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Species Diversity and Abundance of Birds of Chilli Lake, Fatehabad, Haryana

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Abstract:
Avian diversity around Chilli, the historical lake of district Fatehabad, Haryana, India, has been studied for a period of one year. It is situated along the historical fort of Mogul Emperor, Firoz Shah Tughlak for providing the security to the fort from three sides. Once a place for recreation, its existence is in danger now, due to dumping of sewage water and garbage from whole of the town which is affecting the biodiversity severely. To record the avian diversity, periodic weekly visits were conducted in the morning and later in the evening using line transect method and point count method. A total of 21 species of wetland birds belonging to 6 orders and 9 families have been recorded during the study period. Maximum values of Shannon-Weiner index (2.76) and Simpson's diversity index (0.85) were recorded in the month of December while Margalef index value was highest (3.63) in the month of January. Minimum values of Shannon-Weiner index (1.63), Simpson's diversity index (0.49) and Margalef richness index (1.39) were recorded in the month of July. As no previous record of research studies on wetland avian faunal diversity of Chilli lake was found, so the present study was planned to fulfill the lacuna of research on different aspects of avian fauna as well as major threats to them due to anthropogenic activities in the study area.

Keywords: *Abundance, Chilli Lake, Diversity, Wetland birds*

1. Introduction

Wetlands, the lands transitional between terrestrial and aquatic ecosystem (Mitsch and Gosselink, 1986), are important habitats for birds as the latter use these wetlands for feeding, roosting, nesting and rearing young ones (Weller, 1978; Barbier et al., 1997; Tiner, 1999; Stewart, 2001; Soka *et al*., 2013). These wetlands are known as "biological supermarkets" because of extensive food chains and rich biodiversity they support by providing unique habitats for a wide range of flora and fauna (Mitch and Gosselink, 2000). Birds are frequently used as indicator variables in ecological monitoring and assessment because they constitute a well defined taxon that has been widely surveyed, and it is relatively easy to conduct census of them (Lin *et al*., 2008; Amat and Green, 2009). These ecosystems are, however, prone to degradation, pollution, alteration and transformation due to various anthropogenic activities which affect and threaten the globally significant avian diversity. A lot of work has been done on various aspects of avian diversity in different regions of the state of Haryana (Yadav and Malewar, 1978; Gupta and Bajaj, 1997; Kalsi, 1998; Bahuguna *et al*., 2008; Kumar and Gupta, 2009), but no information is available on the avian diversity of Chilli Lake of district Fatehabad, Haryana. Therefore, present work has been carried out to document the avian diversity of the Chilli lake to assess the status and abundance of different avian species and also to monitor the existing threats due to anthropogenic activities in the area.

2. Materials and Methods

2.1. Study Area

The present work has been carried out in and around the Chilli Lake. It is situated on the outskirts of city Fatehabad (Haryana, India), along the 500 year old historical fort of Mogul emperor Firoz Shah at geographical coordinates of 29°31'04.5"N to 75°27'43.5"E. Besides the fort, a 250 year old temple of Lord Krishna, a gurdwara and a marhi of goddess are also situated around the lake. Chilli was once a place for recreation and amusement but due to dumping of garbage in the lake its very existence is in peril now. The sewage water of most parts of the town is being allowed to put in this lake.

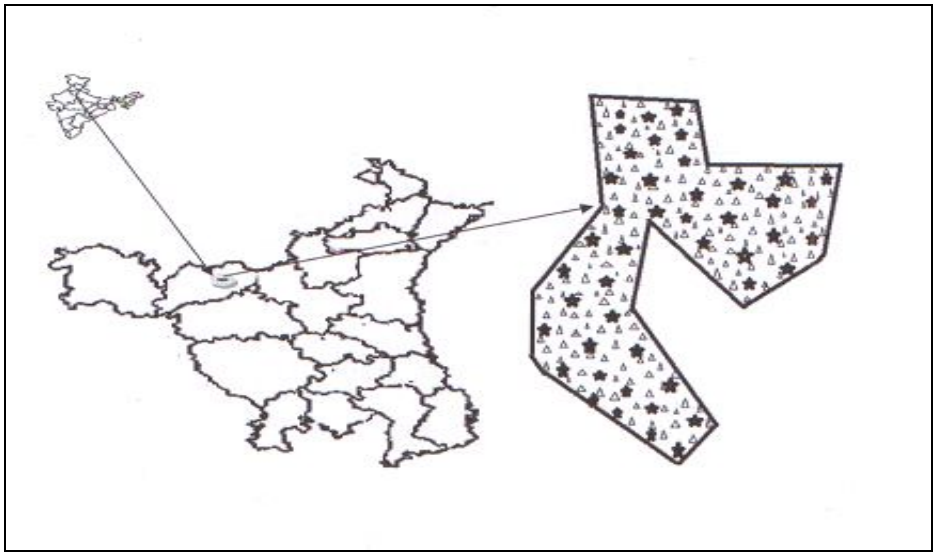

Figure 1: Showing map of study site (Chilli Lake) in Fatehabad, Haryana (India)

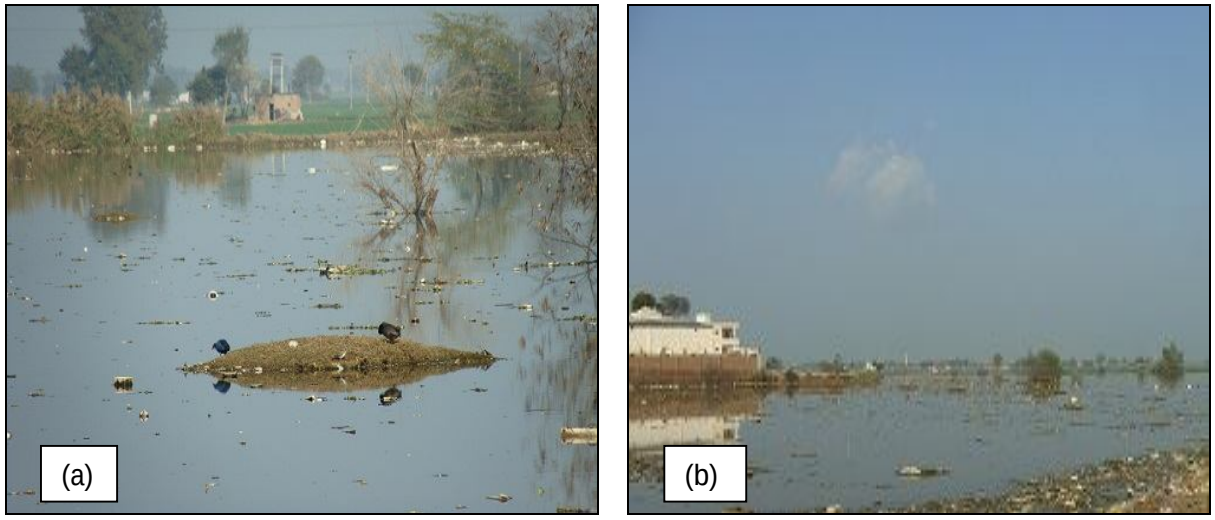

Figure 2: (a) Lake view with low plantation and (b) Water Pollution due to dumping of garbage

2.2. Methodology

To record the avian diversity of the study area, periodic weekly visits were conducted in the morning and later in the evening using line transect method (Gaston, 1975; Sales and Berkmuller, 1988), and point count method (Altman, 1974). Birds were photographed and subsequently identified using standard reference books (Ali, 1996; Grimmet et al., 1998). Classification of the observed bird species was done following Manakandan and Pittie (2001). To observe the status of different avian species, the latter were categorized as 'Resident'(R), 'Local migrants' (LM) and 'Winter migrants' (WM) and 'Summer migrants'. Similarly, on the basis of the frequency of sighting, various bird species were categorized as 'Abundant' or 'A' (encounter rate 95% to 100%), 'Common' or 'C' (encounter rate 60% to 95%), Uncommon or UC (encounter rate 20% to 60%) and 'Rare' or 'Ra' (encounter rate less than 20%) following the terminology used by Srinivasulu and Nagulu (2002). Data was also statistically analyzed to calculate the species diversity, evenness and richness using standard biodiversity indices like Shannon-Weiner diversity index (Shannon-Weaver, 1963), Simpson diversity index (Simpson, 1949) and Margalef richness index (Margalef, 1958).

i. Simpson's Index (D): $\sum n(n-1)/N(n-1)$
   Where n= number of organisms of particular species and
   N= number of organisms of all species
ii. Simpson's Index of Diversity: 1-D
iii. Shannon-Weiner Diversity Index (H'): $-\Sigma p_i \text{ Blog } p_i$
   Where $p_i = n_i/N$, n_i = number of organisms of one species and
   N = number of organism of all species
iv. Margalef Richness Index (D_{Mg}): S-1/log N

Where S = number of species and
N = number of organisms

Water Quality Index (WQI) was calculated using the standards recommended by World Health Organization (WHO), Indian Council for Medical Research (ICMR) and Bureau of Indian Standards (BIS). Weighted Arithmetic water quality index method (Brown et al., 1972) was used to assign the water quality according to the purity of water using the following expression:

$WQI=\sum Q_i W_i / \sum W_i$

Quality rating for each parameter was calculated using the equation:

$Q_i=100[(V_i-V_o / S_i-V_o)]$

Where, V_i is estimated concentration of i^{th} parameter in the analysed water

V_o is ideal value of i^{th} parameter in pure water (V_o=0 except pH-7.0 and DO-14.6 mg/L)

S_i is recommended standard value of i^{th} parameter

Wi (unit weight) of each parameter is calculated using the equation:

$W_i=K/S_i$ where K is proportionality constant

WQI Value	Rating of Water Quality	Grading
0-25	Excellent water quality	A
26-50	Good water quality	B
51-75	Poor water quality	C
76-100	Very poor water quality	D
Above 100	Unsuitable for drinking purpose	E

Table 1: Water Quality Rating according to Weight Arithmetic Water Quality Index Method

3. Results and Discussion

In all, 21wetland bird species belonging to 9 families and 6 orders were recorded in the study area (Table 2). Of these, 3 bird species were categorized as 'abundant', 9 species as 'common', 6 species as 'uncommon' and 3 species as 'rare' (Fig. 4). As far as status of birds is concerned, 6 species were winter migratory, 2 were local migratory and 13 species were resident (Fig. 3). Maximum number of avian species were represented by order Ciconiiformes (6 species), followed by Charadriiformes (5 species), Gruiformes (4 species), Passeriformes (3 species), Columbiformes (2 species) and Coraciiformes (1 species). Earlier, Kumar and Gupta (2009) reported 54 species of wetland birds belonging to 5 orders and 15 families from Kurukshetra and also observed the dominance of order Ciconiiformes. Shannon-Weiner diversity index, Simpson diversity index and Margalef index were also calculated for the observed avian fauna during the study period. The value of Shannon-Weiner index was found to be highest (2.76) in the month of December and lowest (1.63) in the month of July (Table 3) which indicates greater richness and evenness in the month of December. Similarly, value of Simpson's index of diversity was also reported to be maximum (0.85) in the month of December and minimum (0.49) in the month of July. As far as value of Margalef richness index is concerned, it was reported to be highest (3.63) in the month of January and lowest (1.39) in the month of July (Fig. 2). Singh and Laura (2013) have also reported the higher values of diversity indices in the month of December and lower in the month of July for the avian fauna of Tilyar lake, Rohtak (Haryana). High diversity and richness in December may be due to migratory birds visiting the lake for food, forage and breeding sites while reason for low diversity indices values in the month of July may be attributed to high temperature, low food availability and migration of local migratory avian fauna to nearby agriculture fields for food (Maheswaran and Rahmani, 2001).

3.1. Factors Responsible for low Avian Diversity

Chilli Lake is facing threat of water pollution due to dumping of garbage (Figure 2) in and around the lake and also mixing of sewage water from the surroundings. The poor diversity of wetland birds reported during the present study may be attributed to inhabitable habitat and scarcity of food and foraging sites, as the water quality reported by WQI is highly deteriorating and unsuitable for usage. One of the reasons of loss of biodiversity has been attributed to water pollution (Hassan, 2008) which is mainly due to anthropogenic activities. In the present study, WQI of the study area was found to be 236.67 (Table 4) and it showed the water quality rating as unsuitable for the drinking purposes. This much high value of water quality indices of all the stations clearly indicated that the water body is highly polluted, severely degraded and non-supportive for the aquatic biodiversity. Values of physicochemical parameters also revealed the same condition of the study area. Low avian diversity may be due to highly polluted water as pollution affects the aquatic organisms which act as important source of food for birds. Earlier, it has been reported that pollution affects species directly, leading to mortality and reduced reproductive success as well as indirectly through the degradation of habitats (Bird Life International, 2008). Low species count may be considered as loss of biodiversity in the polluted ecosystem which leads to loss of functional biodiversity (Sleem and Hassan, 2010) and habitat destruction (Brandt and Ebbe, 2009).Besides pollution, the encroachment of the wetland for the construction of new settlements and the cutting of trees in the vicinity of the lake is resulting in landscape alteration which may reduce available roosting sites, food and foraging area. Noise generated by plying vehicles on the nearby road may also have direct impact on the prevalence of avian species.

3.2. Conservation Strategies

There should be plantation around the lake to enhance means of roosting, food and foraging for the avian species. Restriction on dumping of garbage, harmful chemicals like pesticides and sewage water in the lake can maintain the water quality which will indirectly help to conserve the bird diversity. To maintain the water quality and reduce the pollution, wastewater treatment should be

done so that discharge of harmful chemicals into the lake water can be prevented. Water quality should be monitored at regular intervals and use of detergents should be prohibited. Intrusion of lake for settlements and its misuse for religious activities like idol immersion should be restricted. Also, research related to diversity, abundance, richness and migration patterns of birds should be regularly carried out, so that reduction in diversity, population size and ecological reasons can be determined.

S. No.	Common Name	Scientific Name	Residential Status	Abundance Status
		Order: Charadriiformes Family: Charadriidae		
1	Red-wattled Lapwing	*Vanellus indicus*	R	C
2	White-tailed Lapwing	*Vanellus leucurus*	WM	UC
		Family: Recurvirostridae		
3	Black-winged Stilt	*Himantopus himantopus*	R	A
		Family: Scolopacidae		
4	Common Sandpiper	*Actitis hypoleucos*	WM	UC
5	Wood Sandpiper	*Tringa glareola*	WM	UC
		Order: Ciconiiformes Family: Ardeidae		
6	Great Egret	*Casmerodius alba*	R	C
7	Little Egret	*Egretta garzetta*	R	C
8	Cattle Egret	*Bubulcus ibis*	R	A
9	Indian Pond Heron	*Ardeola grayii*	R	C
10	Grey Heron	*Ardea cinerea*	R	C
11	Yellow Bittern	*Ixobrychus cinnamomeus*	SM	Ra
		Order: Columbiformes Family: Columbidae		
12	Laughing Dove	*Streptopelia senegalensis*	R	C
13	Eurasian Collared Dove	*Streptopelia decaocto*	R	UC
		Order: Coraciiformes Family: Alcedinidae		
14	White-throated Kingfisher	*Halcyon smyrnensis*	R	C
		Order: Gruiformes Family: Rallidae		
15	Common Moorhen	*Gallinula chloropus*	R	A
16	Common Coot	*Fulica atra*	WM	UC
17	Purple Coot	*Porphyrio porphyrio*	R	UC
18	White-breasted Waterhen	*Amaurornis phoenicurus*	R	C
		Order: Passeriformes Family: Motacillidae		
19	White Wagtail	*Motacilla alba*	WM	UC
20	White-browed Wagtail	*Motacilla maderaspatensis*	R	C
		Family: Laniidae		
21	Long-tailed Shrike	*Lanius schach*	WM	Ra

Table 2: Wetland avian fauna of Chilli Lake, Fatehabad, Haryana
R-Resident, WM-Winter migratory, SM-Summer migratory, A-Abundant, C-Common, UC-Uncommon, Ra-Rare

Month	Shannon-Weiner Index (H')	Simpson's Index (D)	Simpson's Index of Diversity (1-D)	Margalef Richness Index (D_{Mg})
December	2.76	0.15	0.85	3.61
January	2.72	0.16	0.84	3.63
February	2.50	0.20	0.80	3.17
March	2.23	0.25	0.75	2.50
April	2.12	0.28	0.72	2.13
May	2.19	0.26	0.74	2.39
June	2.31	0.24	0.76	2.43
July	1.63	0.51	0.49	1.39
August	2.18	0.26	0.74	2.48
September	2.31	0.21	0.79	2.45
October	2.3	0.22	0.78	2.59
November	2.50	0.19	0.81	2.99

Table 3: Monthly variations in Species diversity indices from Dec, 2012 to Nov, 2013

S. No.	Parameters	Observed Values	Standard Values (S_i)	Unit Weight (W_i)	Quality Rating (Q_i)	W_iQ_i
1	pH	8.10	8.5	0.2190	73.33	16.06
2	TDS (mg/L)	860	500	0.0037	172	0.64
3	Conductivity (mS)	1720	300	0.371	573.33	212.71
4	Alkalinity (mg/L)	489.11	120	0.0155	407.59	6.32
5	Total Hardness (mg/L)	572.17	300	0.0062	190.72	1.18
6	Chloride (mg/L)	327.67	250	0.0074	131.07	0.97
7	DO (mg/L)	3.64	5.0	0.3723	114.17	42.51
8	BOD (mg/L)	2.49	5.0	0.3723	126.15	46.97
9	Calcium (mg/L)	129.84	75	0.025	173.12	4.33
10	Magnesium (mg/L)	60.46	30	0.061	201.53	12.29
Water Quality Index = $\sum Q_iW_i/\sum W_i$ = 236.67						

Table 4: Water Quality Index of Chilli Lake during the study period (December, 2012 to November, 2013)

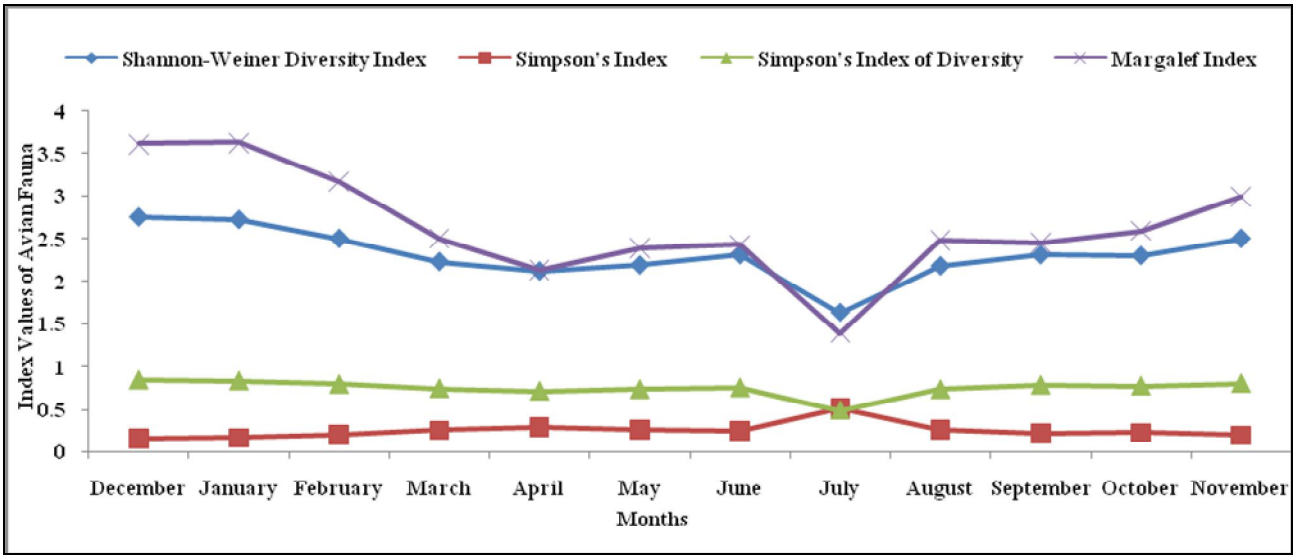

Figure 3: Monthly Variations in Diversity Indices of avian fauna from December, 2012 to November, 2013

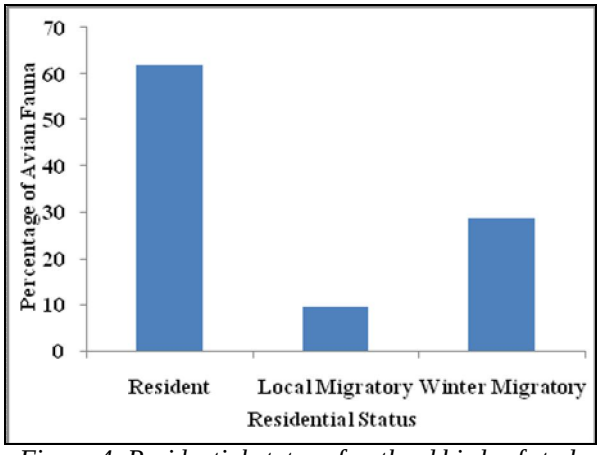

Figure 4: Residential status of wetland birds of study area from December 2012 to November, 2013

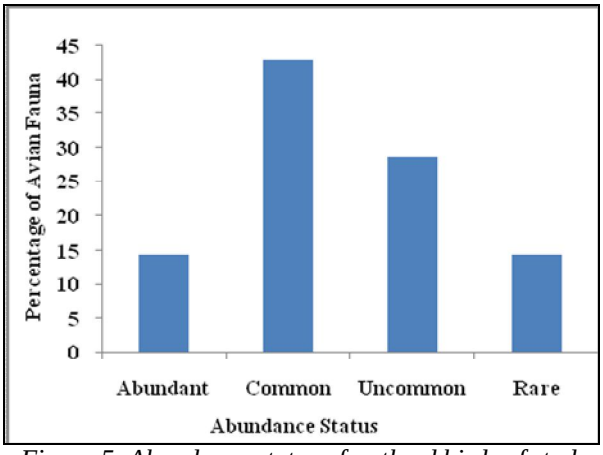

Figure 5: Abundance status of wetland birds of study area from December, 2012 to November, 2013

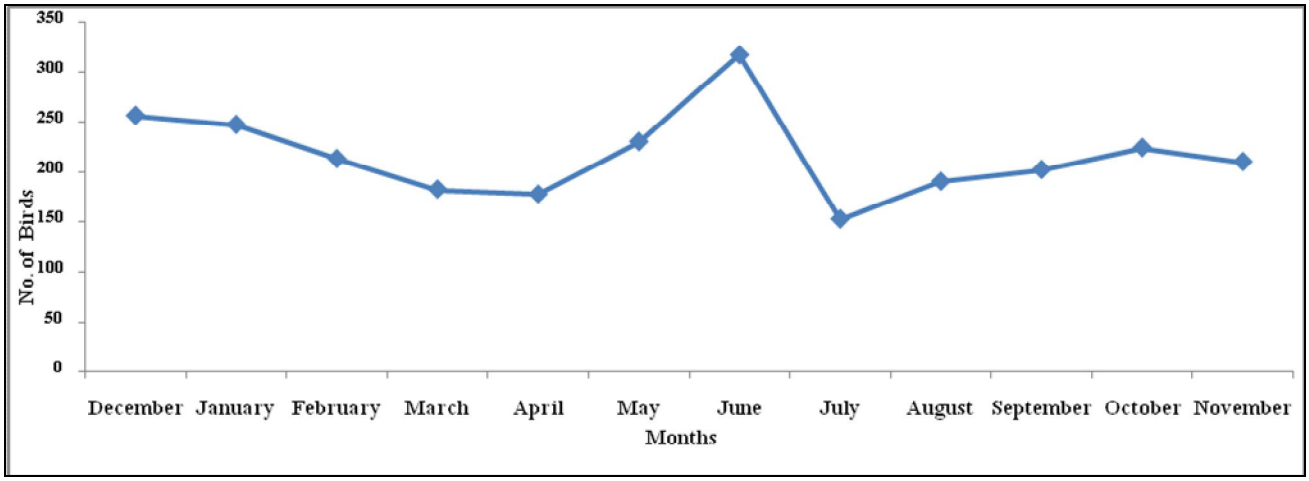

Figure 6: Monthly Variation of avian fauna of Chilli Lake from December, 2012 to November, 2013

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