

# Distribution and Assessment of Water-Bird and Water-Associated Birds Diversity from Two Wetlands of Ajmer, Rajasthan



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### Abstract

Present study has been done to prepare the comprehensive database and assessment of water-birds and water-associated birds diversity in selected two study sites (Site - A: Anasagar Lake; and Site - F: Foyasagar Lake) of Ajmer from March 2017 to February 2018. A total 58 species of water-birds and water-associated birds belonging to 9 orders and 18 families were recorded from two wetlands during the study. Ardeidae (Wb) and Anatidae (Wb) were the most dominant families recorded during winter in terms of species richness. Diversity indices i.e. Jaccard index and Sorenson index were also assessed to compare the present distribution pattern of wetland bird species in study sites.

**Keywords:** Water-Birds, Water-Associated Birds, Diversity Indices, Wetland Bird.

### Introduction

Wetlands are important repositories of various group of faunal biodiversity. They are exclusive habitats and provide the breeding and feeding grounds for various faunal species. Thus they are playing vital role to maintain variety of food-chains and food-webs in different ecosystems. Those avian faunal species which are strictly dependent on wetlands are known as wetland avian species. Simultaneously, avian faunal species using wetlands as partially known as wetland associated avian species or wetland birds and wetland associated birds. In vice-versa condition certain species having distribution around the wetlands but not having any major dependency on wetlands were categorized as terrestrial avian faunal species in concern of avian faunal diversity.

Water-birds play a significant cultural and social role in local communities as well as being an important component of wetland ecosystem (Ramsar Convention Secretariat 2002) defines water-birds as "birds ecologically dependent on wetlands", with the exception of the wetland related raptors (Accipitriforms and Falconiformes) and wetland related owls (Strigiformes) and covers twenty groups of water-birds. Its covers 243 water-birds species including 49 globally threatened species (Birdlife International 2001, 2003; Wetlands International 2002). The water-bird population estimates, third edition by (Wetland International 2002) lists 2,271 biogeographically populations of 868 species. The largest number of water-bird populations (697) is found in Asia. Overall 500 species of birds previously documented from the variety of microhabitats of the state Rajasthan (Grimmett *et al.*, 2004).

Earlier study of Yadav and Swroop (2017) reported the number of species of water-birds to be (40) but due to famine and continuous modification and dry environment avian faunal diversity (wetland birds) seen was less. Main reason for declining the bird diversity are anthropogenic pressure, tourists, disturbance and construction work and change in natural habitat for beautification of lake observed. Anasagar Lake is the most famous and much liked tourist site in Ajmer, region. In comparison of this lake the other wetland of the study, Foyasagar Lake is situated nearly 5.3 kms.(3.3 miles), from the first study site and has comparatively less human pressure. Being slightly away from the city it is not included for tourist interference. In spite of this, diversity indices of wetland birds species as observed in the present study is good. Looking into the above facts, present study is an approach to document the

comprehensive database of wetland avian faunal diversity having presence, occurrence and distribution at Anasagar lake and Foyasagar lake, Ajmer.

#### Profile of Study Area

Area under investigation is in Rajasthan state, the largest state of India. Major part of the state is covered by desert. Aravalli hills diagonally divide state and delimit desert into two distinct ecological regions. Study area is classified as semiarid zone of central Aravalli foothills and mean annual rainfall is 573 mm and temperature ranges from 2<sup>o</sup> to 46<sup>o</sup> C. Ajmer lies between 26<sup>o</sup> 58' and 25<sup>o</sup> 38' North latitude and 73<sup>o</sup> 52' and 75<sup>o</sup> 22' East longitude a centrally located city of Rajasthan. Ajmer has a semi arid climate with high temperatures throughout the year. In the state, Ajmer have certain perennial and annual fresh water bodies, such as Anasagar lake and Foyasagar lake and Churasiyawas water pond . For the compilation of present study these wetlands were selected as the study sites since each has characteristic features in relation to habitat availability. Overall, the climate of the city is pleasant throughout the year which fascinates avian fauna.

#### Anasagar Lake

Anasagar lake a perennial fresh water body has geographical coordinates of 26<sup>o</sup> 28' North latitude and 74<sup>o</sup> 38' East longitude with an altitude of 487.28 meters covering approximately 3864.10 hectare area with the maximum depth (full water level) 3.96 meter to mean depth (full water level) 2.80 meter. The major source of water are Bandi river, rain fall and waste water drain. There are four overflow gates of size 4' X 6' at for inflow and outflow of water. The average annual water level change through precipitation is around 1.00 meter annually. This wetland represents excellent microhabitat for different water birds.

#### Foyasagar Lake

Foyasagar lake was constructed in the year 1892. The dam is situated at the distance of about 6 Kms. from Ajmer city at longitude 94<sup>o</sup> 35" and latitude 26<sup>o</sup> 27". The catchment area of the dam is 28.5 kms. out of which free catchment area is 27. 75 sq. kms. At the time of construction the capacity of the dam was 4.245 million cubic meter. There are mainly two features of Foyasagar road namely Ajaysar feeder and Kar feeder (Dutt, 2007)

#### Satellite Map of Anasagar and Satellite Map of Foyasagar



(Source: Irrigation department of Ajmer, Rajasthan)

#### Review of Literature

Avifaunal biodiversity is an important aspect to learn about wetland ecology because they are important biomass of the wetland ecology. Their population may affect the diversity of wetlands in specific area. Diversity Indices analysis using the Shannon Wiener , Simpson's index, and Jaccard and Sorenson index was attempted by (Hollenbeck and Ripple, 2007 ; Krebs, 1989 ; Bibi and Ali 2013; Lawania, *et al.* 2013) looking for distribution patterns among bird communities. Similar analysis was also carried out for measuring the species richness, evenness, in Ajmer by (Swarrop and Yadav 2017 ; Yadav and Swarrop 2017) (Prakash and Dutt 2018).

#### Material and Methodology

Wetlands at the foothills of Aravalli ranges in central Rajasthan comprises the study area, which are classified into semiarid zone habitats, for covering the all possible habitats. Regular surveys were conducted for the assessment of the wetland bird diversity of two mentioned study areas during the study period. Surveys were carried out during both day and night twice a day between 08.30 - 11.00 hrs and 16.00 - 18.00 hrs. Study sites were observed mainly by Ad-hoc search method with the visual encounter method and Transect methods. Point count method were also used for assessment and confirmation the population of wetland avian diversity. The avian faunal species were identified using various diagnostic keys (Grimmett *et al.*, 1999 and Kumar *et al.*, 2005)

#### Data Analysis

To calculate diversity indices specifically similarity measures namely "Jaccard Index" and "Sorenson Index" were assessed for different sites for comparing the similarities occurred diversity in mentioned two study areas (A) Anasagar lake and (F) Foyasagar lake. Jaccard similarity index was calculated on the basis of bird species richness and diversity indices Margalef's species richness (r), Shannon-Wiener diversity (H') and Simpsons Index (D), Simpsons Index of Diversity (D) were calculated using PAST statistical software (Pandya and Vachhrajani 2010).

<b>Jaccard Index:</b> $C_j = j / (a + b - j)$ Where j = the number of species common to both sites a = the number of species in site A and b = the number of species in site B	<b>Sorenson Index:</b> $C_s = 2j / (a + b)$ Where j = the number of species common to both sites a = the number of species in site A and b = the number of species in site B
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**Result and Discussion**

A total of 58 species representing 18 families and 9 orders of water birds and water associated birds were reported from the two study sites namely Anasagar and Foyasagar lakes during the study period. (Table 1)

**Site (A) Anasagar Lake**

Anasagar lake is a good diversified study site. Over all 48 wetland and wetland associated birds species belonging to 18 families and 9 order were observed from this study site. Wetland birds of families Scolopacidae (Wb) was abundant having (7) species of each family and total 15% of all water birds. 48 species of wetland birds were divided in categories as 3 Most common (MC) ;13 Common (C); 13 Not Common (NC) and 16 were Rare (R). On the basis of microhabitats of Anasagar Lake out of 48 species 30 species were found in wetland / marsh area (WM); 7species were found in all types of microhabitat Wetland / Marsh ; Agricultural Fields ; Forest Areas and Urbanized Areas (WM/AF/FA/UA) ; 3 species were found in Wetland / Marsh ; Agricultural Fields and in Forest Areas (WM/AF/FA); 2 species were found in Agricultural Fields and in Forest Areas (AF/FA) and 4 species were found in Wetland / Marsh ; Agricultural Fields(WM/AF). (Table: 2.)

**Site (F) Foyasagar Lake**

Foyasagar Lake showed less diversified study site in comparison to Anasagar Lake. Over all 42 wetland and wetland associated birds species belonging to the 15 families and 7 order were observed from this study site. Wetland birds family Ardeidae (Wb) and Anadidae (Wb) were abundant having (7) species and total 17% of all water birds. Out of 42 wetland bird species population status were observed in different categories: 3 were Most common (MC); 8 Common (C); 18 Not Common (NC) and 8 were Rare (R) remaining 5 were not categorized (-) . On the basis of microhabitats of Foyasagar Lake out of 42 species 25 species were found in wetland / marsh area (WM); 7 species were found in all types of microhabitat Wetland / Marsh ; Agricultural Fields ; Forest Areas and Urbanized Areas (WM/AF/FA/UA) ; 3 species were found in Wetland / Marsh ; Agricultural Fields and in Forest Areas (WM/AF/FA); 3 species were found in Agricultural Fields and in Forest Areas (AF/FA) and 4

species were found in Wetland / Marsh ; Agricultural Fields(WM/AF). (Table: 2)

**Conclusions**

Overall 58 species of wetland-birds (Wb) and wetland-associated (Wab) birds belonging to 9 orders and 18 families were documented.(Table: 2.1). Similarity or evenness of wetland birds species occurring in two different sites (A) Anasagar and (F) Foyasagar lakes were assessed . Jaccard's (0.666) and Sorenson's (0.80) similarity indices depicted higher similarity between study site (A) and (F). Out of 48 species of wetland birds study site (A) 27.08% were found as Common; 6.25% found as Most Common; 25% found as Not Common and **33.33%** found as Rare.

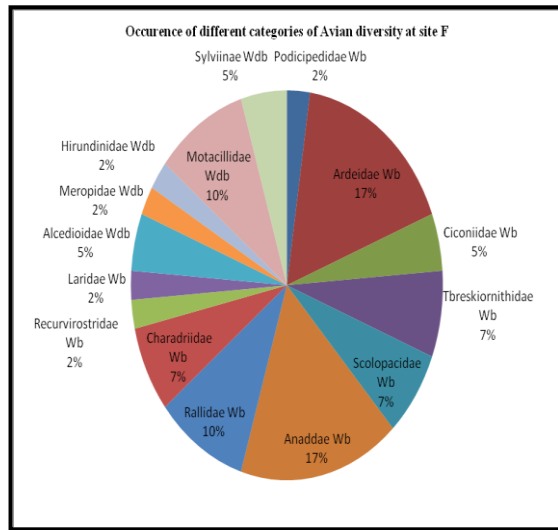
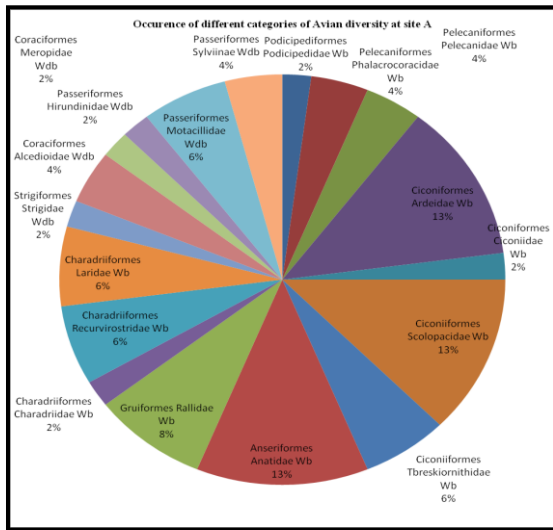
**Species Abundance**

Out of 42 species of wetland birds at study site (F) 19.04% were found as Common; 7.14% found as Most Common; **42.85%** found as Not Common and 19.04% found as Rare. Out of 48 species of wetland birds at study site (A) **33.33%** were found as Rare; 27.08% found as Common; 25.00% found as Not Common and 6.25% found as Most Common. R category in the study site (A) and NC category in study site (F) were dominant categories.

**Habitat Preference**

In the two study sites habitat preference of different families showed distinct preference for different habitat. In study site (A) wetland bird species, categorized (Wb), (Wab) accounted 48 species. Wetland/Marsh habitat from the study area (WM) recorded highest value (**66.66%**) in study site (A), where as the value (**59.52%**) was recorded in study site (F). In addition the various diversity indices of wetland birds at site (A) and (F) are shown in (Table no. 3). The highest value of Shannon Weiner Index (H') was estimated to be (2.69) in study site (A) where as Simpson Index of diversity (D) was estimated to be (0.9406) in study site (A). Simpson's evenness values was estimated to be (0.9353) in study site (A) while the species richness (r) was (48) in study site (A) and (42) in study site (F). The site (A) showed good wetland avian diversity as compared to other study site (F) although this site has higher rate of anthropogenic activities and pollution pressure because of surrounding nearby urbanized areas (Table. 4).

The level of threats to these wetland bird species are different due to the different activity of these species depending on time and adaptive ability in specific habitat .There is a need of conservation of these two wetlands and it is essential to restore their microhabitat so that these wetlands increase their avian biodiversity status .



**Table: 1. Checklist of birds recorded in Anasagar lake and Foyasagar lake with their habitat preferences and their population status.**

Family	Common name	Scientific name	Anasagar	Foyasagar	Micro habitat	Population status		
						Site (A)	Site (F)	Mean value
(1) Podicipedidae Wb	Little Grebe	<i>Tachybaptus ruficollis</i> (Pallas, 1764)	+	+	WM	MC	C	C
(2) Pelecanidae Wb	Great White Pelican	<i>Pelecanus onocrotalus</i> (Linnaeus, 1758)	+	+	WM	C	C	C
	Dalmatian Pelican	<i>Pelecanus crispus</i> (Bruch, 1832)	+	-	WM	NC	-	NC
(3)Phalacrocoracidae Wb	Little Cormorant	<i>Phalacrocorax niger</i> (Vieillot, 1817)	+	+	WM	NC	-	NC
	Great Cormorant	<i>Phalacrocorax carbo</i> (Linnaeus, 1758)	+	-	WM	-	R	R
(4) Ardeidae Wb	Little Egret	<i>Egretta garzetta</i> (Linnaeus, 1766)	+	+	WM/A F	C	C	C
	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	+	+	WM/A F	C	NC	NC
	Cattle Egret	<i>Bulbulcus ibis</i>	-	+	WM/A F/FA/UA	-	MC	MC
	Grey Heron	<i>Ardea cinerea</i>	+	+	WM	-	R	R
	Great Egret	<i>Ardea alba</i>	+	+	WM	C	NC	NC
	Intermediate Egret	<i>Egretta intermedia</i>	+	+	WM	C	NC	NC
	Indian Pond-Heron	<i>Ardeola grayii</i> (Sykes, 1832)	+	+	WM/A F/FA/UA	MC	MC	MC
Purple heron	<i>Ardea purpurea</i>	+	-	WM	-	R	R	
(5) Ciconiidae Wb	Painted Stork	<i>Mycteria leucocephala</i> (Pennant, 1769)	+	+	WM	NC	NC	NC

	Asian Openbill -Stork	<i>Anastomus oscitans</i> (Boddaert, 1783)	-	+	WM	-	R	R
<b>(6)</b> <b>Threskiornithid</b> <b>ae Wb</b>	Oriental White Ibis	<i>Threskiornis</i> <i>melanocephalus</i> (Latham, 1790)	+	+	WM/A F	R	R	R
	Black Ibis	<i>Pseudibis papillosa</i> (Temminck, 1824)	+	+	WM/A F	R	R	R
	Eurasian Spoonbill	<i>Platalea leucorodia</i> Linnaeus 1758	+	+	WM	R	R	R
<b>(7) Anatidae Wb</b>	Bar-headed Goose	<i>Anser indicus</i> (Latham, 1790)	-	+	WM	-	NC	NC
	Brahminy Shelduck	<i>Tadorna ferruginea</i> (Pallas, 1764)	-	+	WM	NC	NC	NC
	Comb Duck	<i>Sarkidiornis melanotos</i> (Pennant, 1769)	+	-	WM	-	R	R
	Spot-billed Duck	<i>Anas poecilorhyncha</i> (J .R. Forester. 1781)	+	+	WM	NC	C	NC
	Northern Shoveler	<i>Anas clypeata</i> (Linnaeus, 1758)	+	+	WM	NC	C	C
	Northern Pintail	<i>Anas acuta</i> (Linnaeus, 1758)	+	+	WM	R	-	R
	Common Teal	<i>Anas crecca</i> (Linnaeus, 1758)	+	+	WM	C	C	C
	Common Pochard	<i>Aythya ferina</i> (Linnaeus, 1758)	+	+	WM	C	NC	NC
<b>(8) Rallidae Wb</b>	White- breasted Waterhen	<i>Amaurornis</i> <i>phoenicurus</i> (Pennant, 1769)	+	+	WM	NC	NC	NC
	Purple Swamphen	<i>Porphyrio porphyrio</i> (Linnaeus, 1758)	+	+	WM	C	NC	NC
	Common Moorhen	<i>Gallinula chloropus</i> (Linnaeus, 1758)	+	+	WM	C	NC	NC
	Common Coot	<i>Fulica atra</i> (Linnaeus. 1758)	+	+	WM	NC	NC	NC
<b>(9) Charadriidae</b> <b>Wb</b>	Little Ringed Plover	<i>Charadrius dubius</i> (Scopoli, 1786)	-	+	WM	R	-	R
	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i> (Boddaert, 1783)	-	+	WM	NC	NC	NC
	Red-wattled Lapwing	<i>Vanellus indicus</i> (Boddaert, 1783)	+	+	WM/A F/FA/U A	MC	MC	MC
<b>(10)</b> <b>Scolopacidae</b> <b>Wb</b>	Black-tailed Godwit	<i>Limosa limosa</i> (Linnaeus, 1758)	+	+	WM	NC	NC	NC
	Spotted Redshank	<i>Tringa erythropus</i> (Pallas, 1764)	-	+	WM	R	R	R
	Common Redshank	<i>Tringa totanus</i> (Linnaeus, 1758)	-	+	WM	R	R	R
	Marsh Sandpiper	<i>Tringa slagnatilis</i> (Bechstein, 1803)	+	+	WM	R	R	R
	Green Sandpiper	<i>Tringa ochropus</i> Linnaeus, 1758	+	+	WM	R	R	R

	Common Snipe	<i>Gallinago gallinago</i> (Linnaeus, 1758)	+	+	WM	R	R	R
	Temminck's Stint	<i>Calidris temminckii</i> (Leister, 1812)	+	+	WM	R	R	R
	Ruff	<i>Philomachus pugnax</i> (Linnaeus, 1758)	+	+	WM	R	R	R
	Common Sandpiper	<i>Actitis hypoleucos</i> (Linnaeus, 1758)	+	+	WM	R	-	R
<b>(11) Recurvirostridae</b> Wb	Black-winged Stilt	<i>Himantopus himantopus</i> (Linnaeus, 1758)	+	+	WM	R	R	R
	Pied Avocet	<i>Recurvirostra avosetta</i> (Linnaeus, 1758)	+	+	WM	R	R	R
<b>(12) Laridae</b> Wb	River Tern	<i>Sterna aurantia</i> (J.E. Gray, 1831)	+	+	WM	NC	NC	NC
	Brown-headed Gull	<i>Larus brunnicephalus</i> (Jerdon, 1840)	+	-	WM	R	-	R
	Black-headed Gull	<i>Larus ridibundus</i> (Linnaeus, 1766)	+	-	WM	R	-	R
<b>(13) Strigidae</b> Wdb	Spotted Owl	<i>Athene brama</i>	+	-	WM/A F/FA/UA	R	C	NC
<b>(14) Alcedinidae</b> Wdb	White-breasted Kingfisher	<i>Halcyon smyrnensis</i> (Linnaeus, 1758)	+	+	WM/A F/FA/UA	C	C	C
	Lesser Pied Kingfisher	<i>Ceryle rudis</i> (Linnaeus, 1758)	+	+	WM/A F/FA/UA	C	NC	C
<b>(15) Meropidae</b> Wdb	Blue-cheeked Bee-eater	<i>Merops persicus</i> (Pallas, 1773)	+	+	WM/A F/FA/UA	C	C	C
<b>(16) Hirundinidae</b> Wdb	Wire-tailed Swallow	<i>Hirundo smithii</i> (Leach, 1818)	+	+	WM/A F/FA	NC	NC	NC
<b>(17) Motacillidae</b> Wdb	Paddy field Pipit	<i>Anthus novaeseelandiae</i>	-	+	AF/FA	C	C	C
	Large Pied Wagtail	<i>Motacilla maderaspatensis</i> (Gmelin, 1789)	+	+	WM/A F/FA/UA	C	-	NC
	Citrine Wagtail	<i>Motacilla citreola</i> (Pallas, 1776)	+	+	WM/A F/FA	NC	R	R
	Yellow Wagtail	<i>Motacilla flava</i> Linnaeus, 1758	+	+	WM/A F/FA	NC	NC	NC
<b>(18) Sylviidae</b> Wdb	Tailor Birds	<i>Orthotomus sutorius</i>	+	+	AF/FA	NC	-	R
	Lesser white throat	<i>Sylvia curruac</i>	+	+	AF/FA	R	NC	R

\*Area under investigation were classified in the following microhabitat for the convenience of the study. Wetland / Marsh (**WM**) ; Agricultural Fields (**AF**) ; Forest Areas (**FA**) and Urbanized Areas (**UA**)

\* Population status of the observed organisms were categories in different categories as Most common (**MC**) ; Common (**C**) ; Not Common (**NC**) and Rare (**R**)

\* Symbol Present (+) Absent (-).

**Table: (2) Order, Family and Species account of Two water bodies of Ajmer site A and site F**

Order	Family	No.of Species at both site	Study site (A)	Study site (A) %	Study site (F)	Study site (F) %
Podicipediformes	Podicipedidae Wb	1	1	2%	1	2%
Pelicaniformes	Pelecanidae Wb	2	2	4%	-	-
Pelicaniformes	Threskiornithidae Wb	3	3	6%	3	7%
Pelicaniformes	Ardeidae Wb	8	6	13%	7	17%
Suliformes	Phalacrocoracidae Wb	2	2	4%	-	-
Cinconiiformes	Ciconiidae Wb	2	1	2%	2	5%
Anseriformes	Anatidae Wb	8	6	13%	7	17%
Gruiformes	Rallidae Wb	4	4	8%	4	10%
Charadriiformes	Charadriidae Wb	3	1	2%	3	7%
Charadriiformes	Scolopacidae Wb	9	7	15%	2	5%
Charadriiformes	Recurvirostridae Wb	2	2	4%	2	5%
Charadriiformes	Laridae Wb	3	3	6%	1	2%
Charadriiformes	Strigidae Wdb	1	1	2%	-	-
Coraciiformes	Alcedioidae Wdb	2	2	4%	2	5%
Coraciiformes	Meropidae Wdb	1	1	2%	1	2%
Passeriformes	Hirundinidae Wdb	1	1	2%	1	2%
Passeriformes	Motacillidae Wdb	4	3	6%	4	10%
Passeriformes	Sylviidae Wdb	2	2	4%	2	5%
Total orders = 9	Total families = 18	Total species = 58	48		42	

**Table No. 3: Diversity Indices values of avifaunal diversity recorded at Anasagar and Foyasagar Lake.**

S. No	Diversity Indices	Anasagar Lake	Foyasagar Lake	Higher Value
1.	Shannon Weiner Index (H')	2.69	2.48	2.69 in (A)
2.	Simpson Index of diversity(D)	0.9406	0.9233	0.9406 in (A)
3.	Simpson evenness ( E)	0.9353	0.8697	0.9353 in (A)
4.	Species richness ( r)	48	42	48 in (A)
5.	Jaccard Index of Similarity the Anasagar (A) and Foyasagar Lake (F)			0.666
6.	Sorenson Index of Similarity the Anasagar (A) and Foyasagar Lake (F)			0.80

**Table No. 4: Population abundance status and Microhabitat occupation percentage recorded at Anasagar and Foyasagar Lake.**

S. No	Population abundance and Microhabitat	Anasagar Lake	Foyasagar Lake	Higher Value in %
1	Common (C)	13 (27.08%)	8 (19.04%)	(27.08%) (A)
2	Most Common (MC)	3 (6.25%)	3 (7.14%)	(7.14%) (F)
3	Not Common (NC)	12 (25%)	18 (42.85%)	(42.85%) (F)
4	Rare (R)	16 (33.33%)	8 (19.04%)	(33.33%) (A)
5	Not Calculated (-)	3 (6.25%)	5 (11.90%)	(11.90%) (F)
6	WM	32 (66.66%)	25 (59.52%)	(66.66%) (A)
7	WM/AF/FA/UA	7 (14.58%)	7 (16.66%)	(16.66%) (F)
8	WM/AF/FA	3(6.25%)	3 (7.14%)	(7.14%) (F)
9	AF/FA	2 (4.16%)	3 (7.14%)	(7.14%) (F)
10	WM/AF	6 (12.5%)	3 (7.14%)	(12.5%) (A)

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#### References

1. Bibi, F. and Z. Ali, (2013): Measurement of diversity indices of avian communities at Taunsa Barrage Wildlife Sanctuary, Pakistan. *The journal of animal and plant Science*, 23. (2). pp. 469-474.
2. Birdlife International, (2001): *Threatened Birds of Asia: The Bird Life International Red data book*. Cambridge UK: Birds Life International.
3. Birdlife International, (2003): *Saving Asia's threatened birds. A guide for government and civil Society*. Cambridge UK: Birds Life International.
4. Dutt, U. (2007): *Diversity and conservation studies of Amphibian and Reptiles around Ajmer area*. M. Phil Dissertation, Dept. of Zoology M.D.S.U. Ajmer, Rajasthan.
5. Grimmett, R., Inskipp, C. and Inskipp, T. (1999): *Pocket guide to the birds of the Indian Subcontinent*. Oxford University Press.
6. Grimmett, R., Inskipp, T. and Mehra, S.P. (2004): *Uttar Bharat ke Pakshi (In Hindi)*. Mumbai: BNHS.
7. Hollenbeck, J. P. and Ripple, W.J. (2007): *Aspen and Conifer Heterogeneity Effects on Bird Diversity in the Northern Yellowstone Ecosystem*. *Western North American Naturalist*. 67(1): pp. 92-101.
8. Krebs, C. J. (1989): *Ecological Methodology*. Harper-Collins Publishers, New York. pp. 654.
9. Kumar, A. Sati, J. P., Tak, P. C. and Alfred, J.R.B. (2005): *Hand book of Indian wetland birds and their conservation*. *Zoological Survey of India*. 26: pp. 468.
10. Lawaniya, N. K. ; Sharma , D. D and Sharma , V. (2013): *Occurrence and Distribution of Avianfauna from certain wetlands of Hadauti plateau, Kota, Rajasthan*. *Int. Jou. of Environmental and Animal Conservation*; Vol. 2(1). pp. 8-21.
11. Pandya, J. P. and Vachhrajani, D. K. (2010): *Birds of Mahi. River estuary, Gujarat, India*. *Journal of Threatened Taxa*, Vol. 2(6): pp. 994-1000. [www.threatenedtaxa.org](http://www.threatenedtaxa.org). June 2010.
12. Prakash, B. and Dutt, U. (2018): *Assessment of diversity Indices of Water-Birds in Fresh Water Lake of Ajmer (Rajasthan)*. *Int. J. Shrinkhala Ek Shodhparak Vaicharik Patrika*. Vol. 5(10) pp.22-27.
13. Ramsar Convention Secretariat, (2002): *Strategic Frame work and guidelines for the future development of the list of wetlands of International Importance of the Convention on Wetlands (Ramsar, Iran, 1971)* Ramsar Convention Bureau, Gland, Switzerland, Available at; [www.ramsar.org/keyguide/list2002e.htm](http://www.ramsar.org/keyguide/list2002e.htm).
14. Swarop, R. and Yadav, I. (2017): *Frequency and Status of Occurrence of Water-Birds at Anasagar Lake, Ajmer*. *Inter. J. for Res. in Applied Science & Engineering Tech. (IJRASET)*. ISSN: 2321- 9653; Vol. 5. Issue (10). pp. 1079-1090.
15. Wetlands International (2002): *Water-bird Population Estimation Third edition, Wetlands International Global Series No. (12)*. Wageningen, The Netherlands.
16. Yadav, I. and Swroop, R. (2017): *Diversity, Abundance and Inter-specific Correlation in Water-birds at Anasagar Lake, Ajmer*. *Int. Jon. Sci. and Res. (IJSR)*., Vol. 6(7). pp. 1306-1317.