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## Foraging guild status, diversity and population structure of waders of the River Ganges in district Rae Bareilly, Uttar Pradesh, India

**Himanshu Mishra, Vikas Kumar and Ashish Kumar**

### Abstract

The Present study was conducted from January 2015 to June 2016, using binoculars and SLR cameras at different sites along the River Ganges in District Rae Bareilly. Waders were identified with the help of key reference books. Counting was executed by using point count method. A total of 19 species of waders were recorded and identified. River Lapwing outnumbered rest of species with a total count of 1363, while Purple Heron were least in number (48). At Gegaso maximum Shannon Diversity Index (H) was reported (2.59) followed by Unchahar (2.56) and minimum at Dalmau (2.53). Values of Simpson's Diversity Index (1-D) of waders were estimated to be 0.8995 at Gegaso, 0.8888 at Dalmau and 0.8899 at Unchahar. Among the recorded species of waders, 9 resident migrant, 8 resident and 2 were recorded as migrant. Foraging guild status reveals that 68.48% of waders were carnivorous, 15.78% omnivorous and 15.78% piscivorous. Moreover, the value of Margalef's richness index and Equitability index (J) were also reported. Outcome of one way ANOVA reveals significant value ( $p < 0.05$ ) with reference to Gegaso (Site-A).

**Keywords:** Guild, diversity, waders, Ganges, population

### 1. Introduction

Biodiversity refers to the variety and variability of life on earth. This can be genetic variation, species variation and ecosystem variation within an area. It establishes a direct connection between ecosystem function and sustainability of natural and managed ecosystems. Richness, abundance and community composition are three critical measurements used to gain insight on the diversity of particular taxa in a natural ecosystem<sup>[1]</sup>. India has more than 1200 species of birds which is over 13% of the world's avifauna. 243 species of water birds are recorded in India, almost half of which are migratory<sup>[2]</sup>. Avifaunal diversity can be most important ecological indicators to evaluate the quality of habitat. Birds are very important organism because they help in the pest control, pollination, scavenger as well as ecological indicator<sup>[3]</sup>. They are among the best monitors of environmental changes and have been used to evaluate the environment throughout the history as biomonitors. Change in their population, behaviour pattern as well as reproductive ability have most often been used to examine the long term effects of habitat fragmentation. Therefore, they are the good indicators of ecological status of any ecosystem<sup>[4]</sup>. Waders are defined as a group of medium sized wading birds, which have a wide variety of bill structures and possess long legs and toes enabling them to live and feed in shallow water habitats. Waders represent the greatest species diversity<sup>[5]</sup>. Waders have been seen wading through the shallow waters and occasionally probing along dry margins of the wetland. They prefer shallow muddy banks of the pond and close by small water spots. The migratory waders need adequate food supply and safety<sup>[6]</sup>. Hutchinson first develop the idea that the boundaries of realized niches are set by competition for limited resources and assumed that groups of species sharing similar resources are common in nature because a complex trophic organization of a community is more suitable than a simpler one<sup>[7]</sup>. Guild is a group of species that exploit the same class of environmental resources in a similar way<sup>[8]</sup>. Guilds are supposed to be coevolved entities that provide important information on community structure<sup>[9-11]</sup>. Foraging habitat use and feeding method can be applied to assign foraging guild to birds<sup>[12]</sup>. Larger river floodplains play an important role in maintaining biodiversity by providing an extraordinary array of habitats<sup>[13]</sup>. Aquatic environment in the river can provide critical habitat to a wide variety of waders.

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Some waders spend their time in both terrestrial and aquatic ecosystems, while others spend most of their time in river water returning to the land for feeding and breeding. The loss and degradation of floodplain habitats are pressing concerns in the conservation of avian diversity [14]. However, riverine habitats are continuously supporting some of the richest avifauna on the continents [15, 16]. The present study was carried out not only to prepare the checklist of waders, but also to find out the basic ecology with reference to their habitat, migratory status and guild status of birds. Because many threats to wader's population have been noticed therefore, study of current population composition and status of wader species is essential and is the basis for future monitoring and implementation of appropriate conservation measures [17, 18].

## 2. Materials and Methods

- A. Study area:** Present study was conducted along the River Ganges in District Raebareli. Area of district Raebareli is 4609 Km<sup>2</sup>. Three sites were selected and named as site A- Gegaso (N-26°03'26.3", E-080°54'39.3") site B- Dalmau (N-26°03'51.6", E-081°01'38.2") and site C- Unchahar (N-25°53'23", E-081°13'08.8"). The Ganges enters in Raebareli from west of Paragana Sareni in the tehsil Dalmau and, forming the southern boundary of the district, run southeast as far as village Barua where it leaves the district. It provides a wintering and staging ground for a number of migratory waterfowls and breeding ground for resident birds.
- B. Identification:** Waders were identified by a pertinent literature 'Birds of the Indian subcontinent' a field guide to the birds of India. Moreover, identification of birds with the help of key reference books [19-21] was done successfully.
- C. Census:** Bird survey and counting was done during early morning from 6 am to 9 am, fortnightly, from January 2015 to June 2016, using binoculars and SLR cameras. Point count method was applied while total number of bird from each wader species was recorded. Block count method was used for estimating waders present in flocks either in flight or on ground.
- D. Statistical analysis:** Mean and Standard deviation was calculated by using Microsoft excel. Simpson's diversity index (1-D) was used to estimate the biodiversity using the equations:  $D = \sum ni (ni-1) / N (N-1)$ , Where D = Simpson's Index of Dominance ni = total number of individuals of a particular species N = the total number of individuals of all species [22]. Similarly Shannon diversity index was determined by  $H' = - \sum (Pi) (\ln Pi)$ , in which Pi = Proportion of total species belonging to ith species [23]. The data collected were analyzed using one way ANOVA. All the calculations were done with the help of Graph Pad Prism5. Species richness and species evenness were also determined with the help of past software

## 3. Results

A total of 19 species of waders were recorded and identified as listed in Table 1. These birds were belonging to 3 orders and 7 families. Maximum (46.34%) of birds were noticed in order Pelecaniformes followed by minimum in order Ciconiiformes (12.60%). Similarly maximum number of waders were recorded in family charadriidae (1696) and minimum in family Rynchopidae (45). River Lapwings outnumbered rest of the species with a total count of 1363, while Purple Herons were least in number (48). Among the

recorded species of waders, 9 resident migrant, 8 resident and 2 were recorded as migrant. Residential status of waders is represented in Fig 5. Moreover, 68.48% of waders were identified as carnivorous, 15.78% omnivorous and 15.78% as piscivorous. Foraging guild status of waders is listed in Fig 4. A detail of mean and standard deviation of individuals of each species of waders is mentioned in Table 2. Total number of waders in different families is reported in Fig 1 and percentage of waders encountered in each order is mentioned in Fig 2. Diversity Indices are given in Table 3. Shannon diversity index (H') accounts for both abundance and evenness of the species present. Simpson's Diversity Index (D) measures the probability that two individuals randomly selected from a sample will belong to the same species. Both Simpson's Diversity Index (D) and Simpson's index of diversity (1-D) ranges between 0 and 1, with 0 indicating infinite diversity and 1 indicating no diversity (bigger the value of D, lower the diversity). The values of Simpson's index of diversity (1-D) also are graphically represented in Fig 3. Simpson's index of diversity (1-D) represents the probability that two individuals randomly selected from a sample will belong to different species. At Gegaso, Shannon Diversity Index (H') was maximum (2.59), followed by Unchahar (2.56) and minimum at Dalmau (2.53). Values of Simpson's index of diversity (1-D) of waders were estimated to be 0.8995 at Gegaso, 0.8888 at Dalmau and 0.8899 at Unchahar. Evenness of wader species, which compares the similarity of the population size of each of the species, were recorded maximum 0.7018 at Gegaso, 0.6851 at Unchahar and minimum 0.6611 at Dalmau. Value of Marglef's richness index and Equitability index (J) are listed in table 3. Outcome of one way ANOVA reveals significant value (p<0.05) for analyzed data is reported in Table 4.

## 4. Discussion

The composition of riparian vegetation determines the allocation and abundance of waders. As riparian vegetation changes along the multifaceted biological and environmental gradients, a particular bird species can appear, increase or decrease in number and vanish as the habitat changes [24]. A larger ecosystem like The Ganges can support an abundance of riverine birds. Waders found suitable habitats in its channels, wetlands and adjacent upland. Waders depend on river banks and adjacent riparian vegetation for nesting habitat on which they breed and raise their young ones. Food availability is one of the most important factors determining bird's distribution [25]. Fishes, invertebrates, molluscs, insect larvae are easily available in riverine ecosystem that is why foraging guild like carnivore outnumbered rest of the guilds like piscivore and omnivore.

Habitat preferences like human habitations, scrublands, aquatic vegetation and expanded crop field etc. and fluctuation in weather profile are probably most important drivers of population dynamics of waders. Species diversity increases as the complexity of habitat increases. Species richness and evenness both are the integral component of diversity. Evenness is a measure of the relative abundance of different species. This is an important component of diversity indices [26-28].

Findings of present investigation reveals that at Gegaso, maximum numbers of waders were recorded because it provides vast sandy banks and rich riparian vegetation that enhance habitat availability for both sand dwelling and tree dwelling waders. Riparian vegetation includes aquatic plants as well as herbs, shrubs and trees along the margins of river.

Almost similar conditions were met with Unchahar. At Unchahar sand banks were moderate but riparian vegetation was rich with nearby trees, that is why population of waders is higher than Dalmau but lower than Gegaso. At Dalmau there was reduction in the area of sand banks as well as riparian vegetation. Trees were located at very long distance from river bank with a few trees in between. That might be the reason of lower value of diversity indices. Evenness was

estimated to be high at Gegaso that is why this site shows maximum species diversity. However, this riverine ecosystem may witness a rapid decrease in wader's diversity in coming years due to habitat destruction in the form of tree cutting, sand lifting from riverbed and indiscriminate pollution. Immense anthropogenic pressures like hunting, fishing, grazing and expansion of crop field etc. are other threats to waders that have been noticed.

**Table 1:** Diversity, Residential and Foraging guild status of waders

S.N.	Common Name	Scientific Name	Order	Family	Residential Status	Foraging guild Status
1	River Lapwing	<i>Vanellus duvaucelii</i> (Lesson, 1826)	Charadriiformes	Charadriidae	R	O
2	Red wattled Lapwing	<i>Vanellus indicus</i> (Boddaert, 1783)	Charadriiformes	Charadriidae	R	O
3	Yellow wattled Lapwing	<i>Vanellus malabaricus</i> (Boddaert, 1783)	Charadriiformes	Charadriidae	R	CV
4	Painted Stork	<i>Mycteria leucocephala</i> (Pennat, 1769)	Ciconiiformes	Ciconiidae	RM	P
5	Asian Open bill	<i>Anastomas oscitans</i> (Boddaert, 1783)	Ciconiiformes	Ciconiidae	R	CV
6	European White Stork	<i>Ciconia ciconia</i> (Linnaeus, 1758)	Ciconiiformes	Ciconiidae	M	CV
7	White necked Stork	<i>Ciconia episcopus</i> (Linnaeus, 1758)	Ciconiiformes	Ciconiidae	M	CV
8	Large Egret	<i>Casmerodius albus</i> (J.E. Gray, 1831)	Pelecaniformes	Ardeidae	RM	CV
9	Purple Heron	<i>Ardea purpurea</i> (Linnaeus, 1766)	Pelecaniformes	Ardeidae	RM	CV
10	Grey Heron	<i>Ardea cinerea</i> (Linnaeus, 1758)	Pelecaniformes	Ardeidae	RM	CV
11	Black crowned Night Heron	<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	Pelecaniformes	Ardeidae	R	CV
12	Cattle Egret	<i>Bubulcus ibis</i> (Linnaeus, 1758)	Pelecaniformes	Ardeidae	RM	CV
13	Little Egret	<i>Egretta garzetta</i> (Linnaeus, 1766)	Pelecaniformes	Ardeidae	R	CV
14	Black Bittern	<i>Dupetor flavicollis</i> (Latham, 1790)	Pelecaniformes	Ardeidae	RM	CV
15	Oriental white Ibis	<i>Threskiornis melanocephalus</i> (Latham, 1790)	Pelecaniformes	Threskiornithidae	R	CV
16	Black Ibis	<i>Pseudibis papillosa</i> (Gmelin, 1789)	Pelecaniformes	Threskiornithidae	R	O
17	Common Sand piper	<i>Actitis hypoleucos</i> (Linnaeus, 1758)	Charadriiformes	Scolopaci	RM	CV
18	Indian Skimmer	<i>Rynchops albicollis</i> (Swainson, 1823)	Charadriiformes	Rynchopidae	RM	P
19	Common Tern	<i>Sterna hirundo</i> (Linnaeus, 1758)	Charadriiformes	Sternidae	RM	P

**Table 2:** Total count, Mean and Standard Deviation of waders

S. N.	Common Name	Gegaso	Dalmau	Unchahar	Total Count	Mean±SD
1	River Lapwing	748	406	209	1363	454.33±272.7312
2	Red wattled Lapwing	130	78	89	297	99±27.40438
3	Yellow wattled Lapwing	45	15	17	77	25.66±16.77299
4	Painted Stork	108	47	32	187	62.33±40.25336
5	Asian Open bill	160	68	79	307	102.33±50.24274
6	European White Stork	122	45	56	223	74.33±41.64533
7	White necked Stork	81	22	29	132	44±32.23352
8	Large Egret	112	85	67	264	88±22.6495
9	Purple Heron	38	14	18	70	23.33±12.8582
10	Grey Heron	74	28	26	128	42.67±27.15388
11	Black crowned Night Heron	143	38	69	250	83.33±53.94751
12	Cattle Egret	530	220	460	1210	403.33±162.5833
13	Little Egret	183	136	157	476	158.67±23.54428
14	Black Bittern	66	32	47	145	48.33±17.03917
15	Oriental white Ibis	390	225	132	747	249±130.6637

16	Black Ibis	138	76	98	312	104±31.43247
17	Common Sand piper	128	67	79	274	91.33±32.31615
18	Indian Skimmer	64	39	45	148	49.33±13.05118
19	Common Tern	391	69	85	545	181.67±181.4644
	<b>Total</b>	<b>3651</b>	<b>1710</b>	<b>1794</b>	<b>7155</b>	<b>2385±1097.19</b>

Table 3: Diversity indices of waders

S. N.	Diversity indices	Gegaso	Dalmau	Unchahar
1	Simpson's Index (D)	0.101	0.112	0.110
2	Simpson's Index of Diversity(1-D)	0.8995	0.8888	0.8899
3	Shannon Diversity Index (H')	2.59	2.53	2.56
4	Evenness Index (E)	0.7018	0.6611	0.6851
5	Margalef's Richness Index	2.194	2.418	2.402
6	Equitability Index (J)	0.8798	0.8594	0.8716

Table 4: ANOVA table of waders.

ANOVA Table	SS	Df	MS	F-Value	P-value
Treatment (between columns)	126700	2	63360	3.439	0.0393*
Treatment (within columns)	99500	54	18430		
Total	1122000	56			

\*(P value is less than 0.05 that is significant)

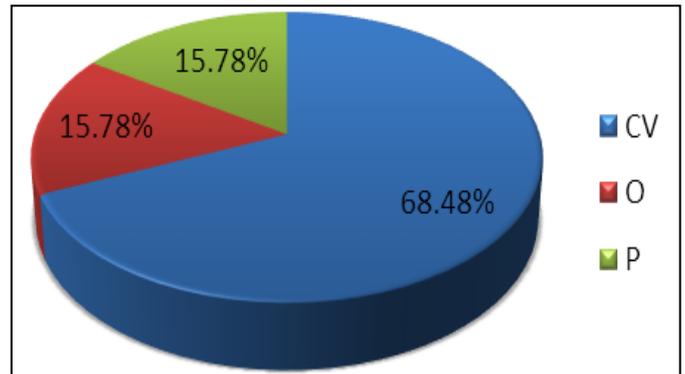


Fig 4: Percentage of Guild status of waders

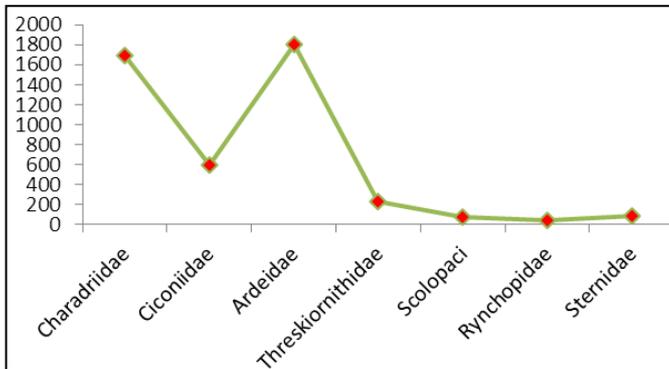


Fig 1: Number of waders in each family

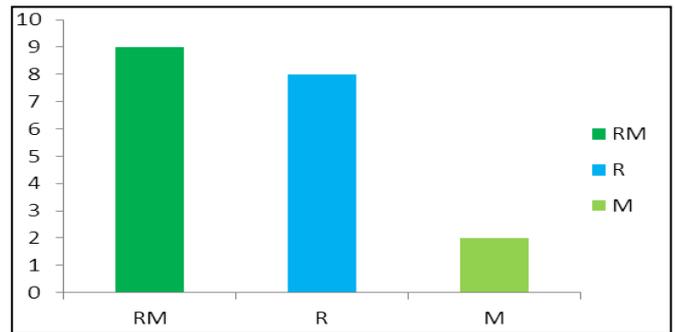


Fig 5: Residential status of waders

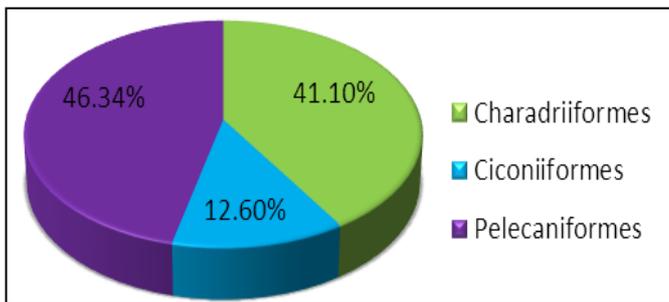


Fig 2: Percentage of waders in each Order

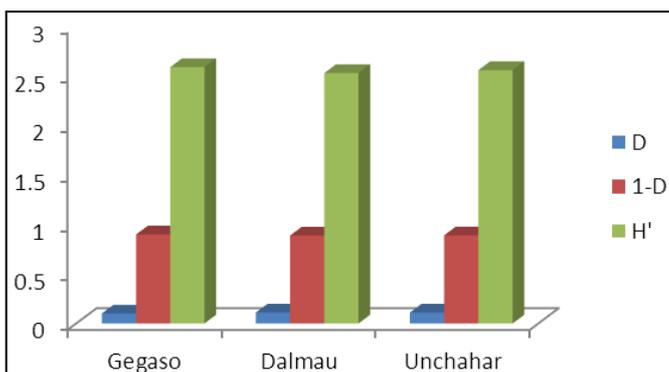


Fig 3: Diversity indices of waders

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