Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2016; 4(6): 272-279

Received: 09-09-2016
Accepted: 10-10-2016

Shruthi HS
Apidology Laboratory, DOS in Zoology, University of Mysore, Karnataka, India

Basavarajappa S
Apidology Laboratory, DOS in Zoology, University of Mysore, Karnataka, India

Correspondence
Shruthi HS
Apidology Laboratory, DOS in Zoology, University of Mysore, Karnataka, India

Study on avian diversity at few aquatic ecosystems of Mysore district, Karnataka, India

Shruthi HS and Basavarajappa S

Abstract
The study on avian diversity at few aquatic ecosystems *viz*., ponds and back water of KRS reservoir of K.R. Nagar Taluk in Mysore District was conducted during 2013 to 2014 by employing various standard methods. Altogether 43 species, which belongs 15 families in four orders of the class Aves were recorded at different aquatic ecosystems. The composition of different species of aquatic birds indicated significant variation (F=3.191; *P*>0.05) between the aquatic ecosystems. Moreover, aquatic bird's diversity (Shannon-Weiner) Index (H^1) didn't show any variation and it was in between 2.013 and 2.858. Different bird species showed variation in their feeding habit, food preference, resting, roosting activities and distributed unevenly at aquatic ecosystems amidst Mysore District. Overall, certain aquatic ecosystems and backwater of KRS Reservoir at K.R. Nagar Taluk extended suitable habitat for 12 migratory bird species, two winter migrants including good number of local bird species. Aquatic habitats and many aquatic bird species are inseparable elements, helpful to mankind in various ways and their presence is very essential to restore local biodiversity.

Keywords: Aquatic ecosystem, bird species, Mysore district

1. Introduction
Aquatic birds are feathered bipedal warm-blooded animals [1] known for their ecological, economical, ethical, medicinal and scientific values [2]. They constitute one of the diverse and large numbers of useful creatures among the living beings [3] and proven as a treasury of biodiversity [4]. They live in/at or nearby various aquatic and semi-aquatic habitats [5-7] for feeding, breeding and nesting [8-10]. Aquatic birds show different life styles hence, considered as bio-tools for exploring various ecological problems and evaluate environmental quality of aquatic ecosystems [11] which have conservation significance.
In India, more than 1, 340 species of birds have been identified [2, 12]. Of all, 310 species are depended on aquatic or semi-aquatic ecosystems [8] and constitute the most visible signs of variety of life forms in wetlands [13]. Moreover, aquatic birds occupied in several tropic levels and involved in food web and food chains of wetland nutrient cycles. As wetlands are most productive, biologically diverse and very fragile ecosystems [14], play a pivotal role in flood control, aquifer recharge, nutrients absorption and erosion control. They help preserve genetic diversity by providing abundant food and suitable habitat for residential aquatic birds in general and migratory birds in particular [15]. Wetlands include >10% of globally threatened bird species [8]. However, in the recent past, wetlands are experiencing immense pressure due to various anthropogenic activities in tropical and subtropical regions [16-18]. Since, wetlands and aquatic birds are inseparable elements, forms a rich array of bird communities [19], their periodic study is very essential to know avifaunal diversity [20].
In Karnataka, 500 bird species are reported by various ornithologists. Among them, 48 bird species are enlisted under threatened category [21]. Basavarajappa (2006) [5] has reported 27 species of aquatic birds from Maidan region of Karnataka. Dayanand (2014) [22] has reported wetland birds from Shimogga District. Reports on bird's composition at wetlands amidst River Cauvery basin in Mysore District are scanty. As, Krishnaraja (KR) Nagara is one of the agriculturally productive Taluks of Mysore District, known for world famous reservoir and Cauvery river basin have created small to medium sized many aquatic habitats which are attracting good number of resident birds, resident migrants and migratory birds year around. However, information on aquatic birds visit to these habitats is fragmentary. Since, assessment of local landscapes for conservation of avifauna can only be understood by knowing the structure of bird community of that region [23], to record the birds present study was undertaken amidst Mysore District.

2. Materials and Methods

2.1 Study Area: In Mysore District, KR Nagar Taluk was selected during 2013-14 for the present study. It is one of the seven Taluks in Mysore Districts (Fig. 1), lies in between $12^0 46^1 02^{11}$ to $12^0 39^1 06^{11}$ N longitude and $76^0 30^1 23^{11}$ to $76^0 30^1 23^{11}$ E latitude at an altitude of 2622 ft msl [24]. The climate is tropical with semi-arid type weather characterized by 10.6 to 36 ^{0}C temperature, 29 to 83% relative humidity and 748.7mm annual rainfall. The perennial river Cauvery drains some part of geographical region of this taluk and become life line to farmers of this region. The paddy is one of the main crops of this Taluk and hence it is called 'Land of Paddy'.

2.2 Methodology

Four ponds at different villages namely: Kesthuru Koppalu, Saligrama, Yellemuddanahally, Byadarahally and backwater landscape nearby KRS Reservoir at Sanyasipura, Chandagala and Mullepettalu were selected randomly (Fig. 1). These places were visited three times in a month to record aquatic birds. Observations were made twice a day from morning 7.00 to 12.00hrs and 15.30 to 18.00hrs in the evening. Aquatic birds were observed at village ponds, nearby agriculture ecosystems and marshy areas by employing variable width line transect method (VWLTM) as described by [25] and an all-out search method (AOSM). Birds living in water and in marshy area were observed by naked eyes and also with the help of Olympus Binocular (10 x 10) and photographed by using Sony-Cyber shot 14.1 Mega Pixel Camera. The recorded aquatic birds were identified based on their morphological features such as beak shape, colour, type of foot (e.g. webbed or non-webbed), colour of shank and foot, feathers colour and size of birds with the help of field guides as per [2, 26, 27]. Per cent occurrence, density and abundance were calculated as per [28] as follows. Aquatic Bird Density (ABD) = Number of individual specific aquatic bird species recorded/Number of study sites covered. Aquatic Bird Abundance (ABA) = Number of individual aquatic bird species/Number of individual of all aquatic bird species. Recorded birds were identified as resident, local migrants and migratory birds as per the description of [2, 26, 27] and their status such as 'Rare', 'Common', 'Very Common' and 'Abundant' was also calculated. Further, analysis of variance (ANOVA) was used to know the difference between the aquatic birds and wetland ecosystems as described by [29]. Shannon-Weiner Diversity Index was calculated by using the formula as per [30].

$H' = -\sum p_i \ln p_i$

H'= Shannon-Weiner Index

P_i= the proportion of individuals found in the I th species

Further, EXCEL software was used to tabulate the collected data, to prepare necessary tables, graphs and figures.

3. Results

Distribution of aquatic birds at different village ponds and backwater areas of KRS Reservoir in K.R. Nagar Taluk is depicted in Table 1. Altogether, 12,555 water birds which belong to 43 species in 15 families and four orders were recorded at few aquatic habitats of Mysore District. Common and scientific names, family, order and number of birds sighted during field study are given in Table 1. Of all, members of Anseriformes were represented by 12 families with good species diversity (33 species) at aquatic habitats of Mysore District. In Anseriformes, family Ardeidae includes long legged wadding birds. They are usually with white, grey, purple or brown coloured body. Many species shows filamentous ornamental plumes during breeding season. Bill is long, straight, sharp, pointed and dagger-like. In the legs, tarsi are very long with elongated slender toes. The middle and outer toes are united by a small web at their base (e.g. *Ardea cinerea, A. purpurea Ardeola grayi, Nycticorax nycticorax, Mesophoyx intermedia, Bubulcus ibis, Egretta garzetta* and *Casmerodius albus*) (Table 1). Family Anatidae includes large conspicuous birds with different sizes considerably. Birds have combinations of white to grey, brown, black and green coloured body with metallic reflections. Bill is typically broad and flat and rounded at the tip. A comb-like fringe or lamellae present inside the bill for straining out food particles in water. Legs are short in size with webbed foot (e.g. *Anas poecilorhyncha, A. querquedula, Anser indicus, Dendrocygna javanica* and *Marmaronetta angustirostris*) (Table 1). Family Charadriidae includes wadding birds and are usually small to medium in size. Bill is short or long, slender and straight or down curved. Legs are short or long with tibiae partly naked (e.g. *Vanellus indicus, Gallinago stenura, Tringa nebularia, Tringa stagnatilis* and *Actitis hypoleucos*) (Table 1). Family Ciconiidae includes large sized, long-legged diurnal birds. They are chiefly terrestrial but feeding in marshy area. Birds are usually white and black in colour with a metallic sheen. Legs are very long, tibia partly naked with moderate sized toes. Toes are provided with web at their base along with blunt claws (e.g. *Anastomus oscitans* and *Mycteria leucocephalus*) (Table 1). Family Dromadidae includes wadding birds with small to medium sized body. Bill is heavy tern-like and black in colour. They resembles like stone-curlew in general behaviour and feed mainly on crabs (e.g. *Dromas ardeola*) (Table 1). Family Jacanidae includes birds with bronze, black, brown and white coloured feathers. Legs are long with naked tibiae. The toes are provided with enormously elongated claws that help to trip lightly over floating leaves and vegetation (e.g. *Hydrophasianus chirurgus* and *Metopidius indicus*) (Table 1). Family Laridae includes gregarious, heavy bodied aquatic birds. They have grey, white and black coloured plumage (e.g. *Sterna aurantia*) (Table 1). Family Pelecanidae includes large, gregarious fish eating birds. They have short sturdy legs with large webbed feet. Birds possess long heavy bill with the upper mandible flattened and hook-tipped. The lower part of bill is with two narrow flexible arches, which hung throughout its length by capacious gular pouches. It functions as a drag net for scooping up fish while swimming (e.g. *Pelecanus philippensis*) (Table 1). Family Phalacrocoracidae includes gregarious, fish eating, colonial water birds. They show characteristic black plumage. Legs are short with large webbed feet, provided with curved claws. Body plumage is not very dense, but resistant to water. Birds soak their body by prolonged immersion and rise off water with some difficulty. But, they show very powerful and sustained flight with the neck stretched out in front (e.g. *Phalacrocorax niger, Phalacrocorax carbo* and *Anhinga melanogaster*) (Table 1). Family Podicipedidae includes aquatic birds with soft rudimentary tail. Legs are placed far back and adapted for diving and swimming (e.g. *Tachybaptus ruficollis*) (Table 1). Family Recurvirostridae includes waders or shore birds. They have white, black or brownish grey coloured plumage (e.g. *Himantopus himantopus*) (Table 1). Family Threskiornithidae includes comparatively long and naked legged marsh birds. They are gregarious. The toes are webbed at the base. They fly in 'V' shape or in wavy diagonal ribbons (e.g. *Threskiornis melanocephala, Plegadis falcinellus* and *Pseudibis papillosa*) (Table 1).

In Coraciiformes, family Alcedinidae includes usually solitary birds adapted chiefly for inland waters. They have blue, green, purple, brown or black and white plumage on the body. They visit aquatic areas more often to feed fish by diving headlong into the water. Sometimes, they live also on large insects and small vertebrates (e.g. *Ceryle rudis, Halcyon smyrnensis* and *Alcedo atthis*) (Table 1). The Gruiformes were represented by only one family i.e., Rallidae that includes small to medium-sized marsh or water birds with few terrestrial forms. They are generally poor fliers. They live in bushes or on floating vegetation on the water (e.g. *Porphyrio porphyrio, Gallinula chloropus, Amaurornis phoenicurus* and *Fulica atra*) (Table 1). The Passeriformes also represented by only one family namely Motacillidae that includes slender bodied terrestrial birds. They are associated with marshy areas or wetlands or reeds. Wings are pointed with long tail. The tail is constantly wagged vertically (e.g. *Motacilla flava, M. alba* and *Anthus rufulus*) (Table 1). Thus, birds belong to Anseriformes were represented by 12 families with good species diversity (33 species) and it was followed by the order Gruiformes with one family (4 species) and order Coraciiformes and Passeriformes with one family each (3 species each were found at aquatic habitats of Mysore District. In general, *F. atra* was more abundant (3074) and it was followed by *Anas poecilorhyncha* (1134) and *Tachybaptus ruficollis* (1082) at aquatic habitats of Mysore District. Similarly, *Mesophoyx intermedia* (940), *Bubulcus ibis* (898), *Ardeola grayii* (893), *Phalacrocorax niger* (572), *Porphyrio porphyrio* (560), *Casmerodius alba* (344) *Tringa stagnatilis* (309) and *Gallinago stenura* (301) were common in this part of the State. However, other bird species number was less than 300 (Table 1). Further, bird's family, species composition, per cent occurrence and their rank are given in Table 2.

In Table 3, number of birds recorded at different aquatic habitats and their diversity index is depicted. Kesthuru Koppalu pond showed highest (2.858) Shannon Wiener Index (H^1) and it was followed by KRS reservoir back water nearby Sanyasipura (2.756). However, at other habitats, the H^1 index was less (Table 3). Moreover, there was a significant variation ($F=3.191$; $P>0.05$) existed between the aquatic bird abundance and the aquatic habitats (Table 3). Per cent occurrence, density, abundance and status of bird species recorded at aquatic habitats are shown in Table 4. Each bird species status was calculated by considering their occurrence, density and abundance in the study area. Overall, 25 bird species were rarely sighted (Table 4) and their per cent occurrence was 7.9, density and abundance was 0.9 and 0.38 respectively (Table 5). Around 12 bird species were commonly sighted (Table 4) with 28.1% occurrence. The commonly occurring bird's density and abundance was 6.6 and 2.34 respectively (Table 5). Only five bird species were very commonly sighted (Table 4) constituted 39.5% bird's composition. Accordingly their density and abundance was high i.e., 21.88 and 6.75 respectively (Table 5). However, *F. atra* alone (Tables 1 and 4) was abundant and represented 24.5% with very high density (67.82) and abundance 26.43) (Table 5). Further, resident, local migrant and migratory birds at aquatic habitats of Mysore District are shown in Table 6. Altogether 29 bird species (67.4%) were residents to Mysore District. Around 12 bird species (27.9%) were migratory, visiting this part of the state during winter season. Only two bird species (4.7%) were local migrants, migrating to nearby places and found at these aquatic habitats during most of the year (Table 6).

Table 1: Birds recorded at few aquatic habitats of Mysore District

Sl. No.	Order	Sl. No.	Family	Sl. No.	Common Name	Scientific Name	No. of birds
	Anseriformes	1.	Anatidae	1.	Spot-billed Duck	*Anas poecilorhyncha*	1134
				2.	Garganey	*Anas querquedula*	30
				3.	Bar-headed Goose	*Anser indicus*	10
				4.	Lesser Whistling-Duck	*Dendrocygna javanica*	29
				5.	Marbled Teal	*Marmaronetta angustirostris*	5
		2.	Ardeidae	6.	Grey Heron	*Ardea cinerea*	34
				7.	Pond Heron	*Ardeola grayii*	893
				8.	Purple Heron	*Ardea purpurea*	61
				9.	Black crowned Night- Heron	*Nycticorax nycticorax*	19
				10.	Intermediate Egret	*Mesophoyx intermedia*	940
				11.	Cattle Egret	*Bubulcus ibis*	898
				12.	Little Egret	*Egretta garzetta*	43
				13.	Large Egret	*Casmerodius alba*	344
		3.	Charadriidae	14.	Red-wattled Lapwing	*Vanellus indicus*	40
				15.	Pintail Snipe	*Gallinago stenura*	301
				16.	Common Greenshank	*Tringa nebularia*	54
				17.	Marsh Sandpiper	*Tringa stagnatilis*	309
				18.	Common Sandpiper	*Actitis hypoleucos*	162
		4.	Ciconiidae	19.	Asian Openbilled Stork	*Anastomus oscitans*	215
				20.	Painted Stork	*Mycteria leucocephala*	42
		5.	Dromadidae	21.	Crab Plover	*Dromas ardeola*	7
		6.	Pelecanidae	22.	Spot-billed Pelican	*Pelecanus philippensis*	115
		7.	Phalacrocoracidae	23.	Little Cormorant	*Phalacrocorax niger*	572
				24.	Great Cormorant	*Phalacrocorax carbo*	4
				25.	Oriental Darter/Darter	*Anhinga melanogaster*	12
		8.	Podicipedidae	26.	Little Grebe	*Tachybaptus ruficollis*	1082
		9.	Jacanidae	27.	Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	28
				28.	Bronze-winged Jacana	*Metopidius indicus*	68
		10.	Laridae	29.	River Tern	*Sterna aurantia*	99
		11.	Recurvirostridae	30.	Black-winged Stilt	*Himantopus himantopus*	253
				31.	Oriental white Ibis	*Threskiornis melanocephalus*	182

		12.	Threskiornithidae	32.	Glossy Ibis	*Plegadis falcinellus*	48
				33.	Black Ibis/Red-naped Ibis	*Pseudibis papillosa*	122
2.	Coraciiformes	13.	Alcedinidae	34.	Lesser pied Kingfisher	*Ceryle rudis*	12
				35.	White- breasted Kingfisher	*Halcyon smyrnensis*	42
				36.	Small blue Kingfisher	*Alcedo atthis*	01
3.	Gruiformes	14.	Rallidae	37.	Purple Moorhen	*Porphyrio porphyrio*	560
				38.	Common Moorhen	*Gallinula chloropus*	270
				39.	White-breasted Water hen	*Amaurornis phoenicurus*	195
				40.	Common Coot	*Fulica atra*	3074
4.	Passeriformes	15.	Motacillidae	41.	Yellow Wagtail	*Motacilla flava*	179
				42.	White Wagtail	*Motacilla alba*	35
				43.	Paddyfield Pipit	*Anthus novaeseelandiae*	31
Total							12,555

Table 2: Birds family, species number and their percent occurrence at few aquatic habitats of Mysore District

Sl. No.	Order	Sl. No.	Family	Species (No.)	% Occurrence	Rank
1.	Anseriformes	1.	Anatidae	5.0	11.6	2
		2.	Ardeidae	8.0	18.6	1
		3.	Charadriidae	5.0	11.6	2
		4.	Ciconiidae	2.0	4.7	5
		5.	Dromadidae	1.0	2.3	6
		6.	Jacanidae	2.0	4.7	5
		7.	Laridae	1.0	2.3	6
		8.	Pelecanidae	1.0	2.3	6
		9.	Phalacrocoracidae	3.0	7.0	4
		10.	Podicipedidae	1.0	2.3	6
		11.	Recurvirostridae	1.0	2.3	6
		12.	Threskiornithidae	3.0	7.0	4
2.	Coraciiformes	13.	Alcedinidae	3.0	7.0	4
3.	Gruiformes	14.	Rallidae	4.0	9.3	3
4.	Passeriformes	15.	Motacillidae	3.0	7.0	4
Total				**43**	100.0	-

Table 3: 'F' value and Shannon-Weiner Index of aquatic birds recorded at few aquatic habitats of Mysore District

Sl. No.	Name Of Habitat	Birds	Shannon Index ($H^{'}$)	'F' Value
1.	Kesthuru Koppalu Pond	1356	2.858	3.191* (P>0.05)
2.	Saligrama Pond	6169	2.398	
3.	Yellemuddanahally Pond	1661	2.556	
4.	K.R. S. Reservoir Back Water Nearby Sanyasipura	707	2.756	
5.	K.R. S. Reservoir Back Water Nearby Chandagala	865	2.360	
6.	Byadarahally Pond	1231	2.417	
7.	K.R. S. Reservoir Back Water Nearby Mulepettalu	566	2.013	
Total		12,555	-	-

Table 4: Per cent occurrence, density, abundance and status of birds at aquatic habitats of Mysore District

Sl. No.	Species	% Occurrence	Density	Abundance	Status
1.	*Anas poecilorhyncha*	9.1	25.44	8.32	VC
2.	*Anas querquedula*	0.4	0.71	0.45	R
3.	*Anser indicus*	0.1	0.02	0.01	R
4.	*Dendrocygna javanica*	0.3	0.60	0.16	R
5.	*Marmaronetta angustirostris*	0.1	0.10	0.01	R
6.	*Anhinga melanogaster*	0.1	0.28	0.10	R
7.	*Ardea cinerea*	0.3	1.16	0.20	R
8.	*Ardeola grayii*	7.1	19.77	7.74	VC
9.	*Ardea purpurea*	0.5	0.99	0.50	R
10.	*Nycticorax nycticorax*	0.2	0.38	0.13	R
11.	*Mesophoyx intermedia*	7.5	21.19	6.69	VC
12.	*Bubulcus ibis*	7.2	19.50	3.12	VC
13.	*Egretta garzetta*	0.3	1.02	0.64	R
14.	*Casmerodius alba*	2.8	8.04	3.06	C
15.	*Vanellus indicus*	0.3	0.51	0.48	R
16.	*Dromas ardeola*	0.1	0.16	0.08	R
17.	*Anastomus oscitans*	1.7	4.60	1.48	C
18.	*Mycteria leucocephalus*	0.3	0.93	0.44	R
19.	*Pelecanus philippines*	0.9	2.39	1.33	R
20.	*Phalacrocorax niger*	4.6	12.64	4.34	C
21.	*Phalacrocorax carbo*	0.1	0.09	0.05	R

22.	*Tachybaptus ruficollis*	8.6	23.54	7.91	VC
23.	*Hydrophasianus chirurgus*	0.2	0.61	0.35	R
24.	*Metopidius indicus*	0.6	1.54	0.62	R
25.	*Sterna aurantia*	0.8	2.07	1.06	R
26.	*Himantopus himantopus*	2.0	5.36	2.83	C
27.	*Gallinago stenura*	2.4	6.80	2.77	C
28.	*Tringa nebularia*	0.5	1.19	0.25	R
29.	*Tringa stagnatilis*	2.5	8.55	1.07	C
30.	*Actitis hypoleucos*	1.3	3.39	0.64	C
31.	*Threskiornis melanocephala*	1.5	4.16	1.51	C
32.	*Plegadis falcinellus*	0.5	1.13	0.86	R
33.	*Pseudibis papillosa*	1.0	2.76	1.07	C
34.	*Porphyrio porphyrio*	4.5	12.65	5.83	C
35.	*Gallinula chloropus*	2.2	6.00	2.29	C
36.	*Amaurornis phoenicurus*	1.6	4.34	1.22	C
37.	*Fulica atra*	24.5	67.82	26.43	A
38.	*Motacilla flava*	0.1	3.65	0.51	R
39.	*Motacilla alba*	0.4	0.80	0.35	R
40.	*Anthus rufulus*	0.3	1.05	0.45	R
41.	*Ceryle rudis*	0.1	0.32	0.17	R
42.	*Halcyon smyrnensis*	0.3	0.81	0.34	R
43.	*Alcedo atthis*	0.1	0.02	0.01	R

Note: R: Rare; C: Common, VC: Very Common and A: Abundant.

Table 5: Status of birds at few aquatic habitats of Mysore District

Sl. No.	Status	Aquatic birds			
		Species	% Occurrence	Density	Abundance
1.	Rare (R)	25	7.9	0.90	0.38
2.	Common (C)	12	28.1	6.60	2.34
3.	Very Common (VC)	05	39.5	21.88	6.75
4.	Abundant (A)	01	24.5	67.82	26.43
Total		43	100.0	-	-

Table 6: Resident, Local Migrant and Migratory birds at few aquatic habitats of Mysore District

Sl. No.	Species	Type	No. of species	% Occurrence
1.	*Anas poecilorhyncha*	Resident	29	67.4
2.	*Anser indicus*			
3.	*Dendrocygna javanica*			
4.	*Anhinga melanogaster*			
5.	*Ardea cinerea*			
6.	*Mesophoyx intermedia*			
7.	*Egretta garzetta*			
8.	*Ardeola grayi*			
9.	*Bubulcus ibis*			
10.	*Ardea purpurea*			
11.	*Casmerodius alba*			
12.	*Ceryle rudis*			
13.	*Vanellus indicus*			
14.	*Anastomus oscitans*			
15.	*Halcyon smyrnensis*			
16.	*Metopidius indicus*			
17.	*Hydrophasianus chirurgus*			
18.	*Sterna aurantia*			
19.	*Anthus rufulus*			
20.	*Pelecanus philippensis*			
21.	*Phalacrocorax niger*			
22.	*Tachybatus ruficollis*			
23.	*Porphyrio porphyrio*			
24.	*Threskiornis melanocephalus*			
25.	*Gallinula chloropus*			
26.	*Amaurornis phoenicurus*			
27.	*Pseudibis papillosa*			
28.	*Nycticorax nycticorax*			
29.	*Alcedo atthis*			
30.	*Fulica atra*	Local Migrant	02	4.7
31.	*Marmaronetta angustirostris*			
32.	*Anas querquedula*	Migratory	12	27.9
33.	*Dromas ardeola*			

34.	*Mycteria leucocephala*			
35.	*Motacilla alba*			
36.	*Himantopus himantopus*			
37.	*Gallinago stenura*			
38.	*Tringa nebularia*			
39.	*Tringa stagnatilis*			
40.	*Actitis hypoleucos*			
41.	*Plegadis falcinellus*			
42.	*Phalacrocorax carbo*			
43.	*Motacilla flava*			
Total		-	43	100

4. Discussion

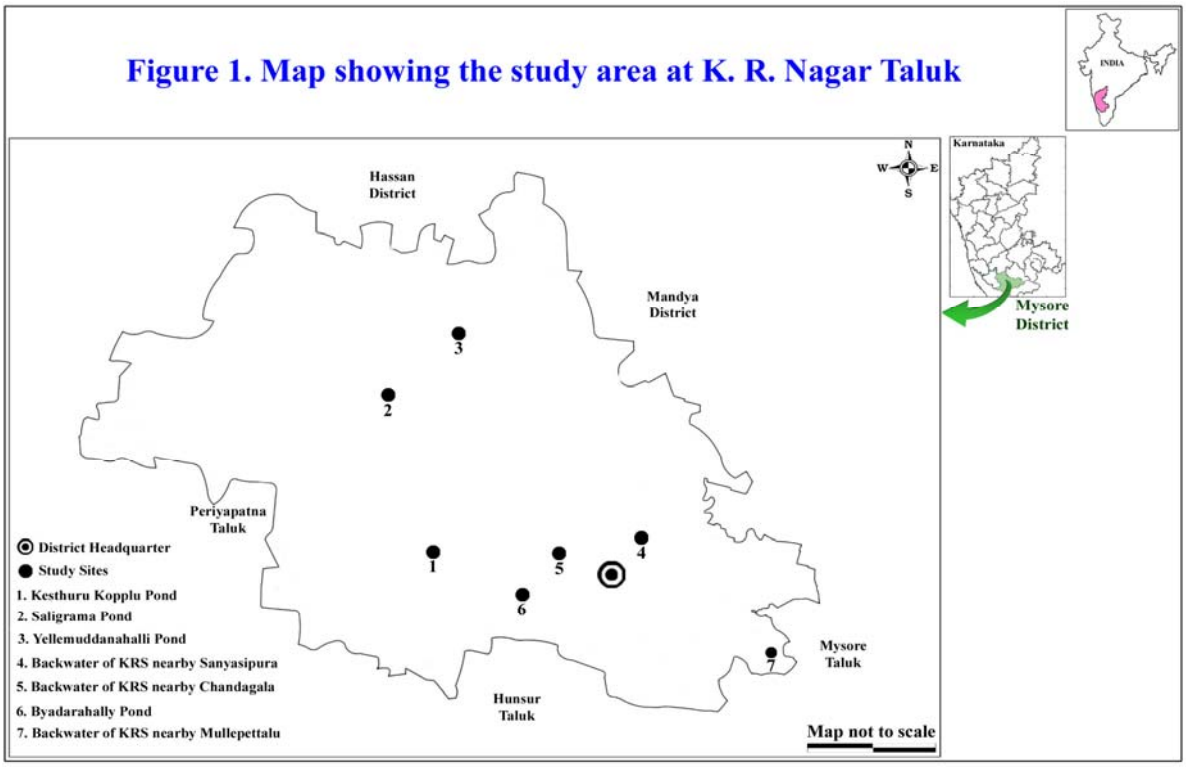

Fig 1: Map showing the study area at K. R. Nagar Taluk

Various ecosystems at K. R. Nagar Taluk of Mysore District possess good number of inland water bodies connected with marshy areas due to the flow of perennial River Cauvery. The ponds of Kesthuru Koppalu, Saligrama, Yellemuddanahally, Byadarahally and KRS backwater nearby Sanyasipura, Chandagala and Mulepettalu villages have provided good source of food to several bird species. Moreover, these aquatic habitats are surrounded by coconut plantation, scattered tall *Eucalyptus* tree species and paddy fields. Further, the landscapes of these ponds are occupied by rooted and floating vegetation accompanied with reeds, wild grasses and scattered mud bunds [31]. Furthermore, majority of farmers grow rain fed crops and some farmers grow paddy by using locally available water source from River Cauvery and its tributaries, which provide good source of food to many aquatic bird species. The aquatic habitats including paddy fields are housed with fishes, frogs, tadpoles, crabs, mollscans, larval forms, insects, growing buds and roots of plants become food to several aquatic birds [32, 33]. As these factors are very essential for normal survival of aquatic birds, become inseparable elements of aquatic habitats [27]. Perhaps, all these prevailed features at village ponds, water ways and backwater of Reservoir might have extended congenial conditions for feeding, roosting, resting and breeding activities partly of fully to 43 bird species which belong to 15 families that are in four orders of the class Aves in this part of the State. Accordingly, few species of Ardeidae, Anatidae, Charadriidae, Ciconiidae Dromadidae, Jacanidae, Laridae, Pelecanidae, Phalacrocoracidae, Podicipedidae, Recurvirostridae and Threskiornithidae family were found amidst these aquatic habitats. Birds of these families are considered as potential species of aquatic ecosystems [34] because of their ecological and scientific values [2], their presence indicated the good local faunal diversity with less human interferences at aquatic ecosystems [5]. Hence, bird species which live at/nearby aquatic habitats or marshy areas require suitable resting or roosting places, good source of food and congenial nesting sites with less human interferences for survival and to conduct breeding activities [34]. However, few species of Ardeidae, Ciconiidae, Pelecanidae and Threskiornithidae family members (e.g. *B. ibis, M. intermedia, P. porphyrio, A. cinerea, A. purpurea, N. nycticorax, E. grazetta, V. indicus, M. leucocephala, P. falcinellus, M. alba and A. rufulus*) live partly nearby aquatic habitats, but not completely depended on aquatic ecosystems. Although these birds are not true water birds, but they spend

some time nearby aquatic ecosystems or live partly in association with water ways (e.g. Ponds, pools and ditches) or marshy areas by visiting different hours of the day. Rallidae family members are true aquatic birds live in association with water bodies. They preferred to spend most of the time in or nearby aquatic/marshy habitats. Similarly, Motacillidae family members also visited aquatic/marshy areas for feeding purposes. However, Alcedinidae family members (e.g. *C. rudis, H. smyrnensis and A. atthis*) were found nearby fresh water habitats and they visited aquatic ecosystems for catching fishes. Sometimes, they did use muddy bank of River and ponds for nest building [8, 9].

Further, in India, around 107 species of migratory bird species were recorded at aquatic ecosystems during winter season and considered them as winter migrants [8]. Since, migratory aquatic birds are most remarkable components of global biodiversity [35], reside in/or on the bank of water reservoirs [36] and conduct feeding, nesting or roosting and breeding activities. During the present study, 12 migratory bird species and two local migrant bird species were recorded. Although, these migratory birds and local migrant birds' density and abundance varied considerably, prefer this region for their survival during some part of the year due to locally available congenial conditions. Thus, few bird species prefer to live at/nearby different aquatic habitats [11] for various reasons and become useful to man as well as local biodiversity in various ways [3]. Interestingly, the diversity index (H^1) of birds at these aquatic ecosystems is near to normal range. Since, aquatic avifauna would become the healthy sign of good aquatic ecosystems and reveal indirectly their quality [13, 8], birds live in or/at aquatic ecosystems play a pivotal role in controlling various insect pests in agriculture ecosystems [32, 4, 37, 38]. They also predate on rodents, scavenge dead animal carcasses, dispense seeds and pollinate many flowering plants at aquatic ecosystems [22]. Despite all these services to aquatic ecosystems by aquatic bird's in turn aquatic ecosystems (e.g. Ponds, lakes ditches and swamps) serve as flight corridors for migratory birds as well as important breeding and foraging habitats for native waterfowls and other bird species [39]. Thus, aquatic habitats and many bird species are inseparable elements, support a rich array of animal species and plant communities [19], helpful to mankind various in ways [10, 40, 5, 32, 20, 34] and their presence is very essential to restore local biodiversity.

5. Acknowledgement

First author thankful to the University of Mysore, Mysore for the Fellowship granted during the M. Phil, studies. Thanks are also due to the Chairman, DOS in Zoology, University of Mysore, Manasagangotri, Mysore for encouragement.

6. Reference

1. Jordan EL, Verma PS, Chordate Zoology S. Chand & Co. Ltd. New Delhi, 2004, 425-538.
2. Ali S, Ripley SD. Hand book of birds of India and Pakistan. Oxford Uni. Press, Delhi, 1996, 110-112.
3. Mitra A, Chattergee C, Mandal FB. Synthetic chemical pesticides and their effects on birds. Res. J Envt. Toxicol. 2011; 10:1-16.
4. Bhat IP, Christopher SS, Hosetti BB. Avifaunal diversity of Anekere wetland, Karkalla, Udupi District, Karnataka, India**.** Journal of Environmental Biology. 2009; 30(6):1059-1062.
5. Basavarajappa S. Aquatic avifauna of agro-ecosystems of Maidan area of Karnataka. Zoo's Print J. 2006; 21(4):2217-2219.
6. Basavarajappa S. Avifaunal in agri-horticultural ecosystems of Maidan area of Davangere District, Karnataka, India. In: Perspectives in animal ecology and reproduction. Daya Publishing House, New Delhi, 2007; 4:264-279.
7. Urfi AJ. Breeding Ecology of Birds. Resonance, 2013, 1-3.
8. Kumar A, Sati JP, Tak PC, Alfred JRB. Handbook on Indian Wetland Birds and their Conservation. ZSI Publ. Kolkata, India. 2005; 26:1-472.
9. Kumar P, Gupta SK. Diversity and Abundance of Wetland Birds around Kurukshetra, India. Our Nature. 2009; 7:187-192.
10. Shivaperuman C, Jayson EA. Birds of Kole wetlands, Thrissur, Kerala. Zoos Print J. 2000; 15(10):344-349.
11. Patil VB. Ornithofaunal Diversity of Ganesh Lake, Barshi, Dist. Solapur, (Maharastara). Interdisciplinary Res. J. 2013; (1):56-59.
12. Manakadan R, Pittie A. Standardized common and scientific names of the birds of the Indian subcontinent. Buceros. 2001; 6(1):1-37.
13. Newton I. The contribution of some recent research on birds to ecological understanding. J Animal Ecol. 1995; 64:675-696.
14. Gibbs JP. The importance of small wetlands for the persistence of local populations of wetland associated animals. Wetlands. 1993; 13:25-31.
15. Harisha MN, Hosetti BB, Ahmad S. Wetland avifauna of Kundavada Lake, Davangere Dist. Karnataka. Curr. Biotica. 2011; 5(3):351-358.
16. Prasad SN, Ramachandra TV, Ahalya N, Sengupta T, Kumar A, Tiwari AK *et al*. Conservation of wetlands of India - A Review. Tropical Ecol. 2002; 43(1):173-186.
17. Gupta AK, Singh SK. Changing wetlands due to discharge of effluent from small scale industries around Varuna river corridor. Ecol. Envt. & Conservation. 2003; 9(2):209-212.
18. Kumar A, Sati JP, Tak PC. Checklist of Indian Water birds. Buceros. 2003; 8(1):1-30.
19. Grimmett R, Inskipp T. Birds of southern India. Om Books International, New Delhi, 2007, 1-478.
20. Rajashekar S, Venkatesh MG. The diversity and abundance of water birds in lakes of Bangalore city, Karnataka, India. Biosystematica. 2010; 4(2):63-73.
21. Patil MS, Hiragond NC. Avifauna diversity along the Ghattaprabha River in Shettihalli, Hukkeri Taluk, North Karnataka. The Ecoscan. 2013; 7(1, 2):79-82.
22. Dayananda GY. Avifaunal Diversity of Gudavi Bird Sanctuary, Sorab, Shimogga, Karnataka. Our Nature. 2014; 7:100-109.
23. Kattan GH, Franco P. Bird diversity along elevation gradients in the Andes of Colombia: Area and mass effects. Global Ecol. Biogeography. 2004; 13:451-458.
24. Kamath US. Karnataka State Gazetter, Government Press, Bangalore, India. 2001, 1-49.
25. Burnham KP, Anderson DR, Laake JL. Estimation of density from line transects sampling of biological populations. Wildlife Monograph. 1980; 72:202.
26. Ali S. Indian Birds. J The Bombay Natural History Society. Bombay. 2004; 9 -12.
27. Grimmett R, Inskipp C, Inskipp T. Birds of the Indian subcontinent India. Oxford Uni. Press, India. 2011; 1-528.
28. Phillips J. Succession, development, the climax and complex organism. An analysis of concepts. Part 1 & 2. J

Ecology. 1959; 22:559-571, 23:488-508.
29. Saha TK. Biostatistics in Theory and Practice. Emkay Publications, Delhi, 1992, 5-104.
30. Mugurran AE. Measuring Biological Diversity. Black Well Publishing Co. Australia, 2004, 106-107.
31. Shruthi HS. Study on aquatic avifauna at few wetland ecosystems of K.R. Nagar Taluk, Mysore District. M. Phil, Dissertation, University of Mysore, Mysore, 2014, 1-70.
32. Basavarajappa S. Role of Avifauna in the paddy pest's management under irrigated conditions of Karnataka. Nat. Conf. Proc. Haveri, Karnataka, 2009; 1-8.
33. Kumar P, Gupta SK. Status of wetland birds of Chinchilla Wildlife Sanctuary, Haryana, India. J Threatened Taxa. 2013; 5(5):3969-3976.
34. Soka EG, Panteleo KT, Munishi Thomas BM. Species diveversity and abundance of avifauna in and around Hombalo wetland in Central Tanzia. J. Biodiversity and Conservation Res. 2013; 1(1):63-71.
35. Li ZWD, Mundkur T. Numbers and distribution of water birds and wetlands in the Asia-Pacific region. In: results of the Asian water bird census, Kuala Lampur. Wetlands International. 2004; 1997-2001.
36. Bhadja P, Vaghela A. Study on Avifaunal Diversity from Two Freshwater Reservoirs of Rajkot, Gujarat, India. Int. J Res. Zool. 2013; 3(2):16-20.
37. Basavarajappa S, Sannappa B, Naika R. Study of Pesticides use in croplands fields of Maidan area, Karnataka, India. In: Perspectives in Animal Ecology and Reproduction (*Edn. Gupta et al.),* Daya Publishing House, Delhi, 2010, 146-165.
38. Manjunath K, Joshi BN. Avifauna of Chandrampalli Dam, Chincholi, Gulburga District Karnataka. Int. J Res. Appl. Natural & Social Sci. 2014; 2(4):1-10.
39. Smith AC, Virgal JA, Panayi D, Armstrong AR. Effects of a diamond mine on Tundra – breeding birds. Arctic. 2008; 58(3):295.
40. Urfi AJ, Sen M, Megnathan T. Counting birds in India: Methodologies and Trends. Curr. Sci. 2005; 89(12):1997-2003.