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Abundance and diversity of water bird assemblages in relation to village ponds in Punjab

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Abstract
The present study was designed to look into the abundance and trophic groups of birds inhabiting in and around the ponds of village Karamgarh (location I) and Sanghera (location II) of district Barnala, Punjab from January to December, 2017. The study results revealed a total bird count of 4108 individuals of 35 bird species belonging to 13 orders at location I and 2284 individuals of 24 bird species belonging to 8 orders at location II. The relative abundance (%) of water dependent birds was 70.44% and 37.30% at location I and II respectively. Detailed analysis showed significant difference between the water-dependent birds at both the locations (Student's t-test, t = 2.66, P = 0.05). The higher tree diversity and absence of weeds in and around the ponds at location I seemed to support higher avian species richness and abundance. Involvement of local community might help to check the anthropogenic activities for pond management and water bird conservation.

Keywords: Abundance, Village ponds, Water birds, Gruiformes, Passeriformes

1. Introduction
Water birds have attracted the attention of public and scientists because of their beauty, abundance, visibility and social behaviour [14]. They represent different guilds and can be used as indicators of environmental changes [18, 24, 22, 5]. Out of 1340 bird species found in India, 310 species are known to depend on different water bodies [15]. Kler [12] recorded 14 species of water birds out of sampled 51 species belonging to 25 families in 13 orders along the Sirhind Canal in Punjab. Water bodies like river, lakes, canals etc are the main foraging areas for these water bird species [7] and are found to be utilized extensively for nesting and roosting [29]. Their high productivity determines coexistence of several species [7]. Water birds comprise a large group of species including Anseriformes, Charadriiformes, Ciconiiformes, Gruiformes, Gaviformes, Pelecaniformes and Procellariformes [25]. Village ponds form an integral part of rural India which is primarily constructed for harvesting rain water and bathing of domestic livestock [2].They have been traditionally used as an economically efficient way to retain water for irrigation. Village ponds are visited by domestic cattle and also receive domestic waste from village households [28]. Water bird assemblage on these ponds depends upon conditions of the pond. Ponds support large number of migratory and resident bird species due to high nutritional value. The birds acquire important nutrients by feeding on benthic fauna and planktons [21]. Increased discharge of waste water from households, coupled with a low infiltration rate has inundated these ponds [2]. Many ponds have been lost and remaining face increasing pressure due to agricultural land drainage, pollution and urban development. Kler [11] recorded decline in the number of water-dependent bird species from 29 to 23 due to anthropogenic activities in ponds of eight villages over a period of six years in Punjab. The present study was designed to look into the species diversity of birds inhabiting in and around the ponds of village Karamgarh and village Sanghera of district Barnala in Punjab state, India. This would be helpful in providing information on the effects of anthropogenic activities on the terrestrial and water-dependent birds.

2. Materials and methods
2.1 Study Area
The present investigation was undertaken in the ponds of two villages namely village Karamgarh (latitude 30° 24' 43" N and longitude 75° 36' 23" E) as location I and village Sanghera (latitude 30° 23' 43" N and longitude 75° 33' 56" E) as location II of district Barnala, Punjab, India. The observations were taken in the months from January to December, 2017. Location I was

12.7 kilometers from district head quarters whereas location II was situated at a distance of 5 kilometers. The distance between two locations was 5.2 kilometers. The two locations differed in the number of ponds which were seven at location I and a single triangular pond at location II. Location I comprised of open-canopy ponds free from water weeds situated within the residential area of studied village. The surrounding area of pond was majorly covered by congress grass (*Parthenium hysterophorus*), bermuda (*Cynodon dactylon*) and giant pigweed (*Trianthema portulacastrum*) and was also utilized by the villagers for dumping animal waste. There were nine species of trees namely kikar (*Acacia nilotica*), neem (*Azadirachta indica*), peepal (*Ficus religiosa*), eucalyptus (*Eucalyptus oblique*), banyan (*Ficus benghalensis*), dhek (*Melia azedarach*), sheesham (*Dalbergia sisso*), mulberry (*Morus alba*) and lasura (*Cordia oblique*) at location I.The pond at location II, situated near human settlement, was completely covered by floating aquatic vegetation and the surrounding area had similar type of vegetation as location I. The tree plantation of the area consists of neem (*Azadirachta indica*), kikar (*Acacia nilotica*), peepal (*Ficus religiosa*), banyan (*Ficus benghalensis*) and eucalyptus (*Eucalyptus oblique*).

The observations were taken once in a week in the morning i.e. from 6 a.m. to 8 a.m. and evening i.e. from 4 p.m. to 6 p.m. During each visit, bird census was carried out. The point transect method was used to study the bird assemblage in the selected ponds. Identification of birds inhabiting and visiting the study area was done on the basis of visual observations on their morphological characters by using binocular (7/50). The movements of the birds was noted as precisely as possible so as to avoid pseudo replication. Bird photography was also done using camera Nikon d 3300. Birds were identified on the basis of keys described by Ali [1]. The checklist was prepared using standardized common and scientific names of the birds following [20]. Data collected on occurrences and abundance of bird was subjected to relative abundance as per Shannon-Wieners Index [13]. The bird species were divided into different trophic groups based on their food type: P- feeds on plant material; V/I- feeds on both vertebrates and invertebrates; I- invertebrates; and P/I- on both plants and invertebrates. The trophic groups were represented according to the proportion of number of individuals as well as number of species at both the locations. Graphical representation of dominance of individuals at both the location was also done.

2.2 Statistical analysis

Spearman rank correlation analysis was used to compare the number of individuals at both the locations. Mann-Whitney test was used to find significant variation among the number of individuals at both the locations. Student's t-test was carried out to find any significant difference between the numbers of individuals of water dependent birds at both the locations.

3. Results

A total of 36 species of birds belonging to 24 families distributed in 13 orders were recorded from the study area. There were counted 4108 birds belonging to 35 species at location I. Out of this, 15 species of birds were water dependent and 20 were terrestrial bird species. At location II, a total of 2284 birds were observed belonging to 24 species, out of which 9 species were water dependent and the rest were terrestrial bird species. There were twelve bird species exclusive to location I as compared to only one species exclusive to location II. Six water-dependent bird species were recorded only at location I. The bird species found at both the locations belonged to orders Charadriiformes, Gruiformes, Pelecaniformes, Anseriformes, Coraciiformes, Podicipediformes, Passseriformes, Psittaciformes, Columbiformes, Strigiformes, Cuculiformes, Apodiformes and Piciformes (Table 1). All the thirteen orders were present in the avian fauna of location I but only 8 orders were represented in the avian fauna of location II. Order Apodiformes, Strigiformes, Anseriformes, Podicipediformes and Piciformes were observed only at location I.

Table 1: Bird species composition observed at village Karamgarh and village Sanghera.

S. No	Name of the species	Scientific names	Order	Trophic level
1.	Black-winged Stilt	*Himantopus himantopus*	Charadriiformes	I
2.	Red-wattled Lapwing	*Vanellus indicus*	Charadriiformes	I
3.	Cattle Egret	*Bulbulcus ibis*	Pelecaniformes	V/I
4.	Smaller Egret	*Egreta garzetta*	Pelecaniformes	V/I
5.	Larger Egret	*Casmerodius albus*	Pelecaniformes	V/I
6.	White-breasted Waterhen	*Amaurornis phoenicurus*	Gruiformes	P/I
7.	White-breasted Kingfisher	*Halcyon smyrensis*	Coraciformes	V/I
8.	Indian Pond Heron	*Ardeola grayii*	Pelecaniformes	V/I
9.	Common Red Shank	*Tringa tetanus*	Charadriiformes	I
10.	Common Moorhen	*Gallinula chloropus*	Gruiformes	P/I
11.	Purple Moorhen	*Porphyrio porphyrio*	Gruiformes	P/I
12.	Spot-billed Duck	*Anas poecilorhyncha*	Anseriformes	P
13.	Little Grebe	*Tachybaptus ruficollis*	Podicipediformes	I
14.	Common Coot	*Fulica atra*	Gruiformes	P/I
15.	Oriental White Ibis	*Threskiornis melanocephalus*	Pelecaniformes	P/I
16.	Black Ibis	*Pseudibis papillosa*	Pelecaniformes	P/I
17.	Asian Pied Starling	*Sturnus contra*	Passeriformes	P/I
18.	Common Myna	*Acridotheres tristis*	Passeriformes	P/I
19.	Bank Myna	*Acridotheres ginginianus*	Passeriformes	P/I
20.	House Crow	*Corvus splendens*	Passeriformes	P/I
21.	Rose-ringed Parakeet	*Psittacula krameri*	Psittaciformes	P
22.	Yellow-legged Green Pigeon	*Treron phoenicoptera*	Columbiformes	P
23.	Eurasian Collared Dove	*Streptopelia decaocto*	Columbiformes	P
24.	Blue Rock Pigeon	*Columbia livia*	Columbiformes	P
25.	Little Green Bee-eater	*Merops orientalis*	Coraciformes	I
26.	Red-vented Bulbul	*Pycnonotus cafer*	Passeriformes	P/I

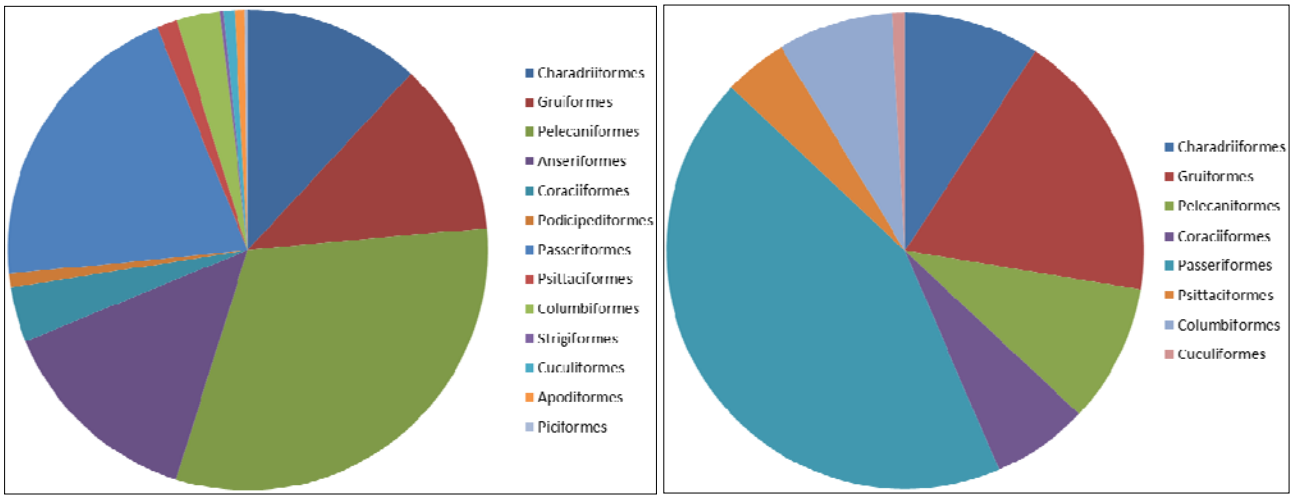
27.	Spotted Owlet	*Athene brama*	Strigiformes	V/I
28.	Indian Robin	*Saxicoloides fulicata*	Passeriformes	I
29.	Purple Sunbird	*Nectarinia asiatica*	Passeriformes	P/I
30.	Black Drongo	*Dicrurus macrocercus*	Passeriformes	P/I
31.	Greater Coucal	*Centropus sinensis*	Cuculiformes	V/I
32.	Indian Chat	*Cercomela fusca*	Passeriformes	I
33.	House Swallow	*Hirundo tahitica*	Passeriformes	I
34.	House Swift	*Apus affinis*	Apodiformes	I
35.	Golden-backed Woodpecker	*Dinopium javanense*	Piciformes	I
36.	Asian Koel	*Endynamys scolopacea*	Cuculiformes	P/I

The relative abundance of most numerous species on and around the ponds of location I was Spot-billed Duck (13.97%), Common Moorhen (13.49%), White-breasted Waterhen (11.51%), Cattle Egret (6.81%) and House Crow were having common relative abundance of 6.11%. While among the least abundant species were Yellow-legged Green Pigeon (0.19%) and Golden-backed Woodpecker (0.19%). Purple Moorhen with relative abundance of 8.98%, House Crow (8.84%), Cattle Egret (7.31%), Little Green Bee-eater (6.26%) and Common Myna (5.56%) were the dominant species at location II. Greater Coucal and White-breasted Kingfisher were the least abundant (Table 2).

Table 2: Characterstics of bird species composition observed at village Karamgarh and village Sanghera.

			Karamgarh		**Sanghera**	
S. No	**Name of the species**	**Scientific names**	**No. of individuals**	**Domiance**	**No. of individuals**	**Domiance**
1.	Black-winged Stilt	*Himantopus himantopus*	234	5.70	126	5.52
2.	Red-wattled Lapwing	*Vanellus indicus*	153	3.72	84	3.68
3.	Cattle Egret	*Bulbulcus ibis*	280	6.82	167	7.31
4.	Smaller Egret	*Egreta garzetta*	38	0.93	0	0.00
5.	Larger Egret	*Casmerodius albus*	31	0.75	0	0.00
6.	White-breasted Waterhen	*Amaurornis phoenicurus*	473	11.51	118	5.17
7.	White-breasted Kingfisher	*Halcyon smyrensis*	30	0.73	7	0.31
8.	Indian Pond Heron	*Ardeola grayii*	119	2.90	14	0.61
9.	Common Red Shank	*Tringa tetanus*	102	2.48	0	0.00
10.	Common Moorhen	*Gallinula chloropus*	554	13.49	97	4.25
11.	Purple Moorhen	*Porphyrio porphyrio*	214	5.21	205	8.98
12.	Spot-billed Duck	*Anas poecilorhyncha*	574	13.97	0	0.00
13.	Little Grebe	*Tachybaptus ruficollis*	38	0.93	0	0.00
14.	Common Coot	*Fulica atra*	43	1.05	0	0.00
15.	Oriental White Ibis	*Threskiornis melanocephalus*	0	0.00	34	1.49
16.	Black Ibis	*Pseudibis papillosa*	11	0.27	0	0.00
17.	Asian Pied Starling	*Sturnus contra*	69	1.68	71	3.11
18.	Common Myna	*Acridotheres tristis*	186	4.53	127	5.56
19.	Bank Myna	*Acridotheres ginginianus*	57	1.39	121	5.30
20.	House Crow	*Corvus splendens*	251	6.11	202	8.84
21.	Rose-ringed Parakeet	*Psittacula krameri*	57	1.39	98	4.29
22.	Yellow-legged Green Pigeon	*Treron phoenicoptera*	8	0.19	0	0.00
23.	Eurasian Collared Dove	*Streptopelia decaocto*	76	1.85	97	4.25
24.	Blue Rock Pigeon	*Columbia livia*	35	0.85	81	3.55
25.	Little Green Bee-eater	*Merops orientalis*	122	2.97	143	6.26
26.	Red-vented Bulbul	*Pycnonotus cafer*	50	1.22	118	5.17
27.	Spotted Owlet	*Athene brama*	10	0.24	0	0.00
28.	Indian Robin	*Saxicoloides fulicata*	52	1.27	100	4.38
29.	Purple Sunbird	*Nectarinia asiatica*	56	1.36	89	3.90
30.	Black Drongo	*Dicrurus macrocercus*	71	1.73	100	4.38
31.	Greater Coucal	*Centropus sinensis*	10	0.24	8	0.35
32.	Indian Chat	*Cercomela fusca*	35	0.85	65	2.85
33.	House Swallow	*Hirundo tahitica*	12	0.29	0	0.00
34.	House Swift	*Apus affinis*	28	0.68	0	0.00
35.	Golden-backed Woodpecker	*Dinopium javanense*	8	0.19	0	0.00
36.	Asian Koel	*Endynamys scolopacea*	21	0.51	12	0.53
			4108	100	2284	100

There was an observable difference in the relative abundance of water-dependent birds at both the locations. The relative abundance (%) of water dependent birds was 70.44% and 37.30% at location I and II respectively while the relative abundance of terrestrial birds was 29.56% and 62.70% at location I and II respectively. Detailed analysis showed significant difference between the water-dependent birds at both the locations (Student's t-test, $t = 2.66$, $P = 0.05$). Gruiformes appeared to be the most crowded order with relative abundance of 31.26% at location I and Passeriformes with relative abundance of 43.48% at location II. This was followed by the second most abundant order Passeriformes (20.42%) at location I and order Gruiformes (18.39%) at location II. Presence of abundant open-canopy ponds, absence of weeds and higher tree diversity seemed to favor the Gruiformes at location I (Fig. 1).



(A) **(B)**

Fig 1: Pie-chart representation of relative abundance of bird orders at location I (A) and location II (B).

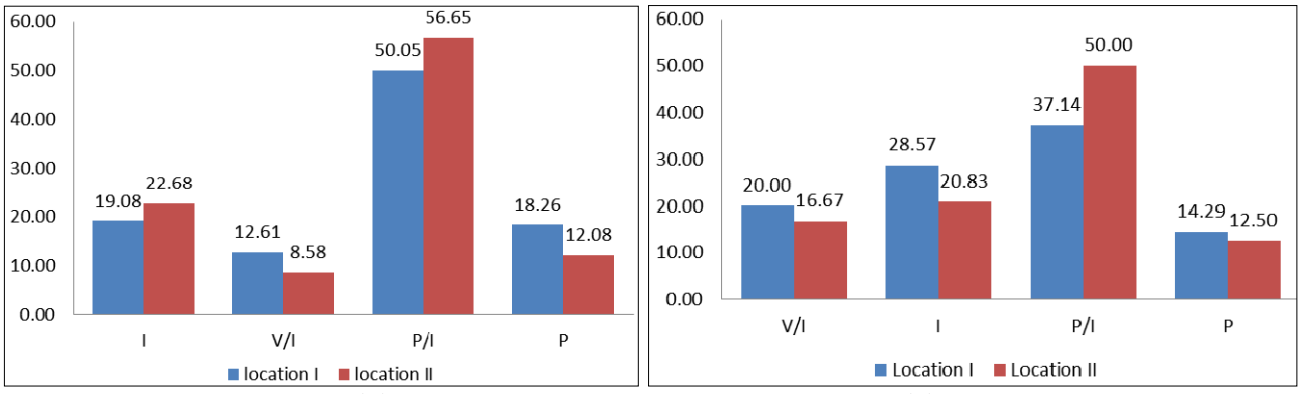
Comparison between the numbers of individuals of only those species which were present at both the locations was carried out. Correlation was found significant at 1% level of significance (Spearman correlation, N=22, ρ=0.627) (Table 3). There was no significant variation among the number of individuals at both the selected locations at 5% level of significance (Mann-Whitney Test, Z=0.957).

Table 3: Results of Spearman rank correlation analysis among Number of individuals observed at village Karamgarh and village Sanghera.

			Karamgarh	Sanghera
Spearman's rho	Karamgarh	Correlation coefficient N	1.000 22	0.627** 22
	Sanghera	Correlation coefficient N	0.627** 22	1.000 22

** Correlation is significant at the 0.01 level of significance (2-tailed)

The proportion of species and individuals at both the locations from various trophic groups of birds is represented graphically (Fig. 2). Plants and invertebrates (P/I) feeders were the dominant followed by invertebrates (I) feeders at both the locations. The abundance of bird individuals feeding on plants and invertebrates (P/I) was 50.05% and 56.65% ; abundance of individuals feeding on invertebrates was 19.08% and 22.68% at location I and II respectively. The proportion of species feeding on plants and invertebrates (P/I) was 37.14% and 50.00% at location I and II respectively while the proportion of species feeding on invertebrates was 28.57% and 20.83% at location I and location II respectively.



(A) **(B)**

Fig 2: Relative abundance (%) of individuals (A) and of species (B) within trophic groups of birds observed at the ponds of Location I (blue) and Location II (red). V/I -feeds on both vertebrates and invertebrates, I- invertebrates, P/I - feeds on plants and invertebrates, and P- plants.

4. Discussion

The present study had revealed that the number of water-dependent bird species, population count and bird orders were higher in open-canopy and managed ponds at location I as compared to weed filled ponds at location II. Gibbard *et al* [8] found that the unpolluted wetland maintained higher water bird density and diversity than polluted ones. It was further mentioned by him that anthropogenic activities affected habitat structure of an area which in turn affected natural property for insane water, wetland and biodiversity. Kler [11] had found decline in number of village ponds due to natural or man-made factors during a field survey conducted in village ponds. Different workers had stated that the water birds being generally at or near the top of most wetland food

chains were highly susceptible to habitat disturbances and therefore considered as good indicators of general condition of aquatic habitats [16, 8 and 9]. Briggs and Holmes [3] observed decrease in water level and filling of the village ponds had negatively affected the species richness and the species composition. Factors like rainfall, temperature humidity and cloudiness had influenced the density and diversity of water-dependent birds [3-4].

In the present study, higher tree diversity and absence of weeds at location I seemed to provide a variety of food resources, shelter from predators, roosting and nesting sites and protection from terrestrial predators. Animal wastes dumped near the ponds provided an additional and alternative nutrition rich diet for the visiting birds. According to Safran *et al* [27], the ecology of water birds have been closely related to the distribution and abundance of food resources and for many species of water birds benthic invertebrates were important dietary components that influenced habitat selection.

Anthropogenic activities, lesser tree diversity and proximity to state highway seemed to be the factors working negatively and resulted in lesser abundance, diversity and richness of birds at location II. Porte and Gupta [26] stated similar findings and mentioned that the disturbance due to various activities like alteration of agricultural practices and anthropogenic practices by human settlement, garbage dumping etc affected avian fauna at ponds. Mohan and Gaur [23] found that intense human activities in and around ponds were one of the factors disturbing the water birds in the ponds. Manikannan *et al* [21] also found that the water bird richness and abundance had seriously declined due to various ecological and anthropogenic factors. The present study showed suitable conditions for Purple Moorhen at location II feeding on garbage heaps. While the ponds at location I seemed to offer better conditions for Spot-billed Duck, Common Moorhen and White-breasted Water hen. Similar results were observed by Kumar *et al* [16]. He recorded Purple Moorhen only in the ponds with water hyacinth as they provided suitable roosting and nesting sites.

The loss and degradation of habitat had been stated to be the greatest threat to the long term survival of water birds [6]. Threat to the ponds due to filling, discharge of sewerage, throwing of domestic garbage, intentional/unintentional introduction of weeds like water hyacinth were the possible factors responsible for decline in the avian community in various ponds/water bodies [11]. According to Gupta *et al* [9], the extremely polluted water linked with dumping of each and every discarded item in the ponds had been recognized as threat to the water birds. The ponds that lacked human interference with less pollution along with providing basic needs i.e. food and shelter were found to have higher bird species [29]. Kupekar *et al* [17] stated that the major threat affecting bird population was the unrestricted habitat loss and degradation of aquatic surrounding due to human activities.

5. Conclusion

It could be concluded from the present study that the village ponds are an essential habitat for the water birds providing them nesting, feeding and breeding sites. So, an effective way to save these birds is to save their habitats. The anthropogenic activities like garbage dumping, filling of ponds and discharge of sewage have negatively affected the bird population. The weed filled ponds along with lower tree diversity possessed lesser bird count as compared to open-canopy ponds. The study showed significant difference between the water dependent bird species at both the locations. The present study emphasized the need for the revival of village ponds, their management, and maintenance of habitat heterogeneity as integral part of bird conservation programmes to check the decline of water dependent bird species in the farmlands of Punjab. Public participation should be given its due importance in agricultural and environmental policies both for rural rejuvenation but also for conservation of water dependent avian diversity.

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