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Community Structure and Population Dynamics of Aquatic Avifauna of Gharana Wetland (Reserve), Jammu, India

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Abstract

The present piece of work has been conducted (2008-09) on Gharana Wetland (Reserve) to determine the seasonal diversity and population dynamics of aquatic avifauna. The study revealed the occurrence of 21 species belonging to 5 orders and 6 families, out of which 6 species were resident, 14 species were migratory and 1 species was occasional visitor. Among migratory aquatic avifauna, 8 species were wintering and 6 species were transients. The highest number of species (18 species) was found in Novemberand February. November had the highest (10673 individuals) and July had the lowest (44 individuals) waterbird population. During November, Bar-headed Goose Anserindicuscontributed 92.01% (9820 individuals) to the total population of 10673 individuals. Family Anatidae accounts for 87.94% of the waterbird count. Various ecological indices as well as statistical methods have also been applied to comment on the community structure of the aquatic avifauna.

Keywords: Community, population, aquatic avifauna, wetland.

Introduction

Wetlands are the areas of marsh, fern, peatland or water, whether natural or artificial; permanent or temporary; with water that is static or flowing; fresh, brackish or salt; including areas of marine water, the depth of which at low tides does not exceed six meters[1]. Wetlands constitute the most productive ecosystems of the world with specific ecological characteristics, functions and values. Their high productivity places them among the richest and most biologically diverse ecosystems in the world[2-3]. Most of the wetlands in India are host to rare, threatened and endangered species of flora and fauna[4]. Waterbirds constitute an important component of wetlands. The diversity of the waterbirds is an indication of the congenial habitat for survival and depicts the various ways of life possible for them in wetlands[5-6].

Ornithological studies indicate that of about 350 taxa out of 2060 taxa, known from the Indian sub-continent, are migrants; including both terrestrial and aquatic birds. Generally, Most of these birds breed outside the sub-continent in the Palaearctic region. India has a rich variety of wetland habitats which provide wintering grounds for these migratory waterbirds. The most copious and remarkable winter migrants to the Indian sub-continent are the ducks and geese (Anatidae) which constitute about 85% of the migrant bird populations, out of approximately 3 million birds[1,7].

Gharana Wetland (Reserve) is one of the important wetland reserves of Jammu region of Jammu and Kashmir state and serves as feeding, resting and wintering grounds for large number of migratory waterbirds during their Palaearctic to Oriental migration. In the present paper, an attempt has been made to evaluate the community structure of aquatic avifauna of Gharana Wetland in different periods of the year, so that proper conservatory measures can be adopted by the wildlife authorities for the preservation of the wetland in accordance with the particular requirements of the avifauna in their habitat.

Material and Methods

Study Area: Gharana Wetland (Reserve) 32º 32′ 26″ N, 74º 41′ 24″ E is irregular in shape, covering approximately 1km^2 surface area and is situated in subtropical Jammu and Kashmir State, North western India (~) 10 miles east of the Indo-Pakistan International border (figure 1). The Wetland is declared as 'Important Bird Area' and is under J and K Wildlife Protection Act, 1978. The wetland lies along the Palaearctic - Oriental migratory route of aquatic birds and serves as a wintering ground for many bird species from Central Asia. It is surrounded by 'Gharana' village on its one half and by agricultural fields along its other side. The present study was conducted from March, 2008 to February, 2009.

Identification: Survey of the wetland to study the aquatic avifauna was conducted by using binocular (Bushnell Costom 10X50) mounted on a tripod at 4-5 day intervals. Birds were counted by four 'main' observers at a time from the terrace of houses near the wetland. An experienced observer was deployed to each 'main' observer to avoid double counting of the birds while they move. Due to the lack of emergent vegetation, it did not interfere with the visibility of the birds during counting. The avifauna thus, observed was identified with the help of pertinent literature: "Birds of the Indian Subcontinent"[8], "A Field Guide

to the Birds of India"[9], "Waterbirds of Northern India"[10], "The Book of Indian Birds"[11] and "A Photographic Guide to the Birds of India"[12].

Census: Census of aquatic avifauna was made during day-time, from 0930h to 1700h, with the help of binocular by Line Transect method[13-14]. Four transects each of 500 m were traversed for counting the birds. Block Count method[14] was adopted for estimating aquatic birds present in dense flocks either in flight or on ground. Each block was about 200 m^2.

Statistical methods: Species diversity was determined by applying Shannon-Weaver Diversity Index[15], $H' = -\sum_{i=1}^{s} pi \ln(pi)$, in which H is the information content of sample (bits/individuals), Sis the number of species and p_i is the proportion of total species belonging to i^{th} species. Simpson's Index of dominance (C) was calculated according to Stone and Pence[16], $C = \sum_{i=1}^{s} pi^2$, where p_i is the proportion of total number of individuals of each species. Species richness was determined applying Marglef's Index[17], $d' = S - 1/\text{Log}_n (N)$, in which S is the total number of species, N is the total number of individuals in sample and Log_n is the Natural log. Evenness was calculated using the Pielou's Index[18], E = H'/ln S, where H' is the Index of diversity of Shannon-Weaver, lnis the Natural log and S is the total number of species.

Percentage similarity of the bird communities in different seasons was calculated by Sorenson's Quotient of Similarity[19], $Q/S = 2j/a + b\ (100)$, where j is the number of species common to both samples, a is the total number of species in sample 1 and b is the total number of species in sample 2. Morisita-Horn Index[20] was applied to determine the similarity of bird communities in different seasons in terms of abundance using the formula: $MH = 2\sum_{i=1}^{n}(Nia\ Nib)/(da + db)\ NaNb$, in which N_{ia} and N_{ib} number of individuals of species 'i' in the samples for site a and b, N_a and N_b are the number of individuals in the samples from sites a and b and n is thetotal number of species.

Chi-square test was applied to test the dependency of species richness on the months[21]. Diversity indices were correlated using Karl Pearson's Coefficient of Correlation which was tested at 5% level using Student-t test. Correlation coefficient and Student-t test was calculated with the help of Microsoft Excel (MS Office, 2007) and SPSS Software (Ver. 16.0).

Results and Discussion

Diversity: During the present study, a total of 21 species belonging to 5 ordersand 6 families were recorded (table 1). Highest number of species (7 species) belonged to Family Ardeidae followed by 6 species to Family Anatidae, 3 species to Family Rallidae and Charadriidae each and 1 species to Family Phalacrocoracidae and Laridae each. Singh[22] and Sharma[23] have recorded 14 and 24 species respectively from Gharana Wetland while Singh[24] had presented the records of 43 species of aquatic avifauna from this wetland. During the present study period, only 21 species of the waterbirds were recorded. No species from Family Podicipitidae, Ciconidae, Threskiornithidae and Recurvirostridae were observed during the present study.

Figure-1
Map of Gharana Wetland (from Google)

Table-1
Aquatic Avifauna inhabiting Gharana Wetland (Reserve)

Name of the Bird	Common Name	Order	Family	Status
Amaurornisphoenicurus	White-breasted Waterhen	Gruiformes	Rallidae	Resident
Porphyrioporphyrio	Purple Moorhen	Gruiformes	Rallidae	Resident
Fulicaatra	Common Coot	Gruiformes	Rallidae	Transient
Anascrecca	Common Teal	Anseriformes	Anatidae	Transient
Anasstrepera	Gadwall	Anseriformes	Anatidae	Wintering
Anasclypeata	Northern Shoveller	Anseriformes	Anatidae	Transient
Anas Penelope	Eurasian Wigeon	Anseriformes	Anatidae	Transient
(Anasacuta	Northern Pintail	Anseriformes	Anatidae	Wintering
Anserindicus	Bar-headed Goose	Anseriformes	Anatidae	Transient
Ardeacinerea	Grey Heron	Ciconiformes	Ardeidae	Wintering
Ardeapurpurea	Purple Heron	Ciconiformes	Ardeidae	Wintering
Ardeolagrayii	Pond Heron	Ciconiformes	Ardeidae	Resident
Bubulcus ibis	Cattle Egret	Ciconiformes	Ardeidae	Resident
Casmerodius alba	Large Egret	Ciconiformes	Ardeidae	Wintering
Egrettagarzetta	Intermediate Egret	Ciconiformes	Ardeidae	Wintering
Egrettaintermedia	Little Egret	Ciconiformes	Ardeidae	Resident
Phalacrocoraxniger	Little Cormorant	Pelecaniformes	Phalacrocoracidae	Wintering
Vanellusindicus	Red Wattled Lapwing	Charadriiformes	Charadriidae	Resident
Vanellusleucurus	White tailed Lapwing	Charadriiformes	Charadriidae	Transient
Tringa tetanus	Common Red Shank	Charadriiformes	Charadriidae	Wintering
Sterna aurantia	Indian River Tern	Charadriiformes	Laridae	Occasional Visitor

Gharana Wetland was subjected to continuous anthropogenic pressure in the form of cattle bathing, washing of clothes and vehicles, entry of domestic sewage and cattle waste, drawing of water by electric motor, hunting, fishing, expansion of agricultural fields towards wetland etc. Man wildlife conflict was also encountered among the villagers as the waterbirds used to destroy their crops in the nearby agricultural fields by foraging over them. On the consequence of this, villagers started scaring campaigns by exploding crackers near the waterbirds to make them fly from the wetland and thereby, directly posing stress on them. Rice fields can provide important waterbird habitat from perspectives of food quality and quantity[25-26] as they provide natural food in the form of moist-soil plant seeds, aquatic invertebrates and green forage[27]. Decline in the waterbird number due to human disturbance[28] in the form of scaring campaigns has also been suggested by Klaassenet al.[29]. The absence of ob.cit. families resulting in the decline in the number of species clearly indicated the possibility of degradation of the habitat conditions. Waterbirds in Gharana Wetland that used to procure their additional food from the rice fields flanking the wetland was principally the main reason behind deliberate interference to the waterbirds by the villagers who had to face a great loss in their crop production.

Out of 21 species, 6 species were categorized as resident, 14 species as migratory and 1 species as occasional visitor. Resident species were White-breasted waterhen, Purple Moorhen, Pond Heron, Cattle Egret, Little Egret and Red-wattled Lapwing. Among migratory waterbirds, two sub-categories were recognized as Transients and Wintering. 6 species of waterbirds *viz.* White tailed Lapwing, Common Coot, Common Teal, Northern Shoveller, Eurasian Wigeon and Bar-headed Goose were categorized as Transients which comprised of those waterbirds which utilized the wetland as stop-over sites. They visited the wetland during their Palaearctic to Oriental journey, stayed there and then migrated southwardly. They again visited the wetland during their Oriental to Palaearctic journey. Wintering waterbirds included those which visited the wetland during their winter migration, utilized the wetland for few months and then returned to their native place. 8 species of waterbirds *viz.* Northern Pintail, Gadwalls, Grey Heron, Purple Heron, Intermediate Egret, Large Egret, Little Cormorants and Common Red Shank were recognized as Wintering waterbirds. Indian River Tern was kept under Occasional visitor which visited the wetland occasionally.Various authors have categorized the avifauna into different categories. Categorization of aquatic avifauna as residents, transients, wintering and local migrants has been opined by Sharma[23]. Xu and Zhao[30] also categorized the waterbirds of Chongming Dongtan Nature Reserve as residents, transients, winter migrants and summer breeders.

Population Dynamics: A well marked seasonal variation in waterbird population was recorded during the present study period. The highest number of waterbird species (18) was found in November, 2008 and February, 2009. Summer months (May, June and July, 2008) had the lowest number of waterbird species (6 species). Monthly records of waterbird population exhibited a peak in water bird population (10673 individuals) in November, 2008 whereas lowest count (44 individuals) was

observed in July, 2008 (table 2, figure 2). Waterbird population in March, 2008 and from August, 2008 to February, 2009 remained higher due to the presence of large number of migratory waterbirds. Highest diversity in winter months was attributed to the influx of migratory waterbirds during this season. Least diversity in the summer months was ascribed to the absence of migratory waterbird species. Giri and Chalise[21] have also recorded the greater diversity in winter months due to the addition of migratory birds in this season. Annual percent contribution of different families of aquatic avifauna were recognized as Anatidae>Charadriidae>Phalacrocoracidae> Ardeidae>Rallidae>Laridae (figure 3).

Table-2
Seasonal variations in Aquatic Avifauna of Gharana Wetland (Reserve)

Name of the Bird	Spring	Summer	Autumn	Winter	Annual Count	Mean ± sd
White-breasted Waterhen	2	6	3	5	16	1.33 ± 0.47
Purple Moorhen	28	27	16	76	147	12.25 ± 9.29
Common Coot	12	0	42	77	131	10.29 ± 12.05
Common Teal	0	0	160	477	637	53.08 ± 67.83
Gadwall	54	0	0	342	396	33 ± 46.77
Northern Shoveller	0	0	0	299	299	24.92 ± 49.57
Eurasian Wigeon	0	0	0	108	108	9 ± 23.84
Northern Pintail	0	0	0	32	32	2.67 ± 8.84
Bar-headed Goose	0	0	0	13212	13212	1101 ± 2730.37
Grey Heron	0	0	2	10	12	1 ± 1.29
Purple Heron	3	0	0	15	18	1.5 ± 2.36
Pond Heron	9	22	12	19	62	5.17 ± 2.41
Cattle Egret	65	75	47	59	246	20.5 ± 9.60
Large Egret	0	0	0	18	18	1.5 ± 2.22
Intermediate Egret	0	0	0	5	5	0.42 ± 0.64
Little Egret	22	30	6	6	64	5.33 ± 4.11
Little Cormorant	19	90	215	133	457	38.08 ± 54.98
Red Wattled Lapwing	19	44	11	30	104	8.67 ± 3.90
White tailed Lapwing	0	0	0	2	2	0.17 ± 0.55
Common Red Shank	0	0	0	730	730	60.83 ± 112.12
Indian River Tern	2	0	0	0	2	0.17 ± 0.55
Total Avifauna Count	**235**	**294**	**514**	**15655**	**16698**	1391.5 ± 2927.1

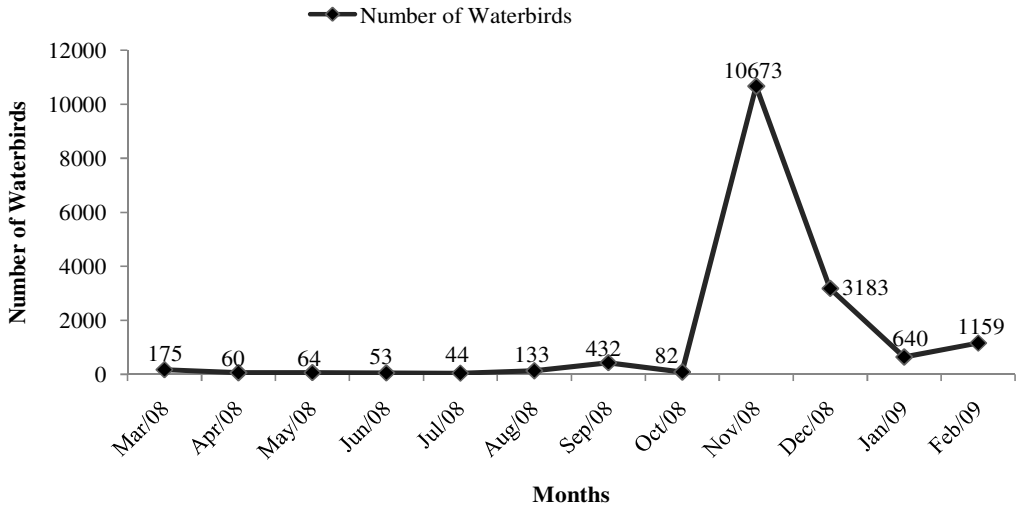

Figure-2
Monthly variations in Aquatic Avifauna of Gharana Wetland (Reserve)

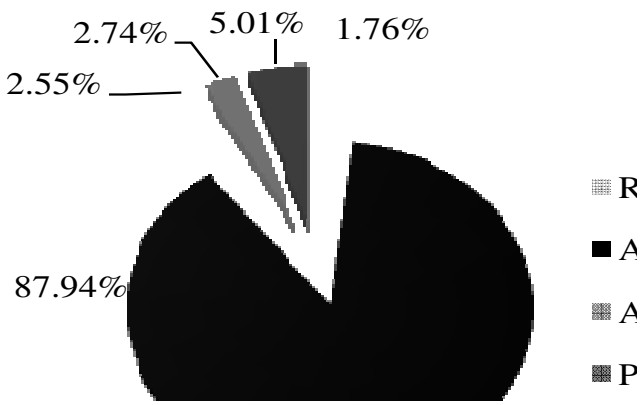

Figure-3
Annual percent contribution of various families of Aquatic avifauna

Bar-headed Goose contributed 92.01% (9820 individuals) to the total population of 10673 individuals in November, 2008, thus constituting the peak in this month.Green forage in rice fields is most important to geese and its availability contributes to the increase in goose populations[31-32]. Geese, being herbivorous/ graminivorous[33] winter in large, contiguous regions of agricultural habitat[34]. Kaminski and Prince[35] and Merendinoet al.[36] reported that waterbirds preferred wetland with vegetational characteristics thereby providing cover and foraging area to them. Moreover, macrobenthic invertebrates which constitute the principle diet for waterfowl[37-41] were more closely associated with aquatic vegetation than the barren substrate[42-43] as decomposition of the vegetation provided an additional nutrients and surface for the proliferation and habitation of macroinvertebrates[35,44-46].

Sharp decline in the waterbird count was observed after March, 2008 i.e. from April to July, 2008. Low waterbird count from April, 2008 to July, 2008 was owing to the absence of maximum number of waterbird species during April, 2008 and the complete absence of migratory waterbirds from May, 2008 to July, 2008. Afterwards, the population of waterbirds started increasing from August to November, 2008 with a peak in November, 2008 and a sharp trough in October, 2008. Number of most of the migratory waterbirds exhibited fall from December, 2008 onwards and a prominent decline was observed in January, 2009 (figure 2). The fall in the population of waterbirds from December, 2008 onwards was the consequence of southward migration of certain transient species while sudden fall in the population during October, 2008 and January, 2009 was credited to the absence of certain species of transient waterbirds in these months. The most diverged season was winter season in terms of species number as well as species abundance. Akosimet al.[47]also recorded more waterbirds in dry season rather than rainy season, which were indicative of the occurrence of migrant birds at the wetland areas of Yankari National Park, during dry season. This observation is in line with the present findings, where large numbers of migratory birds were observed during dry period. Ysebaert[48] observed clear seasonality with lowest number of waterbirds in the period April, 2008 to July, 2008 and a peak in the period November, 2008 to January, 2009. Among all the species, Bar-headed Goose had the largest population. Other abundant waterbirds were Northern Shoveller, Common Red Shank, Little Cormorants, Common Teal and Gadwall whilst the population of the remaining species were relatively small.

Migratory waterbirds (Wintering and Transients) started visiting the Gharana Wetland (Reserve) in August, 2008. Little Cormorants were the first to enter the wetland in this month. Common Coot and Common Teal arrived in September, 2008 while Northern Shoveller, Eurasion Wigeon, Bar-headed Goose, Gadwalls, Common Red Shank, Intermediate Egret and Large Egret registered their arrival in November, 2008. Last arrival among migratory waterbirds was registered by Northern Pintail in February, 2009.

During the period of migration from Oriental to Palaearctic route, Little Cormorants and Gadwalls departured the Gharana Wetland (Reserve) in the month of March, 2008, followed by Common Coots in the month of April, 2008. White-tailed lapwing departured the wetland in January, 2009.Most of the other waterbirds like Common Teal, Northern Shoveller, EurasionWigeon, Bar-headed Goose, Northern Pintail, Common Red Shank, Intermediate Egret and Large Egret left the wetland in the month of February, 2009.

The Shannon-Weaver Index of diversity was highest (H' = 1.982) in January, 2009 and lowest (H' = 0.438) in November, 2008. Shannon-Weaver Index values in January, 2009 revealed that this month had the greatest diversity in terms of both species richness and evenness. Gerritsenet al.[49] revealed that the increases in the value of H'is directly associated with the increase in the number and distribution of species (biotic diversity) within the community, thereby confirming the present observation. Simpson's Index of dominance revealed that November, 2008 had the highest dominance (C = 0.848) and January, 2009 had the lowest (C = 0.176). Simpson's dominance, which weights towards the abundance of the most common species, indicated that greatest dominance was shown by the most abundant species i.e. Bar-headed Goose in the month of November, 2008. Krebs[50] stated that this index gives relatively less importance to rare species and more to common species. The value closer to '0' indicates a low level of dominance i.e. all tax a are equally present while the value closer to '1' exhibits higher level of dominance i.e. one taxon dominates the community completely. The value of Simpson's Index in the month of November was 0.848 i.e. closer to '1', thus, having higher dominance as compared to the value 0.176 (closer to 0), indicating the lower dominance in the month of January, 2009. Simpson[51] opined that dominance varies

inversely with diversity which is in consonance to the present observations. Marglef'srichness Index varied between 1.202 (May, 2008) and 2.476 (January, 2009). Species richness which was greater in winter season was in line with the findings of Hamdiet al.[52]. Zhouet al.[53]also recorded more number of waterbird species in winter season than in summer. Evenness in bird communities was highest (E = 0.932) in May, 2008 and lowest (E = 0.152) in November, 2008 (figure 4). Routledge[54] stated that the value of evenness closer to '0' indicates low evenness and high single species dominance while close to '1' depicts maximum evenness and abundance of all species. In the present study, the value of evenness was 0.932 (closer to 1) in May indicating that all the species were abundant while it was 0.152 (closer to 0) which revealed that there was less evenness and dominance of a single species (Bar-headed Goose).

Correlation coefficients between different diversity indices revealed significant negative correlation between diversity and dominance ($r = - 0.955$, $p<0.05$), diversity and evenness ($r = - 0.880$, $p<0.05$) and dominance and evenness ($r = - 0.929$, $p<0.05$) (table 3). Sorenson's Quotient of similarity was found highest (Q/S = 82.35%) between summer and autumn and lowest (Q/S = 51.85%) between summer and winter. in terms of abundance of aquatic avifauna, Morisita-Horn Index indicated highest similarity (MH = 0.697) between spring and summer and lowest (MH = 0.01) between summer and winter (table 4). Winter season exhibited less similarity in community composition and abundance with other season which may be attributed to the presence of migratory waterbirds as also suggested by Giri and Chalise[21]. Chi-square test recorded that species richness was dependent on the months ($\chi^2 = 24.27$, $p<0.05$). Prevalence of seasonality in the species richness was also recorded by Hamdiet al.[52] and Giri and Chalise[21].

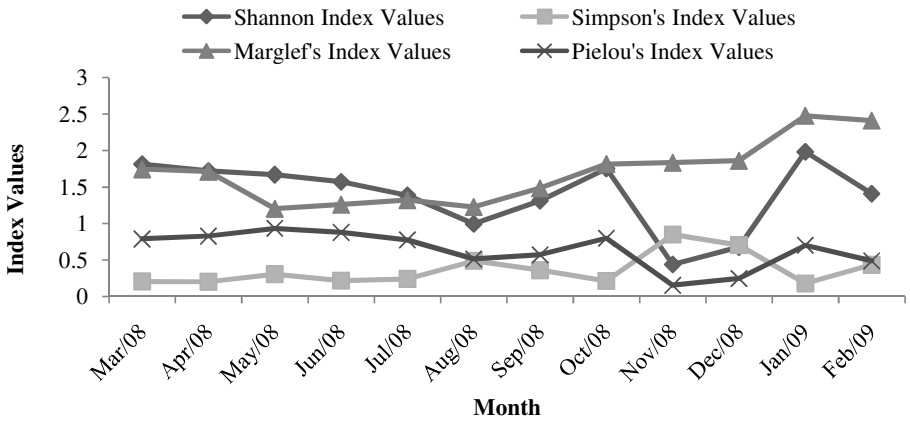

Figure-4
Monthly variations in different Diversity Indices

Table-3
Correlation coefficients (r) between various Diversity Indices

Indices	Shannon Index	Simpson's Index	Marglef's Index	Pielou's Index
Shannon Index		- 0.955*	- 0.126	-0.880*
Simpson's Index			0.078	- 0.929*
Marglef's Index				- 0.330
Pielou's Index				

*marked correlations were significant (P< 0.05).

Table-4
Different Similarity Indicesto compare the community structurebetween different seasons

Compared Seasons	Sorenson's Quotient of Similarity	Morisita-Horn Index
Spring Vs Summer	77.78%	0.697
Spring Vs Autumn	76.19%	0.308
Spring Vs Winter	64.52%	0.018
Summer Vs Autumn	82.35%	0.65
Summer Vs Winter	51.85%	0.01
Autumn Vs Winter	66.67%	0.65

Conclusion

Gharana Wetland serves as an important feeding and wintering ground for large number of migratory waterbirds but the continuous anthropogenic stress over the wetland has resulted into the decline in the number of waterbird species as well as count. Thus, the information generated from this study would be essential to better formulating the various strategies for the conservation of waterbirds as well as their habitat.

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