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Species richness and diversity of avian fauna at village ponds in district Ludhiana of Punjab, India

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ABSTRACT

During the present study, avian species of village ponds of district Ludhiana, Punjab have been documented and a total of 77 species referable to 13 orders and 31 families have been documented from May 2016 to April 2020. Order Passeriformes is found as dominant order with 12 families and 27 species. As per IUCN Red list 2020, all species belong to “Least Concern (LC)” category. Various statistical parameters including Shannon diversity index, Pielou’s evenness index, Margalef’s richness index and Berger-parker index of dominance have been calculated. It has also been revealed that the village ponds in the study area support great bird diversity because these are mainly surrounded by agricultural fields, scattered plantations and residential areas and constitute unique ecological systems. These water bodies are facing problems due to sewage disposal, garbage dumping, pollution, encroachment by weeds and construction of cemented walls which ultimately cause disturbance to the birds inhabiting these water bodies. These village ponds are recorded to host 29 winter migrants, which makes it important to preserve these sites from such threats.

Keywords: Avian diversity, aquatic habitats, village ponds, species, diversity indices.

1. INTRODUCTION

India is a mega diverse country with rich wildlife. In terms of species richness, India is ranked 7th for mammals, 9th for birds and 5th for reptiles. Along with species richness, India also possesses high rates of endemism i.e., 4.5% of birds, 12.6% of mammals, 45.8% of reptiles, 55.8% of amphibians and 33% of plants are endemic (India Biodiversity Portal, 2021). In terms of endemic vertebrate groups, India’s global ranking is 10th in birds with 69 species; 7th in amphibians with 110 species and 5th in reptiles with 156 species (MoEFCC, 2014). Our country has about 1,300 bird species which makes over 13% of the world’s bird diversity (Grimmett and Inskipp, 2010).

The birds in the state of Punjab are broadly related to three ecological zones i.e., wetland zone consisting of rivers, lakes and artificial ponds, agricultural/

rural/urban zone and forests of low hills of Shivaliks (Hussain, 1984). After thoroughly scrutinizing the literature, it has been observed that most of work on avian documentation has been done/being done on major wetlands including the Ramsar sites (Harike wetland, Kanjli wetland and Ropar wetland) of the State and Shivalik foothills.

Unfortunately, little attention has been given so far to the birds associated with village ponds of the state, although they harbour a considerable number of species including migratory birds (Kler and Kumar, 2015; Kaur et al., 2018; Soni et al., 2019; Brraich and Singh, 2021; Kaleka et al., 2021). In view of the above facts, the present study was undertaken to document current status of aquatic bird species found in village ponds in Ludhiana district of Punjab considering that it will act as a model for the rest of the state.

2. MATERIAL AND METHODS

To document avian diversity of village ponds of district Ludhiana (Punjab), monthly surveys have been conducted in the district during May 2016 to April 2020. To complete these surveys, four village ponds were selected on the basis of anthropogenic activities and lack of information about avian diversity prevailing in those ponds.

Aquatic habitat

A pond is a natural or artificial fresh water body having shallow and still water. Ponds are a combination of diverse biotic and abiotic conditions (Oertli et al., 2002). Four pond sites were selected for point count in the study area.

Site-1 (S1) Rahaun pond point count: The Rahaun village is located in Khanna tehsil between latitude 30°0.64" N and longitude 76°12" E. The village is about 10 kms away from Khanna city. The sewage waste of village falls in the pond.

Site-2 (S2) Salaudi pond point count: The village Salaudi Singha Di falls under Samrala tehsil and is situated between latitude 30°0.75" N and longitude 76°0.21" E. The animals drink water from this pond. The pond acts as a sink for household and domestic animal waste.

Site-3 (S3) Malakpur pond point count: The village falls under Payal tehsil and is located between latitude 30°0.56" N and longitude 76°10" E. The pond is surrounded by a religious place (Gurudwara sahib), agricultural fields and open land. The pond is bordered with cemented wall. The village household waste falls in this pond.

Site-4 (S4) Chuhrpur pond point count: The village Chuhrpur falls under Ludhiana West tehsil and is situated between latitude 30°0.94" N and longitude 75°0.79" E. The pond is surrounded by residential area.

The bird diversity was explored using Point count method (Sutherland, 1996) at the village ponds. The number of points was selected depending upon extent of the study area. A single point was observed for about 10 minutes. All birds seen or heard and in flight were recorded. The collected data including species name and number of individuals was recorded in the field diary. Olympus 10X50 DPS binoculars were used to avoid disturbance to the birds. Field photography was done with the help of a DSLR camera Canon 60d. Various field guides Ali and Ripley, (1987), Ali, (2002), Grimmett and Inskipp, (2010) and Inskipp et al., (2011) have been used to identify the bird species. The conservation status of bird species has been assigned as per IUCN Red list status 2020.

A diversity index is a mathematical measure of species diversity in a given community. These indices tell about community composition, species richness, relative abundance and evenness of species. Following statistical indices were used to measure species diversity in a community.

Shannon-Wiener diversity index (H'): This is an important diversity index to account the number of individuals and number of taxa of a community. It varies from 0 to higher values depending on number of present taxa. The formula for Shannon's index is:

$$H' = - [\sum P_i \ln P_i]$$

Where H'= Shannon's diversity index, P_i= Relative Abundance, lnP_i= Natural logarithm of this proportion

Margalef's species richness index (Margalef, 1958): This index is used to calculate the species richness i.e., the number of species present in a particular habitat.

$$Rmf(d') = S-1/\ln(N)$$

Where S=Total number of species, ln=Natural log, N=Total number of individuals in the sample

Pielou's evenness index (Pielou, 1969): It is used to calculate evenness which indicates relative abundance or proportion of individuals among the species.

$$E = H'/\ln S$$

Where H'=Index of diversity of Shannon-Wiener, ln=Natural log, S=Total number of species

Berger-Parker Index of dominance (Berger and Parker, 1970): It is used to calculate the number of individuals of dominant taxon relative to the total number of individuals of a community. The formula is given below.

$$d = N_{\max}/N$$

Where d = Berger-Parker Index, $N_{\max}$ = Number of individuals in the most abundant species, N = Total number of individuals in a community

3. RESULTS

A total of 77 species referable to 13 orders and 31 families from the aquatic habitats i.e., village ponds has been recorded during present studies (Table 1). Order Passeriformes is recorded with maximum number of species i.e., 27 species belonging to 12 families. All 77 species belong to “Least Concern (LC)” category.

Table 1 Distribution of recorded avian species in study sites

S. No.	Common name	Scientific name	IUCN Red List 2020	Aquatic habitats i.e., village ponds			
				S1	S2	S3	S4
1	Little Grebe	<i>Tachybaptus ruficollis</i> (Pallas, 1764)	LC	+	+	+	+
2	Little Cormorant	<i>Microcarbo niger</i> (Vieillot, 1817)	LC	-	+	-	+
3	Purple Heron	<i>Ardea purpurea</i> (Linnaeus, 1766)	LC	+	+	+	+
4	Indian Pond Heron	<i>Ardeola grayii</i> (Sykes, 1832)	LC	+	+	+	+
5	Black-crowned Night Heron	<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	LC	-	+	-	+
6	Cattle Egret	<i>Bubulcus ibis</i> (Linnaeus, 1758)	LC	+	+	+	+
7	Little Egret	<i>Egretta garzetta</i> (Linnaeus, 1766)	LC	-	+	-	-
8	Red-naped Ibis	<i>Pseudibis papillosa</i> (Temminck, 1824)	LC	+	+	+	+
9	Spot-billed Duck	<i>Anas poecilorhyncha</i> Forster, 1781	LC	+	+	+	+
10	Gadwall	<i>Mareca strepera</i> (Linnaeus, 1758)	LC	+	-	+	-
11	Eurasian Wigeon	<i>Mareca penelope</i> (Linnaeus, 1758)	LC	+	-	+	-
12	Common Teal	<i>Anas crecca</i> (Linnaeus, 1758)	LC	+	+	+	-
13	Northern Pintail	<i>Anas acuta</i> (Linnaeus, 1758)	LC	+	+	+	-
14	Northern Shoveler	<i>Spatula clypeata</i> (Linnaeus, 1758)	LC	+	+	+	+
15	Red-crested Pochard	<i>Netta rufina</i> (Pallas, 1773)	LC	+	-	-	-
16	Tufted Duck	<i>Aythya fuligula</i> (Linnaeus, 1758)	LC	+	-	-	-
17	Comb Duck	<i>Sarkidiornis melanotos</i> (Pennant, 1769)	LC	+	+	-	-
18	Lesser Whistling Duck	<i>Dendrocygna javanica</i> (Horsfield, 1821)	LC	+	+	+	-
19	Bar-headed Goose	<i>Anser indicus</i> (Latham, 1790)	LC	+	-	-	-
20	Greylag Goose	<i>Anser anser</i> (Linnaeus, 1758)	LC	+	-	-	-
21	Garganey	<i>Spatula querquedula</i> (Linnaeus, 1758)	LC	+	+	-	-
22	Ruddy Shelduck	<i>Tadorna ferruginea</i> (Pallas, 1764)	LC	+	-	-	-
23	Black Kite	<i>Milvus migrans</i> (Boddaert, 1783)	LC	+	-	+	-
24	Shikra	<i>Accipiter badius</i> (Gmelin, 1788)	LC	+	+	+	-
25	White-breasted Waterhen	<i>Amaurornis phoenicurus</i> (Pennant, 1769)	LC	+	+	+	+
26	Common Moorhen	<i>Gallinula chloropus</i> (Linnaeus, 1758)	LC	+	+	+	+
27	Common Coot	<i>Fulica atra</i> (Linnaeus, 1758)	LC	+	+	+	+
28	Baillon's Crake	<i>Zapornia pusilla</i> (Pallas, 1776)	LC	-	+	-	-
29	Black-winged Stilt	<i>Himantopus himantopus</i> (Linnaeus, 1758)	LC	+	+	+	+
30	Red-wattled Lapwing	<i>Vanellus indicus</i> (Boddaert, 1783)	LC	+	+	+	+
31	White-tailed Lapwing	<i>Vanellus leucurus</i> (Lichtenstein, 1823)	LC	+	-	-	-
32	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i> (Scopoli, 1786)	LC	+	-	-	-
33	Temminck's Stint	<i>Calidris temminckii</i> (Leisler, 1812)	LC	+	-	-	-
34	Common Snipe	<i>Gallinago gallinago</i> (Linnaeus, 1758)	LC	+	-	-	-
35	Painted Snipe	<i>Rostratula benghalensis</i> (Linnaeus, 1758)	LC	+	-	-	-

36	Common Sandpiper	<i>Actitis hypoleucos</i> (Linnaeus, 1758)	LC	+	+	-	-
37	Green Sandpiper	<i>Tringa ochropus</i> (Linnaeus, 1758)	LC	+	+	-	-
38	Wood Sandpiper	<i>Tringa glareola</i> Linnaeus, 1758	LC	+	-	-	-
39	Common Redshank	<i>Tringa totanus</i> (Linnaeus, 1758)	LC	+	-	-	-
40	Rock Pigeon	<i>Columba livia</i> (Gmelin, 1789)	LC	+	+	+	+
41	Eurasian Collared Dove	<i>Streptopelia decaocto</i> (Frisvaldszky, 1838)	LC	+	+	+	+
42	Eastern Spotted Dove	<i>Spilopelia chinensis</i> (Scopoli, 1786)	LC	+	+	+	+
43	Laughing Dove	<i>Spilopelia senegalensis</i> (Linnaeus, 1766)	LC	+	+	+	+
44	Rose-ringed Parakeet	<i>Alexandrinus krameri</i> (Scopoli, 1769)	LC	+	+	+	+
45	Greater Coucal	<i>Centropus sinensis</i> (Stephens, 1815)	LC	+	+	+	+
46	Asian Koel	<i>Eudynamis scolopacea</i> (Linnaeus, 1758)	LC	-	+	-	-
47	Indian Grey Hornbill	<i>Ocyrceros birostris</i> (Scopoli, 1786)	LC	+	-	+	-
48	Common Hoopoe	<i>Upupa epops</i> (Linnaeus, 1758)	LC	+	+	-	-
49	White-breasted Kingfisher	<i>Halcyon smyrnensis</i> (Linnaeus, 1758)	LC	+	+	+	+
50	Green Bee-eater	<i>Merops orientalis</i> (Latham, 1802)	LC	+	+	+	+
51	Wire-tailed Swallow	<i>Hirundo smithii</i> (Leach, 1818)	LC	+	+	+	+
52	Barn Swallow	<i>Hirundo rustica</i> (Linnaeus, 1758)	LC	+	+	-	+
53	Streak-throated Swallow	<i>Petrochelidon fluvicola</i> (Blyth, 1855)	LC	+	-	-	-
54	Long-billed Pipit	<i>Anthus similis</i> (Jerdon, 1840)	LC	+	-	-	-
55	Yellow Wagtail	<i>Motacilla flava</i> (Linnaeus, 1758)	LC	+	+	+	+
56	Citrine Wagtail	<i>Motacilla citreola</i> (Pallas, 1776)	LC	+	+	-	-
57	White-browed Wagtail	<i>Motacilla maderaspatensis</i> (Gmelin, 1789)	LC	+	-	-	-
58	White Wagtail	<i>Motacilla alba</i> Linnaeus, 1758	LC	+	+	-	+
59	Red-vented Bulbul	<i>Pycnonotus cafer</i> (Linnaeus, 1766)	LC	+	+	+	+
60	Oriental Magpie Robin	<i>Copsychus saularis</i> (Linnaeus, 1758)	LC	-	+	-	+
61	Indian Robin	<i>Saxicoloides fulicatus</i> (Linnaeus, 1766)	LC	+	-	+	-
62	Grey Bushchat	<i>Saxicola ferreus</i> (Gray, 1846)	LC	-	+	-	+
63	Ashy Prinia	<i>Prinia socialis</i> (Sykes, 1832)	LC	-	+	-	+
64	Plain Prinia	<i>Prinia inornata</i> (Sykes, 1832)	LC	+	+	-	+
65	Common Tailorbird	<i>Orthotomus sutorius</i> (Pennant, 1769)	LC	-	+	-	+
66	Purple Sunbird	<i>Cinnyris asiaticus</i> (Latham, 1790)	LC	+	+	+	+
67	Indian Silverbill	<i>Euodice malabarica</i> (Linnaeus, 1758)	LC	-	+	-	-
68	Scaly-breasted Munia	<i>Lonchura punctulata</i> (Linnaeus, 1758)	LC	-	+	-	-
69	House Sparrow	<i>Passer domesticus</i> (Linnaeus, 1758)	LC	+	+	+	+
70	Sind Sparrow	<i>Passer pyrrhonotus</i> (Blyth, 1844)	LC	-	+	-	+
71	Baya Weaver	<i>Ploceus philippinus</i> (Linnaeus, 1766)	LC	-	+	-	+
72	Common Starling	<i>Sturnus vulgaris</i> Linnaeus, 1758	LC	+	-	-	-
73	Asian Pied Starling	<i>Gracupica contra</i> (Linnaeus, 1758)	LC	+	+	+	+
74	Common Myna	<i>Acridotheres tristis</i> (Linnaeus, 1766)	LC	+	+	+	+
75	Bank Myna	<i>Acridotheres ginginianus</i> (Latham, 1790)	LC	+	+	-	+
76	Black Drongo	<i>Dicrurus macrocercus</i> (Vieillot, 1817)	LC	+	+	-	+
77	House Crow	<i>Corvus splendens</i> (Vieillot, 1817)	LC	+	+	+	+
	Total			64	56	37	41

Recorded (+) Not Recorded (-)

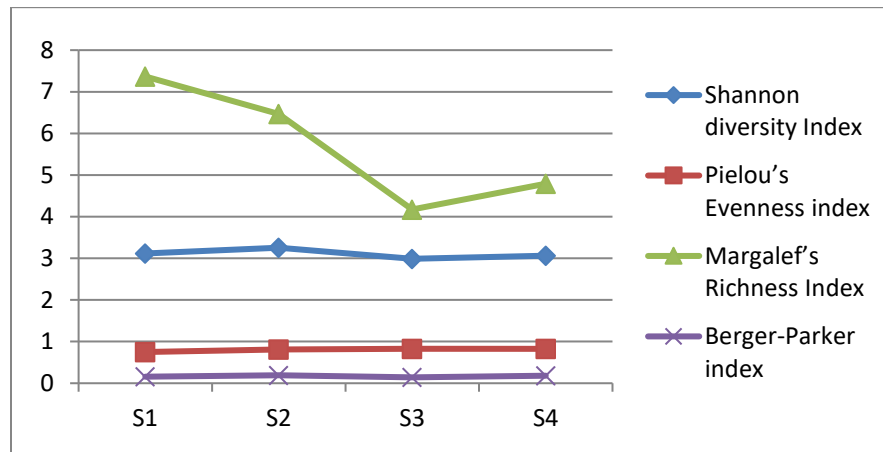


Figure 1 Species diversity, evenness, richness and dominance in study sites during year May 2016 to April 2020

The collected data subjected to Shannon-diversity index showed that all the study sites were high in diversity (Table 2). It has been calculated that site 2 (3.255) is highly diverse followed by site 1 (3.119), site 4 (3.061) and site 3 (2.989). Similarly, the values of Margalef's Richness Index showed that site 1 (7.367) have more number of species ($n=64$) than site 2 (6.469, $n=56$) followed by site 4 (4.793, $n=41$), site 3 (4.173, $n=37$) possess least number of species.

On the basis of Pielou's evenness index, it is found that all the study sites possess nearly even distribution and dispersal of species. All the values are near 1 i.e., site 3 (0.828) followed by site 4 (0.824), site 2 (0.809), site 1 (0.75) each. Berger-Parker index showed that higher the species dominance, the lesser the diversity is. It has also been revealed in present studies that site 2 (0.192) have higher index of dominance as compared to site 4 (0.183), site 1 (0.16) and site 3 (0.141).

Table 2 Measurements of avian diversity and richness at village ponds of district Ludhiana, Punjab

Diversity Indices	Study sites			
	S1	S2	S3	S4
Species number (N)	64	56	37	41
Shannon diversity Index	3.119	3.255	2.989	3.061
Pielou's Evenness index	0.75	0.809	0.828	0.824
Margalef's Richness Index	7.367	6.469	4.173	4.793
Berger-Parker index	0.16	0.192	0.141	0.183

4. DISCUSSION

The present study observed a considerable number ($n=77$) of bird species associated with village ponds of the district Ludhiana. Few studies have also been conducted in some other districts of Punjab and documented 64 species from 19 districts (Kler and Kumar, 2015), 35 and 24 bird species from two village ponds of district Barnala (Kaur et al., 2018), 25 bird species from Moga district (Soni et al., 2019) and 160 species from district Mohali (Brraich and Singh, 2021). All the species recorded comes under "Least Concern" category assigned by IUCN 2020.

As far as the population trend of these species at global level is concerned, it has been observed that some species namely Little Grebe *Tachybaptus ruficollis*, Lesser Whistling Duck *Dendrocygna javanica*, Northern Shoveler *Spatula clypeata*, Northern Pintail *Anas acuta* and Red-naped Ibis *Pseudibis papillosa* are quite common in the study area which show decreasing trend in their population at global level (IUCN Red List 2020). The presence of these species indicates that the study area provides suitable conditions for their survival.

Similarly, Northern Pintail previously considered as not common winter visitor of Punjab (Grimmett and Inskipp, 2010), is found as a very common winter visitor visiting these village ponds in the study area. Lesser Whistling Duck and Black-winged Stilt are some other species whose status has improved in the study area. The improvement in the status of Black-winged Stilt is due to its adaptability to use polluted sites as its nesting as well as feeding grounds.

However, conservation practices should be initiated in the study area because these village ponds are facing problems due to pollution, sewage disposal, garbage dumping and encroachment by weeds and construction of cemented walls which ultimately cause disturbance to the birds inhabiting these sites. The noise pollution is another factor for causing decline in bird species in the

study area. For example, study site 3 i.e., Malakpur village pond is surrounded by a religious place and use of loudspeakers and visits of pilgrims make it difficult for birds to cope up with such disturbances. Only 37 species of birds are recorded from this site and this number is lowest in all other studied pond sites.

The encroachment by some plant species like Water Hyacinth *Eichhornia crassipes* in village ponds also affects the presence of various bird species such as waders and herons etc. However, more individuals of Black-winged Stilt have been recorded from such sites. The anthropogenic activities at water bodies affect the distribution, foraging success, breeding success and ultimately the species richness (Beale and Monaghan, 2004; Rees et al., 2005; Palacio-Nunez et al., 2007; Thiollay, 2007). A considerable number of winter migrants (n=29) have also been recorded from the study area attributing to the geographic position of Punjab which occupies a strategic position in the migratory flyway of the birds (Toor et al., 1982).

Considering these threats to the birdlife in the study area, certain steps need to be taken such as the waste and garbage dumping in fresh water bodies like ponds must be prohibited to attract fresh water birds especially migratory birds. The infestation of weeds such as Water Hyacinth in water bodies must be prevented. Being an invasive species, it spreads all over the water bodies and hence affects the water birds preferring open water. Environmental awareness and educational programmes are also an important step to conserve these bird species.

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Informed consent

Not applicable.

Ethical approval & declaration

In this article, as per the animal regulations in Department of Zoology and Environmental Sciences, Punjabi University, India, the authors observed the Species richness and diversity of avian fauna at village ponds in district Ludhiana of Punjab, India. The Animal ethical guidelines are followed in the study for species observation, identification & experimentation.

Conflicts of interests

The authors declare that there are no conflicts of interests.

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Data and materials availability

All data associated with this study are present in the paper.

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