

Avian diversity in pond ecosystems

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Abstract:

An ecosystem is a complex set of relationships among living resources, habitats and nature. India is blessed with a wide variety of ecosystems. But these are being disturbed increasingly. Of all animals, avians have been the well-known group with which the human beings associated for various purposes (food, communication, pollination, pets etc.). Also, birds are important for biological control in a number of cases.

Thus, an avifaunal diversity and abundance were studied in two managed ponds (those used for extensive fish culture) and in two unmanaged ponds (those that were not used for any commercial purpose). A total of thirty-two (32) species of birds were observed in this study conducted in February to April, 2011, belonging to ten (10) orders, namely **Passeriformes, Apodiformes, Piciformes, Ciconiformes, Anseriformes, Cuculiformes, Galliformes, Coraciiformes, Gruiformes, Psittaciformes**. The climatic and geophysical conditions of both the ponds are almost similar. The dominant orders of resident birds were Passeriformes, Cuculiformes, Coraciiformes with a frequency of occurrence 100%, the rest were Anseriformes and Gruiformes with a frequency of occurrence 50% and 25% respectively; while only one migratory bird *Anas acuta* (Anseriformes) with frequency of occurrence 25% was found in an unmanaged pond. Similarity Indices (Sorenson's Similarity Indices & Renkonen's Percentage Similarity Indices) and Diversity Indices (Shannon-Weiner Function) were calculated to check the differences between managed and unmanaged ponds. Between the two managed ponds, Similarity Indices were high (Sorenson's Similarity Indices-0.8; Renkonen's Percentage Similarity Indices 98%). The same was true for the two unmanaged ponds (Sorenson's Similarity Indices-0.74; Renkonen's Percentage Similarity Indices above 90%). However, Shannon –Weiner Function of species diversity showed a slightly higher value of 2.8 in unmanaged ponds against 2.4 in managed ponds. The comparative assessment therefore shows that a higher diversity of bird species was found in unmanaged ponds.

Key words: *Avifauna, Unmanaged ponds, Managed ponds, Similarity Indices, Diversity Indices, Avifaunal diversity.*

Introduction

Ornithological research has always played a central role in the development of certain aspects of our science. Birds are the most conspicuous and significant component of freshwater wetland ecosystem (Tabur and Ayvaz, 2010) and avian species richness is largely dependent upon the presence of water bodies of a particular area. The functional role of birds in the ecosystem is considered as potential pollinators and scavengers. Despite their importance for maintaining ecological balance, bird species are being threatened due to habitat loss, human persecution and introduced predators. Birds, being most diverse communities and living a variety of habitat niches, are potentially useful as indicators of habitat changes and for other conservation-oriented approaches. Measures of diversity are frequently used as indicators of the wellbeing of ecological systems. Understanding such dynamic patterns of diversity is dependent on the methods of estimation employed. If there are several methods to choose, it can sometimes be difficult to decide on the most suitable methods of measuring diversity. Here, one of the methods (i.e. Point Count method) was taken to make a comparative assessment relating to the diversity of bird species between managed (those used for extensive fish culture) and unmanaged (those that are not used for any commercial purpose) water bodies in a semi-rural area.

Therefore, the specific objectives are:

1. To catalogue the number of birds and tree species observed in the locality
2. To find the best time for bird's watching
3. Check for similarity and diversity indices for comparative assessment

Materials and methods

Study area:

The study was done in Nabagram Gram Panchayat area, situated in the west of Konnagar railway station in Hooghly district (**Figure 1**). Sites were selected by using topographic map collected from Nabagram Gram panchayat office and with the help of the Google earth. A total of 4 ponds were chosen for this research. The details of the ponds selected for this study

are provided in table 1 ponds were categorized into managed and unmanaged ponds. Both the managed ponds are used for commercial fishing. The managed ponds were maximally surrounded by cluster of bamboo trees and one of their banks is partially covered by the holdings, whereas the banks of unmanaged pond 1 and 2 are fully covered by the trees.

Methods used for the study:

Bird watching and recording of relevant data were carried out during the period from February to April, 2011. As the water bodies (managed) are in close approximation and the two ponds shared a common pond bank, birds perch and move on trees of all banks, thus, bird watching was done without differentiating respective water bodies. The observations were made by point count method, where the observer stopped for 2mins and recorded the bird species (Nur et al., 1999; Verma, 2000). Observation was made for five consecutive days from 6 AM to 12 Noon with the help of a binocular. Photographs of birds were taken by a Canon camera and the birds were identified by using standard books such as (*Books of Indian Birds* by Salim Ali (2002) and *The World Atlas of Birds*, Edited by Scott. P (2006).

Indices calculation and Statistical Analysis:

The following were calculated from the number counts recorded:

(i) Frequency (%) = T_1/T_2 [Where, T_1 = Total No. of pond in which species occur
 T_2 = Total No. of pond studied]

(ii) Abundance = Frequency/100

(iii) Diversity (Order) = T_s/ T_p [Where, T_s = Total No. of species found in pond
 T_p = Total No of found in one pond]

Species diversity and similarity indices were calculated following Krebs (1989) and Magurran (2004). The formulas are given below:

Species diversity was calculated using Shannon index. It was calculated from the equation:

(iv) $H' = \sum_{i=1}^s (p_i)(\log_2 p_i)$ [Where, H' = Information content of sample (bits/individual)
= Index of species diversity
 s = Number of species
 p_i = proportion of total sample belonging to *ith* species.]

Jaccard and Sorenson's Similarity Index and Renkonen's Percentage Similarity index for assessing the similarity between unmanaged pond 1 and 2 and managed pond 1 and 2. It was calculated from the equation:

- (v) Jaccard $C_j = j/a+b-j$ [Where, j = the no. of species found at both site A and B]
- (vi) Sorenson's $C_s = 2j/a+b$ a = the no. of species in site A and
b = the no. of species found in site B]
- (vii) Renkonen's $P = \sum \text{minimum} (p_{1i}, p_{2i})$
[Where, p = percentage similarity between site 1 and 2
 P_{1i} = Percentage of species I in community sample 1
 P_{2i} = Percentage of species I in community sample 1]

Statistical analysis (t-test between two groups) was also performed to compare between the pond types in respect of bird and tree species diversity.

Results and discussions

A total of thirty-two (32) species of birds distributed in 10 different orders were observed in this study. The list of bird species in accordance with their presence or absence are reported in **Table 2**. The bird species observed was slightly higher in unmanaged ponds (n= 45) than in managed ones (n=41). Overall the frequency dominance of orders, namely **Passeriformes, Apodiformes, Piciformes, Ciconiformes, Anseriformes, Cuculiformes, Gallifoemes, Coraciiformes, Gruiformes, Psittaciformes** were framed in a pie diagram in the **Figure 2a** and **2b** for unmanaged and managed pond respectively. The graph, irrespective of pond types, reflects that Passeriformes is the most frequently found order followed by Ciconiformes in unmanaged ponds and Piciformes in managed ponds. In **Figure 3**, overall comparative distribution (order wise) of species showed that birds belonging to 60% orders were found in unmanaged water bodies.

The dominant orders of resident birds were Passeriformes, Cuculiformes, Coraciiformes with a frequency of occurrence 100%, the rest were Anseriformes and Gruiformes with a frequency of occurrence 50% and 25% respectively; while only one migratory bird *Anas acuta* (Anseriformes) with frequency of occurrence 25% was found in an

unmanaged pond (**Table 3**). Among total number of bird species twenty-six ($n=26$) are residential, four ($n=4$) are residential-migratory and only two ($n=2$) are migratory (**Table 4**). Additionally, when the observation time is divided into 3 slots, it was interestingly found that 7 to 9 AM in the morning is the best time to observe birds for this locality (**Figure 4**). Simultaneously, the number of tree species were indirectly affected birds' diversity. Observation related to presence of tree species surrounding the ponds also suggested that managed ponds have a very less number of trees compared to unmanaged ones and the difference is significant (**Figure 5**). This might also indicate the presence of more disturbances in managed pond areas. Similarity Indices (Sorenson's Similarity Indices & Renkonen's Percentage Similarity Indices) and Diversity Indices (Shannon-Weiner Function) were calculated to check the differences between managed and unmanaged ponds and are reported in **Table 5 and 6** respectively. Between the two managed ponds, Similarity Indices were high (Sorenson's Similarity Indices-0.8; Renkonen's Percentage Similarity Indices 98%). The same was true for the two unmanaged ponds (Sorenson's Similarity Indices-0.74; Renkonen's Percentage Similarity Indices above 90%), thereby showing similarity between the two managed and two unmanaged ponds. Though similarity was more observed in managed compared to unmanaged ponds. However, Shannon –Weiner Function of species diversity showed a slightly higher value of 2.8 in unmanaged ponds against 2.4 in managed ponds may indicate bird diversity was slightly higher in unmanaged ponds. However, no significant difference was found between the two diversity measure. But when we observed the difference day-wise the number of bird species was significantly high in unmanaged ponds.

Though the climatic and geophysical conditions of both the ponds are almost similar, there are differences in terms of biodiversity elements. Fish eating birds like Kingfisher were found more in managed ponds. Due to the excessive interruption of fisherman, numbers of trees surrounding the pond banks were low. The unmanaged ponds on the other hands maintain their natural vegetation because these water bodies were not used for any commercial purpose. Thus, the comparative assessment therefore shows that a higher diversity of bird species was found in unmanaged ponds.

Other studies related to avian diversity in aquatic ecosystem also showed Passeriformes as dominant order of birds (Patra & Chakrabarti 2014; Rahalkar & Tiwari 2014) and birds were found to be different with varying habitats (Kumar and Gupta 2009). Village and semi urban ponds were also reported as a representative niche of bird species as our results revealed

(Rahalkar & Tiwari 2014). Similar to our study, conservation risks of birds in ponds due to human activities was also reported by Kumar and Gupta in 2009 and future of this avian fauna is in danger due to unchecked growth of different areas around water waterbodies (Patra & Chakrabarti 2014).

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Tables and Figures

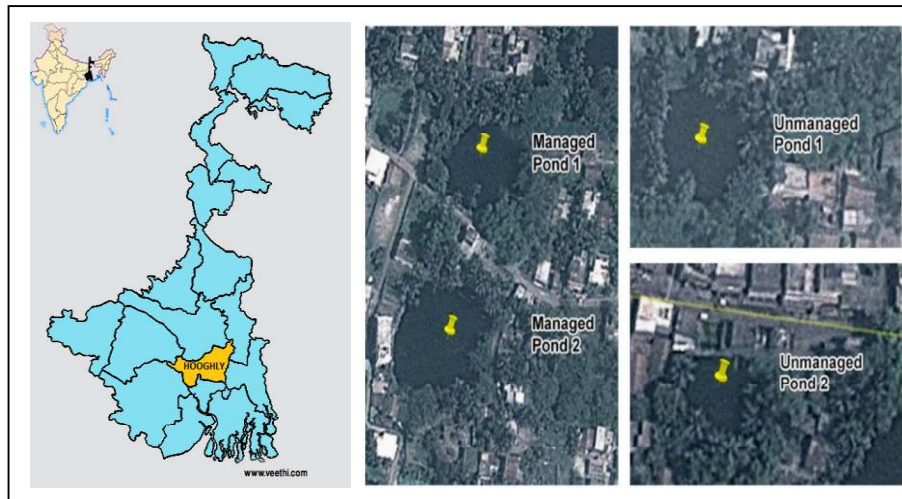


Figure 1. Study sites

Table 1. Location of study sites (managed and unmanaged ponds)

	Ponds	Location	Latitude	Longitude	Diameter	Distance from the Konnagar Railway Station
Unmanaged	Pond 1	Kanaipur , Hooghly District	22° 42' 7.31°N	88° 19' 33.97°E	100ft/60ft	1.5 kms
	Pond 2	Kanaipur , Hooghly District	22° 41' 53.16°N	88° 19' 25.06°E	60ft/40ft	1.5 kms
Managed	Pond 1	Bansai, Hooghly District	22° 42' 5.19°N	88° 19' 1.08°E	110ft/90ft	2 kms
	Pond 2	Bansai, Hooghly District	22° 42' 3.08°N	88° 19' 0.95°N	125ft/80ft	2 kms

Table 2. List of avifauna according to their presence absence in the study sites

Sl.No	Name of the species	Common name	Order	Unmanaged		Managed	
				pond 1	pond 2	pond 1	pond 2
1	<i>Copsychus saularis</i>	Oriental magpie robin	Passeriformes	+	+	+	+
2	<i>Passer domesticus</i>	House crow	Passeriformes	+	-	+	+
3	<i>Streptopelia chinensis</i>	Spotted dove	Galliformes	+	+	+	+
4	<i>Dicurus macrocercus</i>	Black drongo	Passeriformes	+	+	+	+
5	<i>Megalaima hemacephala</i>	Copper smith barbet	Piciformes	-	-	+	+
6	<i>Orthotomus sutorius</i>	Common tailor	Passeriformes	+	+	+	+
7	<i>Dendrocitta vagabanda</i>	Tree pie	Passeriformes	+	-	+	+
8	<i>Acridotherus tritis</i>	Common mayna	Passeriformes	+	+	+	+
9	<i>Oriolus chinensis</i>	Black headed oriole	Passeriformes	+	+	-	-
10	<i>Halcyon smyrnensis</i>	White breasted kingfisher	Coraciformes	+	+	+	+
11	<i>Dinopium benghalense</i>	Lesser golden black woodpecker	Piciformes	-	-	+	+
12	<i>Pelecanus onocrotalus</i>	Great white pelican	Ciconiformes	+	-	+	-
13	<i>Bubulcus ibis</i>	Cattel egret	Gruiformes	+	-	-	-
14	<i>Psittacula krameri</i>	Rose ringed parakeet	Pssittaciformes	+	+	-	-
15	<i>Psittacula eupatris</i>	Alexandrine parakeet	Pssittaciformes	+	+	-	+
16	<i>Ardeola grayii</i>	Indian pond heron	Ciconiformes	+	+	+	+
17	<i>Aythya ferina</i>	Common poachard	Anseriformes	+	+	-	-
18	<i>Dryocopus javensis</i>	Great black woodpeaker	Piciformes	+	-	+	-
19	<i>Pericrocotus flammens</i>	Scarlet Minivet	Passeriformes	-	-	+	+

20	<i>Pycnonotus cafer</i>	Red vented bulbul	Passeriformes	+	+	+	+
21	<i>Sturnus contra</i>	Asian pied starling	Passeriformes	+	-	-	+
22	<i>Glucidium radiatum</i>	Jungle owlet	Apodiformes	+	-	+	-
23	<i>Eudynamys scolopacea</i>	Asian Koel	Cuculiformes	+	+	+	+
24	<i>Columba livia</i>	Pegion	Galliformes	+	+	+	-
25	<i>Passer domesticus</i>	House sparrow	Passeriformes	+	+	-	-
26	<i>Fulica atra</i>	Common coot	Anseriformes	+	-	+	+
27	<i>Centropus sinensis</i>	Greater coucal	Cuculiformes	-	+	+	+
28	<i>Anus acuta</i>	Bali hans	Anseriformes	+	-	-	-
29	<i>Turdiodes caudatus</i>	Common babbler	Passeriformes	-	+	-	-
30	<i>Cypsiurus balasinensis</i>	Palm swift	Apodiformes	+	+	-	-
31	<i>Milvus migrans</i>	Black Kite	Ciconiformes	+	-	+	-
32	<i>Corvus corax</i>	Common raven	Passeriformes	+	+	+	+
Total No. of species				27	18	22	19

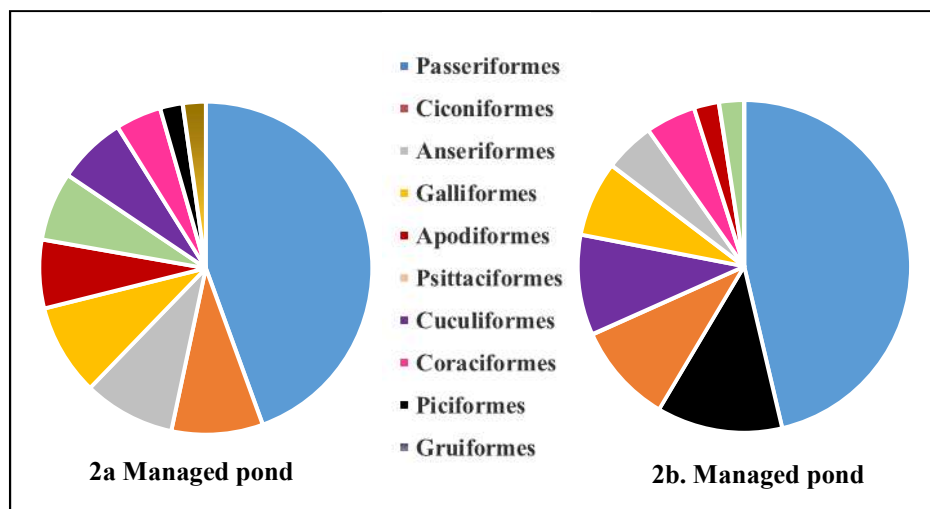


Figure 2. Order frequency of bird species found in Unmanaged (a) and managed ponds (b).

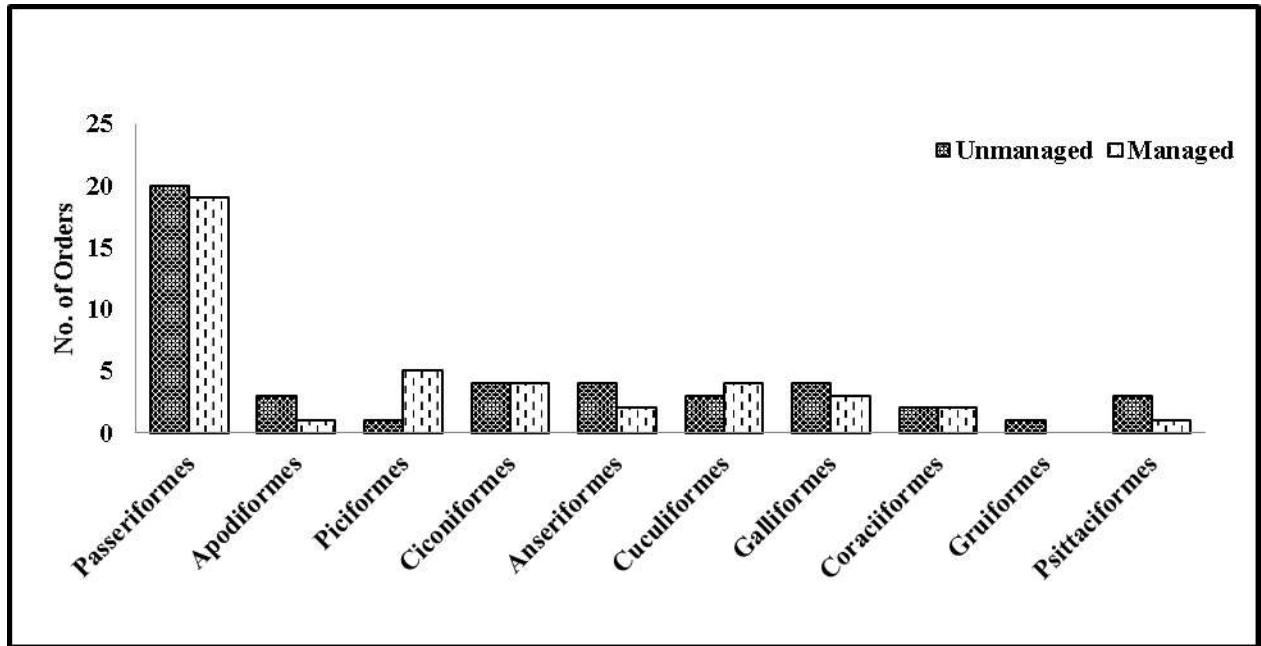


Figure 3. Order wise distribution of bird species in unmanaged & managed water bodies

Table-3 Frequency and abundance of avifauna recorded around four studied ponds (two unmanaged and two managed)

Sl.No	Name of the species	Common name	Order	Habitat	Frequency	Abundance
1	<i>Copsychus saularis</i>	Oriental magpie robin	Passeriformes	R	100%	1
2	<i>Passer domesticus</i>	House crow	Passeriformes	R	75%	.75
3	<i>Streptopelia chinensis</i>	Spotted dove	Galliformes	R	100%	1
4	<i>Dicurus macrocercus</i>	Black drongo	Passeriformes	R	100%	1
5	<i>Megalaima hemacephala</i>	Copper smith barbet	Piciformes	R	50%	.50
6	<i>Orthotomus sutorius</i>	Common tailor	Passeriformes	R	100%	1
7	<i>Dendrocitta vagabanda</i>	Tree pie	Passeriformes	R	75%	.75
8	<i>Acridotherus tritis</i>	Common mayna	Passeriformes	R	100%	1

9	<i>Oriolus chinensis</i>	Black headed oriole	Passeriformes	RM	50%	.50
10	<i>Halcyon smyrnensis</i>	White breasted kingfisher	Coraciformes	R	100%	1
11	<i>Dinopium benghalense</i>	Lesser golden black woodpecker	Piciformes	R	50%	.50
12	<i>Pelecanus onocrotalus</i>	Great white pelican	Ciconiformes	RM	50%	.50
13	<i>Bubulcus ibis</i>	Cattel egret	Gruiformes	RM	25%	.25
14	<i>Psittacula krameri</i>	Rose ringed parakeet	Pssittaciformes	R	25%	.25
15	<i>Psittacula eupatris</i>	Alexandrine parakeet	Pssittaciformes	R	50%	.50
16	<i>Ardeola grayii</i>	Indian pond heron	Ciconiformes	R	100%	1
17	<i>Aythya ferina</i>	Common poachard	Anseriformes	M	50%	.50
18	<i>Dryocopus javensis</i>	Great black woodpeaker	Piciformes	R	25%	.25
19	<i>Pericrocotus flammens</i>	Scarlet Minivet	Passeriformes	R	50%	.50
20	<i>Pycnonotus cafer</i>	Red vented bulbul	Passeriformes	R	100%	1
21	<i>Sturnus contra</i>	Asian pied starling	Passeriformes	R	50%	.50
22	<i>Glucidium radiatum</i>	Jungle owlet	Apodiformes	R	50%	.50
23	<i>Eudynamis scolopacea</i>	Asian Koel	Cuculiformes	R	100%	1
24	<i>Columba livia</i>	Pegion	Galliformes	R	75%	.75
25	<i>Passer domesticus</i>	House sparrow	Passeriformes	R	50%	.50
26	<i>Fulica atra</i>	Common coot	Anseriformes	RM	75%	.75
27	<i>Centropus sinensis</i>	Greater coucal	Cuculiformes	R	75%	.75
28	<i>Anus acuta</i>	Bali hans	Anseriformes	M	25%	.25
29	<i>Turdiodes caudatus</i>	Common babbler	Passeriformes	R	25%	.25
30	<i>Cypsiurus balasinensis</i>	Palm swift	Apodiformes	R	50%	.50

31	<i>Milvus migrans</i>	Black Kite	Ciconiformes	R	50%	.50
32	<i>Corvus corax</i>	Common raven	Passeriformes	R	100%	1

R= residential

M= Migratory

RM= Residential Migratory

Table 4. Number of species and their Frequency of Occurrence found in the two pond types based on their Habitats

Habitats	Number of species	Managed ponds		Unmanaged ponds	
		No. of species	Freq. of occurrence	No. of species	Freq. of occurrence
Residential (R)	26	11	100 50	15	100 75 50
Residential-Migratory (RM)	4	-	50	4	-
Migratory (M)	2	-	-	2	50 25

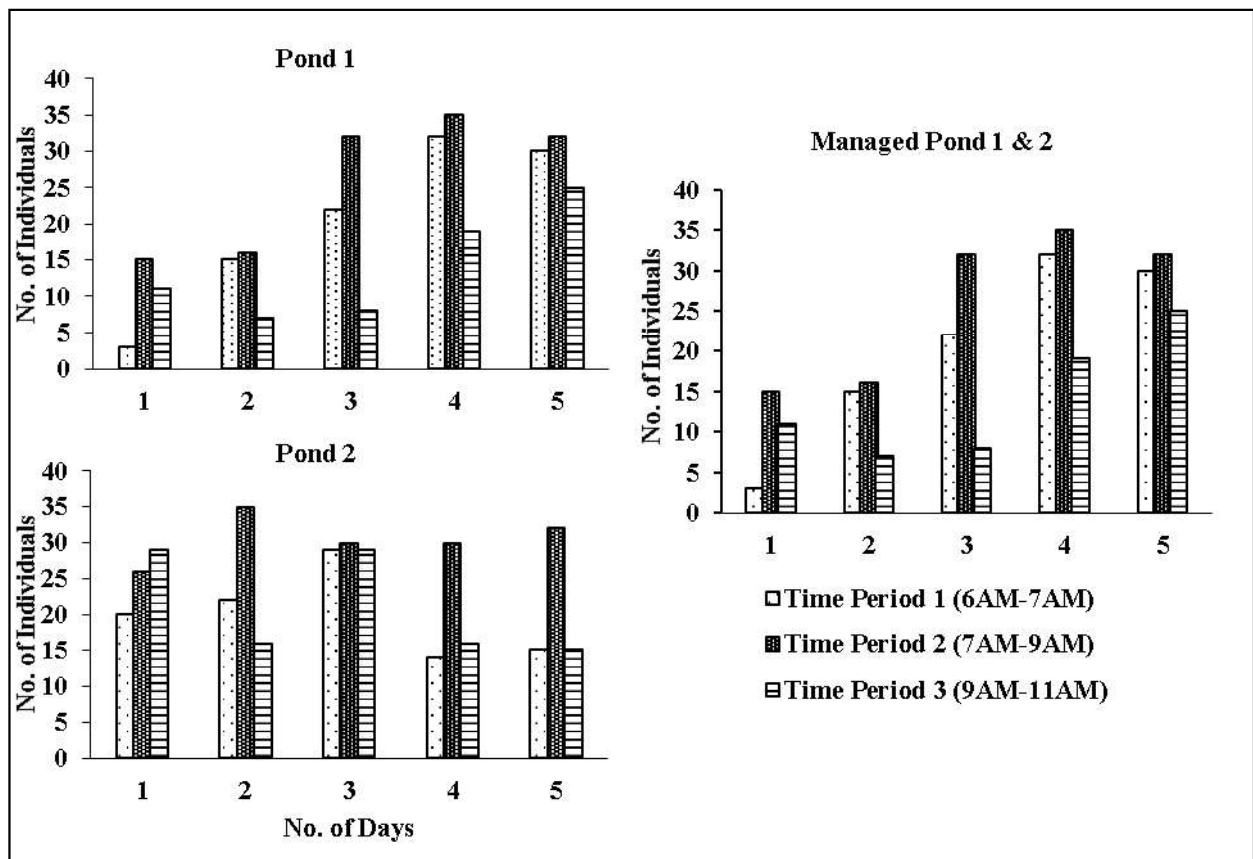


Figure 4. Showing the best time for bird watching.

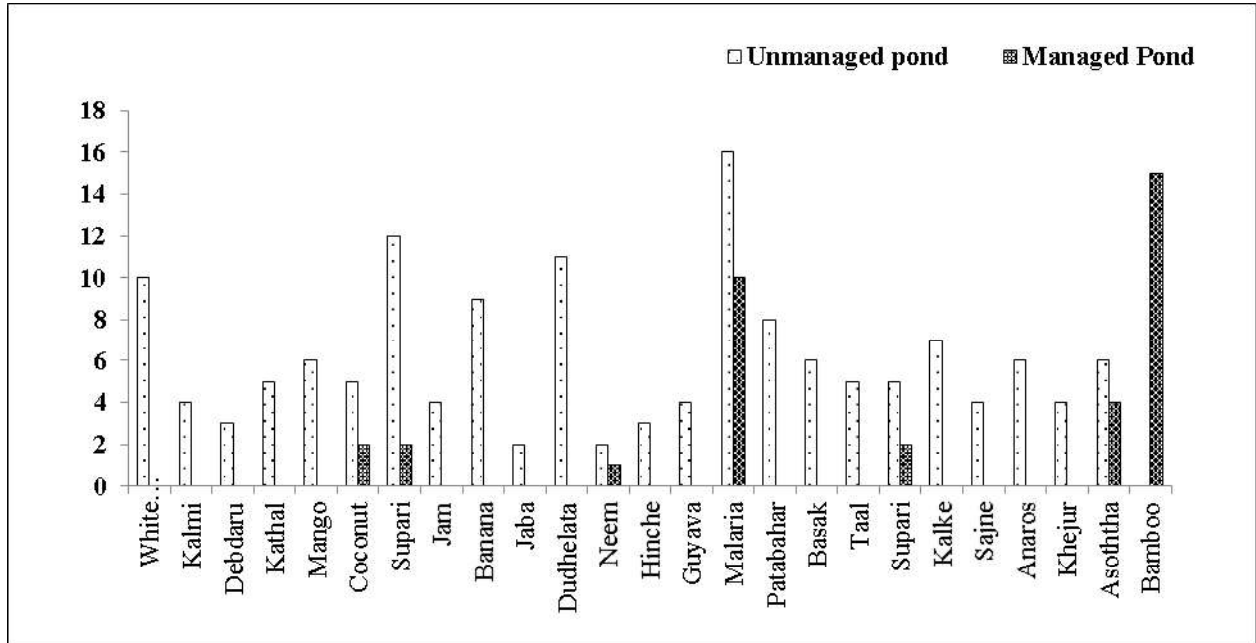


Figure 5. Comparative assessment of number of trees in the managed and unmanaged pond types.

Table5. Similarity Indices between two managed ponds and two unmanaged ponds

Similarity Indices			
Sl.No.	Name of the Indices	Value	
		Managed Pond	Unmanaged Pond
1	Jaccard Similarity Indices ($C_j = j/a+b-j$)	0.8	0.6
2	Sorenson's Similarity Indices ($C_s = 2j/a+b$)	0.8	0.7
3	Renkonen's Percentage Similarity Indices [$P = \sum \text{minimum}(p_{i1}, p_{i2})$]	98	90

Table-6 Diversity Indices between managed and unmanaged ponds

Diversity Indices			
Name of the Indices	Value (in bits per individual)		
Shanon-Weiner Function $[H' = \sum p_i \ln(p_i)]$	Unmanaged Pond 1	Unmanaged Pond 2	Managed pond 1 & 2
	2.77	2.69	2.45

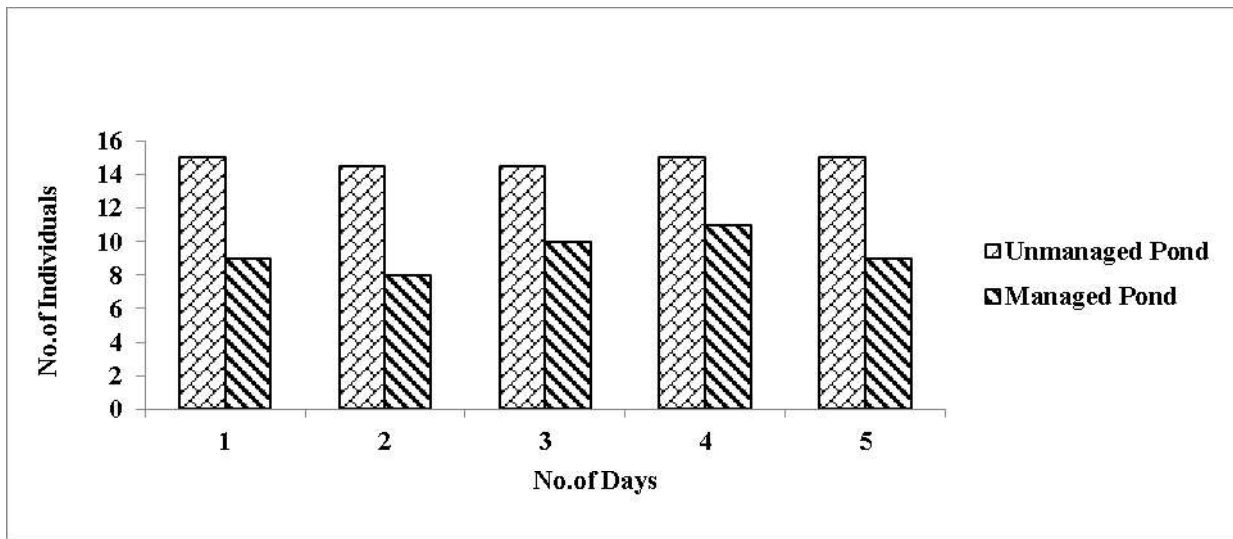


Fig.6 Comparative figures of bird's species diversity found in unmanaged & managed water bodies