds, mangrove forests and importance of wetland ecosystem for daily sustenance of life to be given to the local people for the conservation of this eco-system. A documentary film could be produced to with the prediction of future major changes in the Kuttanad titled “Kuttanad – after twenty years”. This will give a grim picture with a clear message to the people.

c. Elevate the status of Kumarakom heronry to a full-fledged sanctuary as per Wildlife (Protection) Act for the protection of 11 species of breeding birds and its unique nesting habitat.

d. “*Pathiramanal*”, an island in the Vembanad Lake, should be protected giving a special status as “community reserve” for preserving the typical flora and fauna of the Kuttanad region.

e. Regulation of inflow and outflow from the Thanneermukkom saltwater barrage should be done properly according to the management strategies proposed in the earlier published works.

f. Reclamation of wetlands for industrial, settlement, plantation and cultivation purposes should be restricted and Government departments should be persuaded to have strict environmental impact assessment (EIA) before the implementation of any new projects in the area.

g. Restoration of mangroves in the area should be executed. For the production of new plants, vegetative propagation and tissue culture methods can be opted.

h. Remaining sacred groves must be preserved under the guidance of forest department and local owners like temple authorities.

i. Solid waste and wastewater treatment facilities

must be developed in all tourist resorts in the Vembanad region.

j. All tourist establishments must provide a fraction of money from the yearly profit for the restoration activities of the Kuttanad wetlands through government and local NGO's.

k. Mobile checking facilities should be initiated to seize polluting boats and its license should be withheld.

l. A detailed study on the movements of the birds of this area should be conducted during various seasons to determine the spatial and temporal pattern of bird migration and ecological reasons should be identified to determine the drastic reduction in the population of many bird groups.

CONCLUSIONS

This study increased the information and knowledge available on the avifauna of Kuttanad wetlands. Kuttanad wetland is rich in wetland bird species. Degradation of this unique wetland ecosystem, hunting and habitat alteration is still prevailing in this part of the Vembanad-Kole Ramsar this threatens the birdlife directly as well as indirectly. As Kole wetlands, Kuttanad wetland is also serving as halting area for the trans-continental migrants; urgent measures should be taken to protect this wetland ecosystem for the conservation of birds especially migratory and breeding colonial nesting birds. This region holds more than the estimated number of South Asian biogeographical population of six species of waterbirds. At present the low lands of Kerala are under high threat of landscape modification due to population growth, tourism and other infrastructure developmental activities. Regular monitoring of wetland should be taken up. In-depth studies on the avifauna, especially endangered birds, should be undertaken. Hence urgent conservation measures have to be implemented and a protected area has to be evolved for preserving the remaining tract of mangroves and faunal heritage of this unique region. Local people should be made aware of the importance of wetlands, waterfowl (Sashikumar & Palot 2002) and other common birds. Without the involvement of common people of this region conservation of the wetlands will not be successful.

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