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Community structure and habitat utilization with reference to water depth by wetland birds at Anasagar Lake, Ajmer, Rajasthan

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Abstract
Anasagar lake of Ajmer, Rajasthan is one of the largest human-made lakes in central Rajasthan. The lake has an important place in the migratory route and wintering habitat for migratory birds of Europe, Asia and Africa. The water birds and water-associated birds are directly dependent on wetlands and are affected adversely due to the loss and degradation of wetlands. Various studies indicate that managing water bodies helps in mitigating the adverse effect on migration and habitat utilization of birds. The hypothesis of this research is to examine the diversity of water and wetland-dependent avifauna including the number of individuals present in two classified zones of Anasagar Lake that are Deep water zone and Shallow water zone, avian fauna that uses the two classified zones as feeding ground were accounted for observations.

Keywords: water depth, avifauna, Ajmer, Anasagar, niche

Introduction
Wetlands play an important role in the protection of biodiversity and is an essential habitat for various type of living components in an ecosystem (Dai *et al.*, 2019) [4]. More than 50 percent of wetlands in the world are lost in the past hundred years, and the rest are degrading due to the influence of anthropogenic activities (Fraser and Keddy, 2005) [7]. Migratory birds, the important species of water bodies are majorly affected due to changes in water levels (Bancroft *et al.*, 2002) [2]. Habitat suitability is directly proportional to habitat use and habitat quality (Coppes *et al.*, 2018) [3]. Water bodies provide diversified benefits to water bird species such as a site for roosting, foraging, and nesting (Erwin and Beck, 2007) [6]. Studies indicate that depth of the water body is an important variable that affects the use of wetland habitat by water bird s (Elphick and Oring, 1998) [5]. Water depth directly affects the foraging efficiency of water birds especially in the case of shorebirds because of their morphology including the length and shape of tarsometataris, birds with long necks, bills, and legs can feed efficiently in deeper habitats (Baker, 1979; Powell, 1987) [1, 115]. Water bodies with deeper water levels support a higher density of diving water birds (Stapanian, 2003) [18] but still the birds need a roosting site for such waterfowls (Hattori and Mae, 2001) [11]. The increased depth slows the locomotion of water bird s because of increased resistance to water (Gawlik, 2002) [8]. Previously, in various studies the anasagar lake is known to host more than 95 species in the water zone and nearby terrestrial regions (Jadon *et al.*, 2019) and 58 species associated with water in anasagar (Prakash and Dutt, 2018) [16] and the wetlands of central Rajasthan near anasagar lake are reported to host more than 90 species of birds (Sharma *et al.*, 2012) [17] In this study we explored the preference and utilization of deep and shallow water zones by water bird s at anasagar lake, and discussed the importance of conservation of the lake.

Materials and Methods
Study area
Anasagar lake situated in the district of Ajmer in State Rajasthan of India at 26º28'N and 74º37'E coordinates is one of the largest artificially constructed lakes spanning an area of about 330 hectares. The depth of anasagar lake is 16ft. The water body stores the rainwater running from catchment areas and treated sewage water. The lake is surrounded by aravalli hills and lies in an ecotone between arid and semiarid Rajasthan. The lake is surrounded by urban settlements from all sides leaving no other natural habitats within the range.

Survey Methods
The field surveys and observations were recorded for two years from January 2020 to January 2022. Birds were recorded systematically by walking on the pathways along the shorelines and the point count method was implemented from fixed observation points. The identification of birds was done using available literature (Manakadan and Pittie, 2001; Gill and Donsker 2017) [14, 9]. Statistical Analysis was done with the help of PAST (Hammer *et al.*, 2001) [10] Software along with Relative Diversity Index (RDi) (Torre-Cuadros, 2007) [19], and the

similarity between both the zones was calculated using Jaccard and Sorenson Index (Magurran, 1988) [13]. The water body was classified into two zones are Deep water zone and the Shallow Water zone, The area of Anasagar lake which ranges from 0-1 M of length was marked as Shallow Water zone, and the area with depth greater than 1 meter was marked as Deep water zone. The depth was measured by the help of boats and secchi disk. The photographic evidences were collected using Canon 1300 D camera with a lens of 55-300 mm. The observed species of birds were classified into wetland birds and wetland-dependent birds (Kumar *et al.,* 2005) [12].

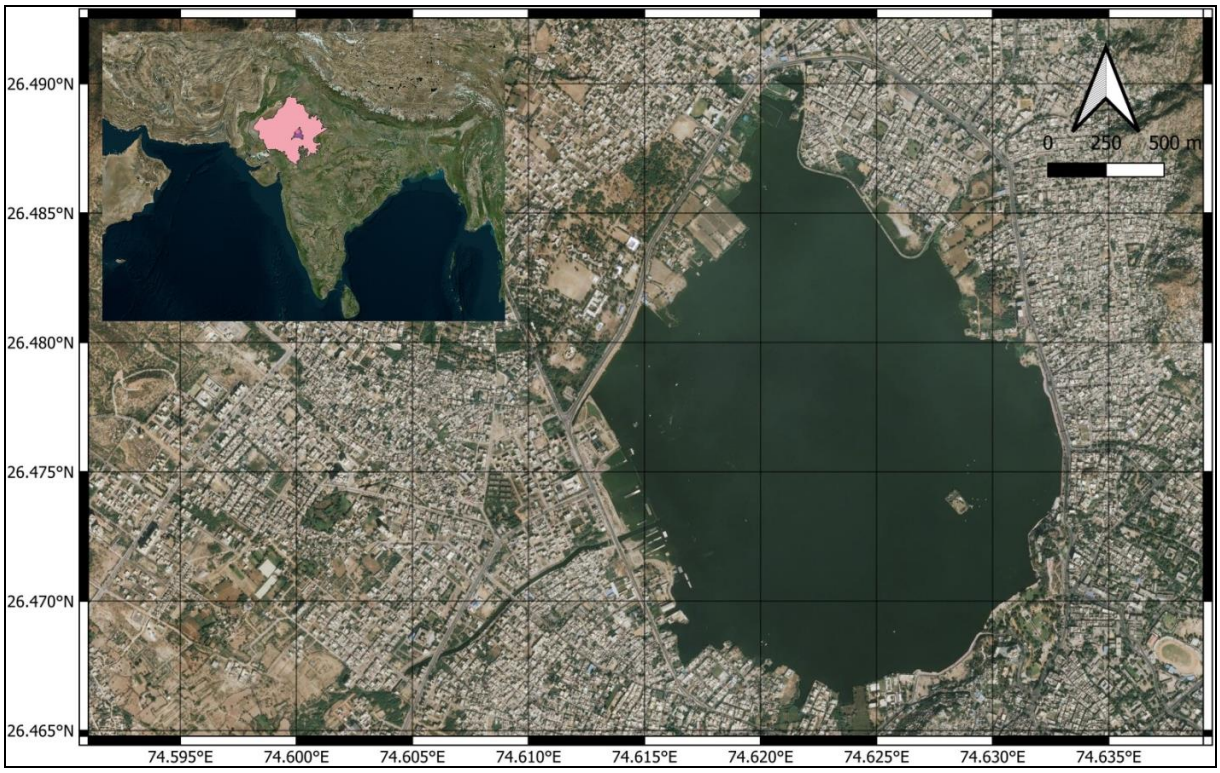

Fig 1: Satellite map of study site: Anasagar Lake, Ajmer, Rajasthan.

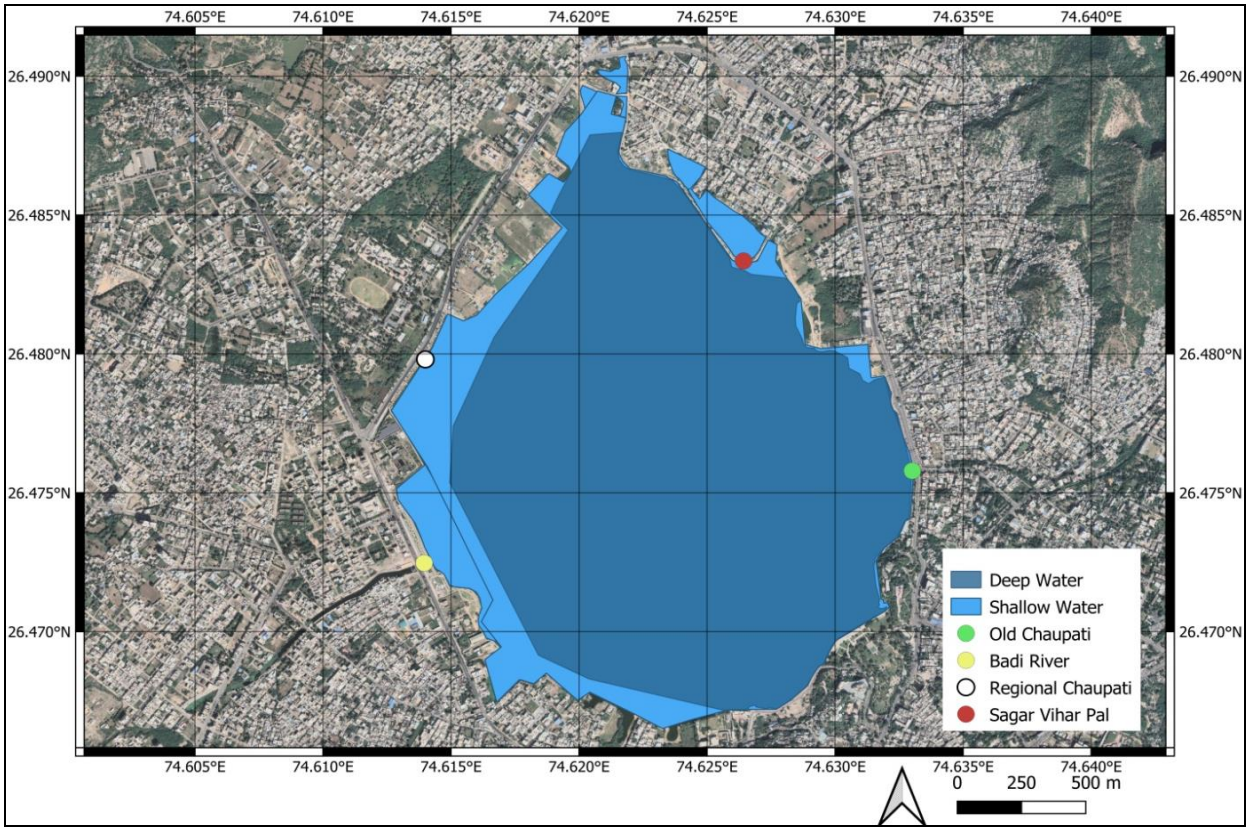

Fig 2: Division of Shallow and Deep-Water Zone at Anasagar Lake, Ajmer.

Observations and Results

Table 1: Checklist of observed species and presence/absence in deep and shallow water.

S. No	Species	Deep water zone	Shallow Water Zone
	1 indicates presence in the zone and 0 indicates the absence		
Wetland Birds			
Order Anseriformes			
Family Anatidae			
1	Knob-billed Duck		
	Sarkidiornis melanotos	0	1
2	Garganey		
	Spatula querquedula	0	1
3	Northern Shoveler		
	Spatula clypeata	0	1
4	Gadwall		
	Mareca strepera	0	1
5	Indian Spot-billed Duck		
	Anas poecilorhyncha	1	1
6	Mallard		
	Anas platyrhynchos	1	1
7	Northern Pintail		
	Anas acuta	0	1
8	Common Teal		
	Anas crecca	0	1
9	Common Pochard		
	Aythya ferina	1	0
10	Ferruginous Duck		
	Aythya nyroca	0	1
Order Phoenicopteriformes			
Family Phoenicoperidae			
11	Greater Flamingo		
	Phoenicopterus roseus	0	1
12	Lesser Flamingo		
	Phoeniconaias minor	0	1
Order Podicipediformes			
Family Podicipedidae			
13	Little Grebe		
	Tachybaptus ruficollis	1	1
Order Gruiformes			
Family Rallidae			
14	Common Moorhen		
	Gallinula chloropus	0	1
15	Eurasian Coot		
	Fulica atra	1	1
16	Grey-headed Swamphen		
	Porphyrio poliocephalus	0	1
17	White-breasted Waterhen		
	Amaurornis phoenicurus	0	1
Order Charadriiformes			
Family Recurvirostridae			
18	Black-winged Stilt		
	Himantopus himantopus	0	1
19	Pied Avocet		
	Recurvirostra avosetta	0	1
Family Charadriidae			
20	Red-wattled Lapwing		
	Vanellus indicus	0	1
21	Kentish Plover		
	Charadrius alexandrinus	0	1
22	Little Ringed Plover		
	Charadrius dubius	0	1

Family Rostratulidae			
23	Greater Painted-snipe		
	Rostratula benghalensis	0	1
Family Scolopacidae			
24	Black-tailed Godwit		
	Limosa limosa	0	1
25	Ruff		
	Calidris pugnax	0	1
26	Temminck's Stint		
	Calidris temminckii	0	1
27	Little Stint		
	Calidris minuta	0	1
28	Common Snipe		
	Gallinago gallinago	0	1
29	Common Sandpiper		
	Actitis hypoleucos	0	1
30	Green Sandpiper		
	Tringa ochropus	0	1
31	Spotted Redshank		
	Tringa erythropus	0	1
32	Marsh Sandpiper		
	Tringa stagnatilis	0	1
33	Wood Sandpiper		
	Tringa glareola	0	1
34	Common Redshank		
	Tringa totanus	0	1
Family Laridae			
35	Black-headed Gull		
	Chroicocephalus ridibundus	1	0
36	Brown-headed Gull		
	Chroicocephalus brunnicephalus	1	0
37	Pallas's Gull		
	Ichthyaetus ichthyaetus	1	0
38	Gull-billed Tern		
	Gelochelidon nilotica	1	1
39	Whiskered Tern		
	Chlidonias hybrida	1	1
40	River Tern		
	Sterna aurantia	1	1
Order Ciconiiformes			
Family Ciconiidae			
41	Asian Openbill		
	Anastomus oscitans	0	1
42	Painted Stork		
	Mycteria leucocephala	0	1
Order Suliformes			
Family Anhingidae			
43	Oriental Darter		
	Anhinga melanogaster	1	0
Family Phalacrocoracidae			
44	Little Cormorant		
	Microcarbo niger	1	0
45	Great Cormorant		
	Phalacrocorax carbo	1	0
46	Indian Cormorant		
	Phalacrocorax fuscicollis	1	0
Order Pelecaniiformes			
Family Pelecanidae			
47	Great White Pelican		
	Pelecanus onocrotalus	1	0
48	Dalmatian Pelican		

	Pelecanus crispus	1	0
Family Arediae			
49	Grey Heron		
	Ardea cinerea	1	1
50	Purple Heron		
	Ardea purpurea	1	1
51	Great Egret		
	Ardea alba	1	1
52	Intermediate Egret		
	Ardea intermedia	1	1
53	Little Egret		
	Egretta garzetta	1	1
54	Cattle Egret		
	Bubulcus ibis	0	1
55	Indian Pond Heron		
	Ardeola grayii	1	1
56	Striated Heron		
	Butorides striata	1	1
57	Black-crowned Night Heron		
	Nycticorax nycticorax	1	1
Family Threskiornithidae			
58	Glossy Ibis		
	Plegadis falcinellus	0	1
59	Black-headed Ibis		
	Threskiornis melanocephalus	0	1
60	Red-naped Ibis		
	Pseudibis papillosa	0	1
61	Eurasian Spoonbill		
	Platalea leucorodia	0	1
Wetland Dependent Birds			
Order Accipitriiformes			
Family Pandionidae			
1	Osprey		
	Pandion haliaetus	1	0
Family Accipitridae			
2	Western Marsh Harrier		
	Circus aeruginosus	1	0
Order Coraciiformes			
Family Alcedinidae			
3	Common Kingfisher		
	Alcedo atthis	1	1
4	White-throated Kingfisher		
	Halcyon smyrnensis	1	1
5	Pied Kingfisher		
	Ceryle rudis	1	1
Family Meropidae			
6	Green Bee-eater		
	Merops orientalis	1	1
7	Blue-cheeked Bee-eater		
	Merops persicus	0	1
8	Blue-tailed Bee-eater		
	Merops philippinus	0	1
Order Passeriformes			
Family Hirundinidae			
9	Wire-tailed Swallow		
	Hirundo smithii	1	1
10	Red-rumped Swallow		
	Cecropis daurica	1	1
11	Streak-throated Swallow		
	Petrochelidon fluvicola	1	1
Family Motacillidae			

12	Grey Wagtail		
	Motacilla cinerea	0	1
13	Western Yellow Wagtail		
	Motacilla flava	0	1
14	Citrine Wagtail		
	Motacilla citreola	0	1
15	White-browed Wagtail		
	Motacilla maderaspatensis	0	1
16	White Wagtail		
	Motacilla alba	0	1

Total 77 species of avifauna were recorded associated with anasagar lake, out of those 61 species were classified as wetland birds and 16 species were classified as wetland-dependent birds. The observed species belonged to 11 Orders and 21 Families, 8 orders and 15 families belonged to wetland birds and 3 orders and 6 families belonged to wetland-dependent birds. Order Charadriiformes dominated the study area with 23 species followed by Pelacaniformes with 15 species and Passeriformes with 8 species. Similarly, Family Scolopacidae dominated the study area with 11 species and a Relative Diversity index (RDi) value of 14.28% followed by Antidae with 10 species and RDi value of 12.98% and 9 species of Family Aridae with a RDi value of 11.68%. From the observed species 77 belong to Least concern category of IUCN followed by 7 species of Near-threatened category *viz*. Ferruginous pochard, Lesser flamingo, Black-Tailed godwit, Painted Stork, Oriental Darter, Dalmatian pelican and Black-headed Ibis, and 2 species of Vulnerable category *viz*, Common pochard and River tern.

Table 2: Statistical analysis of observed data.

Parameter	Deep Water Zone	Shallow Water Zone
Total Taxa	34	65
Number Species only utilizing the particular zone	12	43
Percentage of species only utilizing the particular zone	35.29%	66.15%
Number of Species utilizing both the zones	22(28.57%)	
Individuals	3291	3752
Dominance	0.1264	0.04101
Shannon Index	2.47	3.568
Evenness Index	0.3477	0.5453
Jaccard and Sorenson Similarity index value	0.437	

Statistical analysis shows that 34 out of 77 recorded species were recorded utilizing deep water zone as foraging ground and from these 34 species 12 species were only using the deep zone for foraging making it 35.29% of species observed feeding in deep water zone and 15.58% of overall species recorded at anasagar lake, 65 species were recorded foraging in shallow water zone of anasagar lake out of that 43 species preferred only the shallow water zone for foraging making it 66.15% and 55.84% of overall species. It is observed that 22 species from observed 77 species utilize both the zones of anasagar lake for foraging making it 28.57% of the total observed species. 3752 individuals of 43 species were recorded from shallow water zone and 3291 individuals of species were recorded from deep water zone. The higher number of dominance index was recorded in Deep water zone with a value of 0.1264 compared to the Shallow water zone with a value of 0.04101, The range of dominance index is from 0 to 1, greater value indicates that the zone or habitat is dominated by one particular species. The Shannon index value which indicates the species diversity, when observed between 0 and 1 is known to be a zone or habitat with low diversity, if an observed value is between 1 to 3 the zone or habitat is said to be moderately diverse and if the observed value is greater than 3 the zone or habitat is said to be highly diverse, from the records it is observed that the Deep water zone has a Shannon index value of 2.47 compared to Shallow water with a Shannon index value of 3.568 making it a highly diverse zone for birds. Similarly higher evenness value was observed from the Shallow water zone when compared to Deep water zone, 0.5453 and 0.3477 respectively. Jaccard and Sorenson index shows the similarity between two zones, the value ranges from 0 to 1 where 0 indicates zones with completely diverse community and 1 indicates zones with completely similar community, the observed value for both the zones is 0.437.

Fig 3

Conclusion

The increase in water level over the years resulted in increase of Deep water zone and a decrease in shallow water zone at anasagar lake of Ajmer. The wetland needs to be managed properly to meet the water depth need for different water bird groups, The order charadriiformes that dominated the study area with the highest number of species include shorebirds. The members of this order live near the water surface. And generally have smaller legs and beaks not suitable for Deep water zone, increase in deep water zone will result in reduction and elimination of the species of this order from anasagar lake, similarly in case of pelacaniformes which prefer the shallow water zone for foraging because deeper water can reduce the foraging efficiency because prey can escape not only horizontally but also vertically, in shallow zone it is not possible for the prey to escape vertically from the bird, Also in the deep water zone it is more difficult or predatory bird species to locate the prey due to high turbidity of water. Water depth also affects the net energy intake of water bird s as foraging efficiency is inversely proportional to increase in water depth. By the statistical analysis it is proved that the shallow water zone hosts high diversity of wetland and wetland-dependent birds in anasagar lake. Most of the species prefer shallow zone over the deep water zone for their nutritional requirement. But after the construction of pathway around the anasagar lake which has limited the shoreline of the lake and continuous injection of sewage water of Ajmer city is now a concern that it will only increase the depth of the water body.

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