

Aquatic Avian Composition, Diversity and Their Food Resources in the Selected Ponds of Naya Raipur, Chhattisgarh, India

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Abstract: Birds always have been an organism of fascination to humans. Pond (eco)system attracts several aquatic bird species. They boast a good habitat and food-store in the form of aquatic vegetation, fishes, insects, crabs, molluscs, dipterans, etc. and procure a satisfying abode for the aquatic avian. Overcoming the anthropogenic disturbances and habitat destruction, few aquatic birds 'check-in' in these standing water (lowland) and its surrounding (shoreline/uplands). The study was conducted from January, 2015 to December, 2017. Three ponds, *Sendh Pond*, *Jhanj Pond* and *Khandwa Pond*, were selected for the study at Naya Raipur, Chhattisgarh. Overall, including the three ponds, a total of 100 species of aquatic birds belonging to 9 orders and 23 families were recorded. Of them, 50 species were Resident (R), 46 species were Migratory (M), and 4 species were Local Migratory (LM) categories. According to the IUCN status (2017) 1 species was Vulnerable (VU), 6 species were Near Threatened (NT) 93 species were Least Concerned (LC). Also 1 species belonged to Schedule I of Wildlife (Protection) Act, 1972. Pond wise analysis for the aquatic birds under various categories was also done, to determine the difference amongst different ponds. Categorization, for feeding guild behaviour of aquatic birds, was also executed to find out the Insectivorous, Carnivorous, and Omnivorous aquatic birds. In the Omnivorous category, we interestingly worked out for the green feeders too, and identified the aquatic plants/ plant parts as bird food, supported by our field observations, and enlisted them in addition to the early available data of aquatic plants for the region. The Shannon-Weiner (H') diversity index from yearly population counts at the three ponds was also determined, while estimating and discussing the threats and their impact. This prudent work shall cover up the sustaining lacuna, and contribute for the baseline records and will be good paradigm for future works.

Keywords: Aquatic avian, Naya Raipur, Aquatic plants, food resource, guild behavior.

1. INTRODUCTION

Birds always have been an organism of fascination to humans. They also, in addition, are considered as a prime part and an indicator of a healthy ecosystem. The wetland habitat of the pond (eco)system attracts several aquatic and near-aquatic bird species. These lentic (pond) systems foster good microclimate around the (wet)land.

A Pond is commonly described by limnologists as a quiet body of water so shallow that rooted plants grow completely across it. There is a little wave action and the bottom is usually covered with mud (Reid, 1967). They are shallow enough to allow sunlight to penetrate in and support up to the rooted-submerged vegetation. These water bodies, when left undisturbed, develops variety in the assemblage of species. In the long run, when it grows old, are *worthy* to earn silt, and a good assembly of living lives. Thereby, creating conducive conditions for the settlement of avian communities and serving prime food sources for them, carrying edible meals of several profile which includes Fishes, Insects, Crabs, Molluscs, Dipterans, and of course the primary producers Aquatic Plants. Hence, procuring a satisfying abode for them to nest, roost, and aggregate to suffice their perpetuation.

The aquatic avian species are attracted by the good habitat and food-store formulated by the diverse aquatic vegetation, water, and shelter in the ponds of Naya Raipur, Chhattisgarh. In the vicinity of Sendh Pond the Harriers like Pallid harrier,

Montagu Harrier, Pied Harrier, and Marsh Harrier used to roost, but due to recent anthropogenic disturbances and habitat destruction in the aura of development they have abandoned the roost. Yet, a good number of aquatic birds 'check-in' in these standing waters and its surrounding. These ponds (wetlands) owing to their morphology, welcome diverse avian fauna both local and (including local migrants) migratory (migrates from far-lands to these Central (Indian) plains for wintering) (Hora, 1949) and few passerby / vagrants.

Wetlands >5 Hectares in size are utilized by diving ducks, smaller wetlands were most used if they were elongated because diving ducks need areas large enough for take-off and landing (Todd, 1997). Whereas, Diving ducks prefers wetlands with no emergent vegetation regions or that had only exterior rings of emergent vegetation; this again may stem from their need for a large take off and landing area. (Anderson *et. al.*, 2000).

Earlier works reflect the foraging and feeding behaviours of Northern Pintails and Green-winged Teal dabbling for food along pond margins in shallow water areas optimal for their body size; Ruddy ducks foraged in deeper water areas by diving. Thus it appeared that each duck species exploited foods from the ponds that were most easily obtainable given their morphological and behavioral attributes (Kramer & Euliss, 1986). Similarity in food habits was difficult to observe and assess, as the habitat use by the birds changes as per the morphology of the ponds (Euliss, 1989). When water might not be present at the land surface, but might be close enough to the land surface to maintain the vegetation and foods that are needed by birds. Birds may use wetlands located in depressions in an otherwise dry landscape, along streams, or in tidally influenced areas near shorelines. (Robert Jr., 1996)

Describing the **Diving Ducks**, of the Genus *Aythya*, which have legs set far back and far apart which makes walking awkward. Heavy bodies require a running start on water for take-off. Common Pochard, Tufted Duck, Ferruginous Duck, Red Crested Pochard. Whereas, the **Dabbling Ducks** are surface-feeding members of the Genus *Anas*: the familiar "puddle ducks" of freshwater shallows and chiefly in winter salt marshes. Dabblers feed by tipping tail up, to reach aquatic plants, seeds, and snails. They require no running start to take off but spring directly into flight. Indian Spot-billed Duck, Gadwall, Common Teal, Eurasian Wigeon, Northern Pintail, Northern Shoveler, Garganey, Cotton Teal (Dunn & Alderfer, 2006).

Taking into account for the feeding behavior of Aquatic birds- freshwater rooted vascular, floating vascular, and algal wetlands appeared to be more valuable to Whistling-ducks than other wetlands (Anderson *et. al.*, 2000). Whistling-ducks depend on rice fields for cover and food. (Kramer & Euliss, 1986) found cereal grains to be the most important food items of wintering Black-bellied Whistling-ducks in north west Mexico; seeds from several moist-soil plant species also were of value. During the breeding season Black-bellied and Fulvous Whistling-ducks feed primarily on plant foods, but animal matter also is taken (Bolen & Forsyth, 1967; Hohman *et. al.* 1996).

The primary aim was to study the species composition and diversity while recognizing food resource utilization for the aquatic birds according to their guild behaviour, as the explorations shall help us to gain comprehensive knowledge about the ecosystem operations (Hohman *et. al.*, 1996; Jha, 2013; Klaassen & Nolet, 2007; Bolen & Rylander, 1983). The earliest arrivals and last departures of migrating bird species which comes here to spend winter. The assessment of population status of aquatic birds and figuring out the Shannon-Weiner diversity index [H'] (1963) Shannon-Weiner

Diversity Index $H' = - \sum pi * \ln(pi)$ [H'= species diversity index

pi = proportion of the total no. of individuals belonging to the i^{th} species]

Maximum possible value of species diversity $H_{max} = \ln(S)$ [S = total number of species]

Species evenness(equitability) index $J' = \frac{H'}{H_{max}}$

The scope of this study was restricted to categories of **aquatic** (bird species which are strong swimmers being dabblers or divers, with striking plumage features, whose habit and habitat are totally aquatic for nesting, feeding, or shelter during wintering, applicable to migratory species and otherwise for resident (including breeding) species), **near-aquatic** (bird species habit and habitat are dependent on water resource/ wetland products) and **waders** (the shoreline species depending mostly on lowland(water) and upland products) avian. (Hoyer, 2013; Robert Jr., 1996; Fretweil, *et. al.*, 1996).

No such study had been prior executed / undertaken by any worker in the selected ponds of Naya Raipur, whilst they are three major waterbodies of Naya Raipur. So, this shall be a first prudent attempt to fill this lacuna and suffice a base-line data for the aquatic avian fauna in the ponds of Naya Raipur, Chhattisgarh.

2. METHODOLOGY

STUDY AREA:

Naya Raipur is a newly planned capital **smart-city** for Chhattisgarh state, notified by *Section 64 of Nagar Tatha Gramnivesh Adhiniyam, 1973*. It lies 25 km away, to the south-east of capital city Raipur and is divided into three layers **Layer I, Layer II** and **Layer III** as per their development plan by the NRDA (Naya Raipur Development Authority) (Oomen, 2008).

The summer temperature ranges from 30°C (min.) to 46°C(max.) and winter temperature from 5°C (min.) to 25°C (max.). Annual Rainfall (1150-1400mm) is due South-West monsoon which usually heralds from early June, mostly as afternoon winds followed by showers. Dropping the temperature down to cooler units and gradual rise in humid conditions which continues till October. The soil type is black regur soil, red-yellow soil, and murram land.

Out of the several ponds in the area, three ponds were selected (Figure-1), pertaining to its diversity and assembly of species, at Naya Raipur, Chhattisgarh for the studies *viz.* **Sendh Pond** and **Jhanj Pond** which comes under the NRDA and **Khandwa Pond** under the Chhattisgarh State Forest Department.

Sendh Pond located at (21° 12' 1'' N & 21° 12' 27'' N to 81° 48' 36'' E & 81° 49' 2'' E) Sector 4

adjacent to the International Cricket Stadium, Naya Raipur, is a charm for Naya Raipur. With maximum water spread area of 171 Hectares (**Bhuvan, WBIS 2.0**). It could be regarded as a large pond serving for variety of water use patterns which includes bathing, washing, irrigation purpose and cattle use. It owes its water retention to the surface run-offs and annual precipitation.

Jhanj Pond located at (21° 8' 27.10'' N & 21° 9' 2.46'' N to 81° 46' 21.50'' E & 81° 46' 7.48'' E) Sector 24, Naya Raipur. It was initially constructed to cater the needs of irrigation and human diverse water use patterns, with maximum water spread of 102 Hectares (Bhuvan, WBIS 2.0). Water retention is from surface run-offs and annual rainfall.

Khandwa Pond located at (21° 05' 42'' N & 21° 6' 18'' N to 81° 46' 12'' E & 81° 47' 12'' E) at Sector 39, Naya Raipur falls under protected area "*Jungle Safari*" which was inaugurated on 2nd November, 2016. Prior, this pond owes to be a large pond catering the water needs for irrigation and diverse range of human use. It is spread over an area of 52.52 Ha, with maximum water spread area of 77 Hectare (Bhuvan, WBIS 2.0).

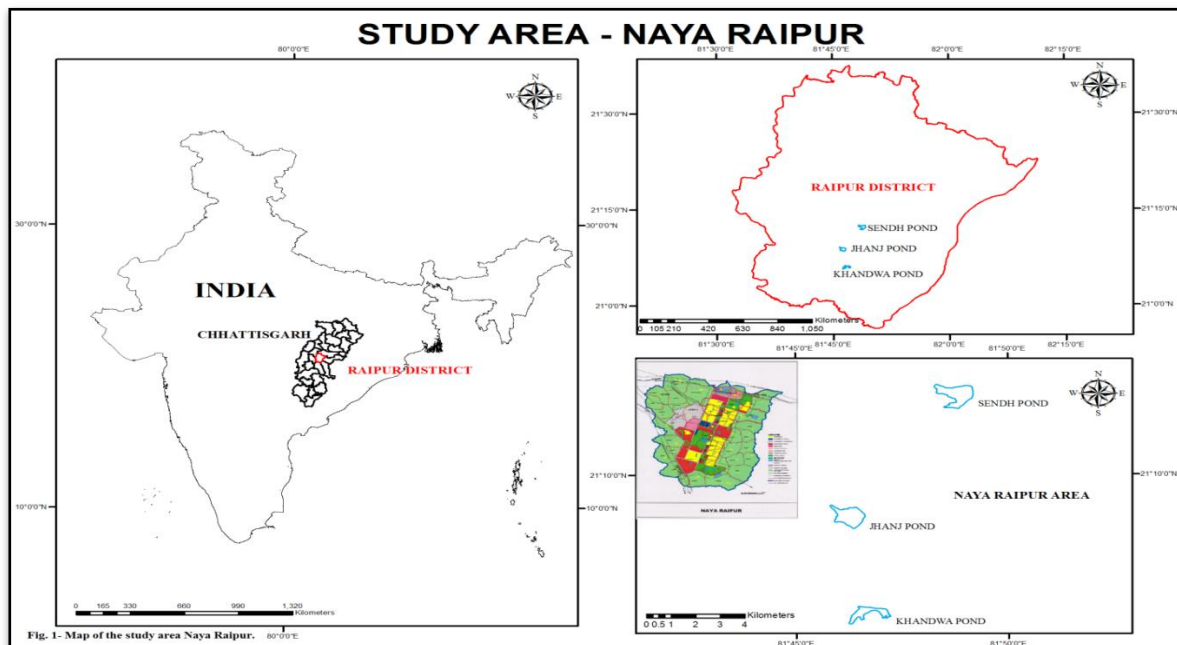


Figure-1

METHODS:

The study was conducted from January, 2015 to December, 2017. Population estimation for aquatic birds was done by Point Count Method and also by walking around the peripheral-accessible area of the pond seasonally. At times non-

motorised wooden canoes of the local fishermen was used to facilitate closer surveys, at the proximity of birds in the water. Strict care was taken, not to overlook or bias the count for any individual species encountered. The study was conducted seasonally, Winter(October to February) Summer (March to May) Monsoon(June to September), the count took place tentatively every fortnight surveying 1st and 15th of a month at Sendh Pond, 2nd and 16th of a month at Jhanj Pond, 3rd and 17th of a month at Khandwa Pond. The surveys were invariably carried out in different hours of the day for Point count studies starting 0600-1000 hrs, 1000-1600hrs, 1600hrs onwards till visibility, depending on the prevailing season and weather conditions the appropriate time slot was opted as per the ability, convenience and other needful field resources. Each opted survey lasted for 4-6hrs. All the seasonal data including the random days' survey were collected and clubbed together as yearly data. The guidance of past studies carried out by D' Abreu, (1935) & Hewetson (1956) and yester year's (2000-2012) seasonal field data of author (A. M. K. Bharos, Unpublished) was utilized to get good basis to design and support the study. The aquatic, near-aquatic and wader species were seen of interest and recorded by the aid of 8-16 X 40 binoculars of Olympus make, Photographs & Videos were taken by Canon by SX 30, Canon SX 60, and Nikon P900 Digital Cameras for later prudent identification and other studies following Ali and Ripley (1987); Rahmani & Islam (2008); Rahmani (2008); Grimmett *et. al.* (2011).The nomenclature of the recorded avifauna was done following Praveen *et. al.* (2016). The Shanon-Weiner diversity index (H'), H_{max} and Evenness index (J') was calculated on yearly basis for each of the three ponds. While the evaluation of these indices, the species which were not recorded, during any of the selected years, were omitted from the diversity index calculation tables.

The calls and behaviour of the aquatic birds were also taken into account to ascertain their identity and support the study. Survey for these studies were undertaken at intermittent dates of a month and day-long site visits as per above defined time-slots. Any suitable place, with good accessible visibility on the flocks, was chosen to sit on the ground, without vehicle, in the dried interior parts of the ponds to study the habit, behavior, identifying food by watching the birds feeding on the plant / animal resource, later when the birds have moved away from the spot, moving to that same point to collect and/or identify regurgitated and / or maneuvered samples (whenever found) to confirm the feeds. We kept on changing the sitting-spots randomly on each visit, to gain good and uniform observations from each pond area. Wildlife (Protection) Act, (1972) does not permit capture and/ or dissection of wild animals(birds), so the visual observations were the only pathway to conduct and conclude our study. The employment of Binoculars and Cameras were exploited to confirm observations and assertions. Prior works of the work (Mukherjee, Ajit K. 1969, 1971a, 1971b, 1974, 1975, 1976) and Ali and Ripley (1987)were followed.

3. RESULT & DISCUSSION

The study was confined to three ponds, viz. Sendh Pond, Jhanj Pond, and Khandwa Pond of Naya Raipur. Which took place from January 2015 to December 2017. The avian species observed have been enlisted (Table 1). The methodology for study and the geographical detail have been discussed above.

Table 1

S.No	Order	Family	English name	Scientific name	Resident Status	IUCN Status	Feeding Habits	A/ W/ NA	Sendh Pond	Jhanj Pond	Khandwa Pond		
1	Anseriformes	Anatidae	Lesser Whistling Duck	<i>Dendrocygna javanica</i> (Horsfield, 1821)	R	LC	Omnivorous	A	Y	Y	Y		
2			Bar-headed Goose	<i>Anser indicus</i> (Latham, 1790)	M	LC	Omnivorous	A	Y	N	N		
3			Greylag Goose	<i>Anser anser</i> (Linnaeus, 1758)	M	LC	Omnivorous	A	N	Y	N		
4			Red-crested Pochard	<i>Nettion rufina</i> (Pallas, 1773)	M	LC	Omnivorous	A	Y	Y	Y		
5			Common Pochard	<i>Ardea ferina</i> (Linnaeus, 1758)	M	NT	Omnivorous	A	Y	Y	Y		
6			Ferruginous Duck	<i>Ardea sacra</i> (Gmelin, 1789)	M	NT	Omnivorous	A	Y	N	N		
7			Tufted Duck	<i>Ardea fulva</i> (Linnaeus, 1758)	M	LC	Omnivorous	A	Y	Y	Y		
8			Garganey	<i>Spatula querquedula</i> (Linnaeus, 1758)	M	LC	Omnivorous	A	Y	Y	Y		
9			Northern Shoveler	<i>Spatula clypeata</i> (Linnaeus, 1758)	M	LC	Omnivorous	A	Y	Y	Y		
10			Gadwall	<i>Mareca strepera</i> (Linnaeus, 1758)	M	LC	Omnivorous	A	Y	Y	Y		
11			Eurasian Wigeon	<i>Mareca penelope</i> (Linnaeus, 1758)	M	LC	Omnivorous	A	Y	Y	Y		
12			Indian Spot-billed Duck	<i>Anas positorquata</i> (J.R. Forster, 1781)	R	LC	Omnivorous	A	Y	Y	Y		
13			Northern Pintail	<i>Anas acuta</i> (Linnaeus, 1758)	M	LC	Omnivorous	A	Y	Y	Y		
14			Common Teal	<i>Anas crecca</i> (Linnaeus, 1758)	M	LC	Omnivorous	A	Y	Y	Y		
15			Comb Duck	<i>Sarkidiornis melanotos</i> (Pennant, 1769)	R	LC	Omnivorous	A	Y	Y	Y		
16	Cotton Tail	<i>Nettion coronandicapua</i> (J.F. Gmelin, 1789)	R	LC	Omnivorous	A	Y	Y	Y				
17	Phoenicopteriformes	Podicipedidae	Little Grebe	<i>Tachypeta ruficollis</i> (Pallas, 1764)	R	LC	Omnivorous	A	Y	Y	Y		
18			Great Crested Grebe	<i>Podiceps cristatus</i> (Linnaeus, 1758)	M	LC	Omnivorous	A	Y	Y	N		
19	Gruiformes	Rallidae	Slaty-legged Crake	<i>Rallina eurizonoides</i> (Lafresnaye, 1845)	LM	LC	Omnivorous	W	Y	Y	N		
20			Ruddy-breasted Crake	<i>Zapornia fusca</i> (Linnaeus, 1766)	LM	LC	Omnivorous	W	Y	Y	N		
21			Brown Crake	<i>Zapornia akoni</i> (Sylv., 1832)	LM	LC	Omnivorous	W	Y	Y	Y		
22			White-breasted Waterhen	<i>Amurornis phaeoventris</i> (Pennant, 1769)	R	LC	Omnivorous	W	Y	Y	Y		
23			Watercock	<i>Gallinix cinerea</i> (J.F. Gmelin, 1789)	R	LC	Omnivorous	W	Y	N	N		
24			Purple Swamphen	<i>Porphyrio porphyrio</i> (Linnaeus, 1758)	R	LC	Omnivorous	W	Y	Y	Y		
25			Common Moorhen	<i>Gallinula chloropus</i> (Linnaeus, 1758)	R	LC	Omnivorous	W	Y	Y	Y		
26			Common Coot	<i>Fulica atra</i> (Linnaeus, 1758)	M	LC	Omnivorous	W	Y	Y	Y		
27			Pelecaniformes	Ciconiidae	Painted Stork	<i>Mycteria leucocephala</i> (Pennant, 1769)	R	NT	Carnivorous	NA	Y	Y	Y
28					Asian Openbill	<i>Anastomus oscitans</i> (Boddaert, 1783)	R	LC	Carnivorous	NA	Y	Y	Y
29					Black Stork	<i>Ciconia nigra</i> (Linnaeus, 1758)	M	LC	Carnivorous	NA	Y	Y	Y
30					Woolly-necked Stork	<i>Ciconia cygnoptera</i> (Boddaert, 1783)	R	LC	Carnivorous	NA	Y	Y	Y
31	Yellow Bittern	<i>Boobybus cinereus</i> (J.F. Gmelin, 1789)			R	LC	Carnivorous	NA	Y	Y	Y		
32	Cinnamon Bittern	<i>Boobybus cinereus</i> (J.F. Gmelin, 1789)			R	LC	Carnivorous	NA	Y	Y	Y		
33	Black Bittern	<i>Boobybus flavicollis</i> (Latham, 1790)			R	LC	Carnivorous	NA	Y	Y	Y		
34	Black-crowned Night Heron	<i>Nycticorax nycticorax</i> (Linnaeus, 1758)			R	LC	Carnivorous	NA	Y	Y	Y		
35	Striated Heron	<i>Butorides striata</i> (Linnaeus, 1758)			R	LC	Carnivorous	NA	Y	Y	Y		
36	Indian Pond Heron	<i>Ardea asiatica</i> (Sylv., 1832)			R	LC	Carnivorous	NA	Y	Y	Y		
37	Cattle Egret	<i>Bubulcus ibis</i> (Linnaeus, 1758)	R	LC	Carnivorous	NA	Y	Y	Y				
38	Grey Heron	<i>Ardea cinerea</i> (Linnaeus, 1758)	R	LC	Carnivorous	NA	Y	Y	Y				
39	Purple Heron	<i>Ardea purpurea</i> (Linnaeus, 1766)	R	LC	Carnivorous	NA	Y	Y	Y				
40	Great Egret	<i>Ardea alba</i> (Linnaeus, 1758)	R	LC	Carnivorous	NA	Y	Y	Y				
41	Intermediate Egret	<i>Ardea intermedia</i> (Vigier, 1829)	R	LC	Carnivorous	NA	Y	Y	Y				
42	Little Egret	<i>Egretta garzetta</i> (Linnaeus, 1766)	R	LC	Carnivorous	NA	Y	Y	Y				
43	Threskiornithidae		Black-headed Ibis	<i>Threskiornis melanoleuca</i> (Latham, 1790)	R	NT	Omnivorous	NA	Y	Y	Y		
44			Indian Black Ibis	<i>Pseudibis papillosa</i> (Temminck, 1824)	R	LC	Omnivorous	NA	Y	N	N		
45	Phalacrocoracidae		Little Cormorant	<i>Microcarbo niger</i> (Villot, 1817)	R	LC	Carnivorous	A	Y	Y	Y		
46			Great Cormorant	<i>Phalacrocorax carbo</i> (Linnaeus, 1758)	LM	LC	Carnivorous	A	Y	Y	Y		
47			Indian Cormorant	<i>Phalacrocorax fasciatus</i> (Stephens, 1826)	R	LC	Carnivorous	A	Y	Y	Y		
48	Anhinga		Oriental Darter	<i>Anhinga melanogaster</i> (Pennant, 1769)	R	NT	Carnivorous	A	N	N	Y		

49	Charadriiformes	Recurvirostridae	Black-winged Stilt	<i>Himantopus himantopus</i> (Linnaeus, 1758)	R	LC	Omnivorous	W	Y	Y	Y
50		Charadriidae	Little Ringed Plover	<i>Charadrius dubius</i> (Scopoli, 1786)	M	LC	Insectivorous	W	Y	Y	Y
51			Kantish Plover	<i>Charadrius alexandrinus</i> (Linnaeus, 1758)	M	LC	Insectivorous	W	Y	Y	Y
52			Yellow-wattled Lapwing	<i>Vanellus malabaricus</i> (Boddaert, 1783)	R	LC	Insectivorous	NA	Y	Y	Y
53			Red-wattled Lapwing	<i>Vanellus indicus</i> (Boddaert, 1783)	R	LC	Omnivorous	NA	Y	Y	Y
54		Rostratulidae	Greater Painted-snipe	<i>Rostratula benghalensis</i> (Linnaeus, 1758)	R	LC	Omnivorous	W	Y	N	N
55		Jacaniidae	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i> (Scopoli, 1786)	R	LC	Omnivorous	W	Y	Y	Y
56			Bronze-winged Jacana	<i>Metopidius indicus</i> (Latham, 1790)	R	LC	Omnivorous	W	Y	Y	Y
57		Scolopacidae	Little Stint	<i>Calidris minuta</i> Leisler, 1812)	M	LC	Insectivorous	W	Y	Y	Y
58			Common Snipe	<i>Gallinago gallinago</i> (Linnaeus, 1758)	R	LC	Insectivorous	W	Y	Y	Y
59			Common Sandpiper	<i>Actitis hypoleucos</i> (Linnaeus, 1758)	M	LC	Insectivorous	W	Y	Y	Y
60			Green Sandpiper	<i>Tringa ochropus</i> (Linnaeus, 1758)	M	LC	Insectivorous	W	Y	Y	Y
61			Spotted Redshank	<i>Tringa erythropus</i> (Pallas, 1764)	M	LC	Insectivorous	W	Y	Y	Y
62			Common Greenshank	<i>Tringa nebularia</i> (Gunnerus, 1767)	M	LC	Insectivorous	W	Y	Y	Y
63			Common Redshank	<i>Tringa totanus</i> (Linnaeus, 1758)	M	LC	Insectivorous	W	Y	Y	Y
64			Wood Sandpiper	<i>Tringa glareola</i> (Linnaeus, 1758)	M	LC	Insectivorous	W	Y	Y	Y
65			Marsh Sandpiper	<i>Tringa stagnatilis</i> (Bechstein, 1803)	M	LC	Insectivorous	W	Y	Y	Y
66		Laridae	River Tern	<i>Sterna aurantia</i> (J.E. Gray, 1831)	M	LC	Carnivorous	W	Y	N	N
67	Accipitriformes	Pandionidae	Osprey	<i>Pandion haliaetus</i> (Linnaeus, 1758)	R	LC	Carnivorous	NA	N	Y	Y
68		Accipitridae	Black-winged Kite	<i>Elanus caeruleus</i> (Desfontaines, 1789)	R	LC	Carnivorous	NA	Y	Y	Y
69			Indian Spotted Eagle	<i>Clanga hastata</i> (Lesson, 1831)	M	VU	Carnivorous	NA	Y	Y	Y
70			Eastern Marsh Harrier	<i>Circus spilonotus</i> (Kaup, 1847)	M	LC	Carnivorous	NA	Y	Y	Y
71			Pallid Harrier	<i>Circus macrorous</i> (S.G. Gmelin, 1770)	M	NT	Carnivorous	NA	Y	Y	Y
72			Pied Harrier	<i>Circus melanoleucos</i> (Pennant, 1769)	M	LC	Carnivorous	NA	Y	Y	Y
73			Montagu's Harrier	<i>Circus pygargus</i> (Linnaeus, 1758)	M	LC	Carnivorous	NA	Y	Y	Y
74			Shikra	<i>Accipiter badius</i> (J.F. Gmelin, 1788)	R	LC	Carnivorous	NA	Y	Y	Y
75			Northern Goshawk	<i>Accipiter gentilis</i> (Linnaeus, 1758)	M	LC	Carnivorous	NA	Y	Y	Y
76			Black Kite	<i>Mitrus migrans</i> (Boddaert, 1783)	R	LC	Carnivorous	NA	Y	Y	Y
77	Strigiformes	Strigidae	Indian Eagle Owl	<i>Bubo bengalensis</i> (Franklin, 1851)	R	LC	Carnivorous	NA	N	N	Y
78			Brown fish owl	<i>Ketupa zeylonensis</i> (J.F. Gmelin, 1788)	R	LC	Carnivorous	NA	Y	Y	Y
79	Coraciiformes	Meropidae	Green Bee-eater	<i>Merops orientalis</i> (Latham, 1801)	R	LC	Insectivorous	NA	Y	Y	Y
80		Alcedinidae	Common Kingfisher	<i>Alcedo atthis</i> (Linnaeus, 1758)	R	LC	Carnivorous	NA	Y	Y	Y
81			Pied Kingfisher	<i>Ceryle rudis</i> (Linnaeus, 1758)	R	LC	Carnivorous	NA	Y	Y	Y
82			White-throated Kingfisher	<i>Haliastur intermedius</i> (Linnaeus, 1758)	R	LC	Carnivorous	NA	Y	Y	Y
83	Psittaciformes	Motacillidae	Water Pipit	<i>Anthus spinoletta</i> (Linnaeus, 1758)	M	LC	Insectivorous	W	Y	Y	Y
84			Richard's Pipit	<i>Anthus richardi</i> (Vieillot, 1818)	M	LC	Insectivorous	W	Y	Y	Y
85			Paddyfield Pipit	<i>Anthus rufulus</i> (Vieillot, 1818)	M	LC	Insectivorous	W	Y	Y	Y
86			Tawny Pipit	<i>Anthus campestris</i> (Linnaeus, 1758)	M	LC	Insectivorous	W	Y	Y	Y
87			Western Yellow Wagtail	<i>Motacilla flava</i> (Linnaeus, 1758)	M	LC	Insectivorous	W	Y	Y	Y
88			Grey Wagtail	<i>Motacilla cinerea</i> (Tunstall, 1771)	M	LC	Insectivorous	W	Y	Y	Y
89			Citrine Wagtail	<i>Motacilla citreola</i> (Pallas, 1776)	M	LC	Insectivorous	W	Y	Y	Y
90			White-browed Wagtail	<i>Motacilla madagascariensis</i> (J.F. Gmelin, 1789)	R	LC	Insectivorous	W	Y	Y	Y
91			White Wagtail	<i>Motacilla alba</i> (Linnaeus, 1758)	M	LC	Insectivorous	W	Y	Y	Y
92		Alaudidae	Greater short-toed Lark	<i>Calandrella brachydactyla</i> (Leisler, 1814)	M	LC	Insectivorous	NA	Y	Y	Y
93		Acrocephalidae	Blyth's Reed Warbler	<i>Acrocephalus dumetorum</i> (Blyth, 1849)	M	LC	Insectivorous	NA	Y	Y	Y
94			Paddyfield Warbler	<i>Acrocephalus agricola</i> (Jerdon, 1854)	R	LC	Insectivorous	NA	Y	Y	Y
95			Clamorous Reed Warbler	<i>Acrocephalus stentoreus</i> (Hemprich & Ehrenberg, 1833)	M	LC	Insectivorous	NA	Y	Y	Y
96		Hirundinidae	Red-rumped Swallow	<i>Cecropis daurica</i> (Laxmann, 1769)	M	LC	Insectivorous	NA	Y	Y	Y
97			Straited Swallow	<i>Cecropis striolata</i> (Schlegel, 1844)	M	LC	Insectivorous	NA	Y	Y	Y
98			Wire-tailed Swallow	<i>Hirundo smithii</i> (Leach, 1818)	R	LC	Insectivorous	NA	Y	Y	Y
99			Bank Swallow	<i>Hirundo rustica</i> (Linnaeus, 1758)	M	LC	Insectivorous	NA	Y	Y	Y
100			Plain martin	<i>Riparia paludicola</i> (Vieillot, 1817)	R	LC	Insectivorous	NA	Y	Y	Y
9 Orders		23 Families	100 species								
KEY:				IUCN status	Count	WPA	1				
Resident Status				VU	1						
R= Resident				NT	6						
M= Migratory				LC	93						
LM= Local Migratory				Total	100						
IUCN status				Habitat Category	Count						
VU= Vulnerable				Aquatic(A)	23						
NT= Near Threatened				Near Aquatic (NA)	45						
LC= Least Concern				Waders (W)	33						
				Total	100						
Category				Feeding Guild of Birds	Count						
A= Aquatic				Insectivorous	31						
NA= Near aquatic				Carnivorous	36						
W= Wader				Omnivorous	33						
Occurrence				Total	100						
Y= Recorded											
N= Not recorded											

Overall, including the three ponds, a total of 100 species belonging to 9 orders and 23 families were recorded, comprising of 50 species as Resident(R), 46 species as Migratory(M), and 4 species as Local Migratory(LM). According to the IUCN status (2017) 1 species was Vulnerable(VU), 6 species were Near Threatened (NT) 93 species were Least Concerned (LC). Also 1 species belonged to Schedule I of Wildlife (Protection) Act, 1972.

The family-wise analysis (Fig. 2) revealed, the approximate Abundance percentage with respect to total species was worked out which resulted into Anatidae- 16 species (16%) and Ardeidae – 12species (12%) being the most abundant, with respect to high scores of different species records. Rest of the species belonging to 21 families had lower counts.

Table 2: Aquatic Plants of the Jhanj Pond including Sindh Pond and Khandwa Pond (Bux & Acharya, 2017)

Sl. No.	Plant Species
1	<i>Ageratum conyzoides</i> L.
2	<i>Alternanthera paronychioides</i> St.Hil.Voy.Bres.
3	<i>Alternanthera philoxeroides</i> (Mart.) Griseb.
4	<i>Alternanthera sessilis</i> (L.) DC.
5	<i>Alysicarpus monilifer</i> (L.)DC.

6	<i>Ammannia baccifera</i> L.
7	<i>Ammannia multiflora</i> Roxb.
8	<i>Aneilema spiratum</i> (L.)
9	<i>Aponogeton crispus</i> Thunb.
10	<i>Aponogeton natans</i> L.
11	<i>Arundinella pumila</i> (Hochst. ex A.Rich.) Steud.
12	<i>Bergia ammannioides</i> Roxb.
13	<i>Bergia capensis</i> L.
14	<i>Blumea lacera</i> (Burm. fil.) DC.
15	<i>Blumea oxyodonta</i> DC.
16	<i>Blyxa octandra</i> (Roxb.) Planch. ex Thwaites
17	<i>Bothriochloa pertusa</i> (L.) A.Camus
18	<i>Brachiaria ramosa</i> (L.) Stapf
19	<i>Bulbostylis barbata</i> (Rottb.) C.B.Clarke
20	<i>Butomopsis lanceolata</i> (Roxb.) Kunth
21	<i>Caesulia axillaris</i> Roxb.
22	<i>Celosia argentea</i> L.
23	<i>Centella asiatica</i> (L.) Urb.
24	<i>Chrysopogon aciculatus</i> (Retz.) Trin.
25	<i>Coldenia procumbens</i> L.
26	<i>Commelina benghalensis</i> L., nom. cons.
27	<i>Crinum asiaticum</i> L.
28	<i>Crotalaria pallida</i> Aiton
29	<i>Croton bonplandianus</i> Baill.
30	<i>Cyanotis axillaris</i> (L.) D.Don ex Sweet
31	<i>Cynodon dactylon</i> (L.) Pers.
32	<i>Cyperus alopecuroides</i> Rottb.
33	<i>Cyperus brevifolius</i> (Rottb.) Hassk.
34	<i>Cyperus castaneus</i> Willd.
35	<i>Cyperus compressus</i> L.
36	<i>Cyperus cuspidatus</i> Kunth.
37	<i>Cyperus difformis</i> L.
38	<i>Cyperus iria</i> L.
39	<i>Cyperus pilosus</i> Vahl
40	<i>Cyperus platystylis</i> R.Br.
41	<i>Cyperus sanguinolentus</i> Vahl.
42	<i>Dactyloctenium aegyptium</i> (L.) Willd.
43	<i>Desmodium triflorum</i> (L.) DC.
44	<i>Digitaria sanguinalis</i> (L.) Scop.
45	<i>Echinochloa colona</i> (L.) Link
46	<i>Echinops echinatus</i> Roxb.
47	<i>Eclipta alba</i> (L.) Hassk.
48	<i>Eleocharis acutangula</i> subsp. acutangula
49	<i>Eleocharis atropurpurea</i> (Retz.) J.Presl & C.Presl
50	<i>Eleocharis congesta</i> D.Don
51	<i>Eleocharis dulcis</i> (Burm.f.) Trin. ex Hensch.
52	<i>Eleocharis retroflexa</i> (Poir.) Urb.
53	<i>Eleusine coracana</i> (L.) Gaertn.
54	<i>Eragrostis nutans</i> (Retz.) Nees ex Steud.
55	<i>Eriocaulon quinquangulare</i> L.
56	<i>Evolvulus nummularius</i> (L.)
57	<i>Exacum pedunculatum</i> L.
58	<i>Fimbristylis aestivalis</i> (Retz.) Vahl
59	<i>Fimbristylis bisumbellata</i> (Forssk.) Bubani
60	<i>Fimbristylis dichotoma</i> (L.)
61	<i>Gnaphalium indicum</i> auct. non. L.
62	<i>Grangea maderaspatana</i> (L.) Poir.

63	<i>Heliotropium indicum</i> L.
64	<i>Heliotropium supinum</i> L.
65	<i>Heteropogon contortus</i> (L.) P.Beauv. ex Roem. & Schult.
66	<i>Hoppea dichotoma</i> Hayne ex Willd.
67	<i>Hydrilla verticillata</i> (L.f.) Royle
68	<i>Hygrophila auriculata</i> Schum.
69	<i>Indigofera linifolia</i> (L.f.) Retz.
70	<i>Ipomoea aquatica</i> Forsk.
71	<i>Ipomoea carnea</i> Jacq.
72	<i>Ischaemum rugosum</i> Salisb.
73	<i>Jatropha gossypifolia</i> L.
74	<i>Jussiaea repens</i> (L.)
75	<i>Lantana camara</i> L.
76	<i>Limnophila heterophylla</i> (Roxb.) Benth.
77	<i>Limnophila indica</i> (L.) Druce
78	<i>Lindernia crustacea</i> (L.) F. Muell.
79	<i>Lindernia oppositifolia</i> (L.) Mukerjee
80	<i>Lippia nodiflora</i> (L.) Michx.
81	<i>Malvastrum coromandelianum</i> L.
82	<i>Merremia emarginata</i> (Burm. fil.) Hall. fil.
83	<i>Najas indica</i> (Willd.) Cham.
84	<i>Najas marina</i> L.
85	<i>Nymphaea caerulea</i> Savigny.
86	<i>Nymphaea pubescens</i> Willd.
87	<i>Nymphaea rubra</i> Roxb.
88	<i>Nymphoides indica</i> (L.) Kuntze
89	<i>Oldenlandia corymbosa</i> L.
90	<i>Oldenlandia pumila</i>
91	<i>Oryza rufipogon</i> Griff.
92	<i>Panicum repens</i> L.
93	<i>Paspalum distichum</i> L.
94	<i>Paspalum plicatulum</i> Michx.
95	<i>Pennisetum pedicellatum</i> Trin.
96	<i>Polygonum glabrum</i> Willd.
97	<i>Portulaca oleracea</i> L.
98	<i>Potamogeton crispus</i> L.
99	<i>Potamogeton nodosus</i> Poir.
100	<i>Potamogeton pectinatus</i>
101	<i>Pseudoraphis spinescens</i> (R.Br.) Vickery
102	<i>Rhynchospora colorata</i> (L.) H.Pfeiff.
103	<i>Rotala indica</i> (Willd.) Koehne
104	<i>Saccharum spontaneum</i> L.
105	<i>Sacciolepis myosuroides</i> (R.Br.) A.Camus
106	<i>Scirpus articulatus</i> L.
107	<i>Scirpus juncoides</i> Roxb.
108	<i>Scirpus squarrosus</i> L.
109	<i>Scirpus supinus</i> L.
110	<i>Solanum</i> sp.
111	<i>Sphaeranthus indicus</i> L.
112	<i>Spilanthes calva</i> DC.
113	<i>Striga angustifolia</i> (D. Don) C.J. Saldanha
114	<i>Themeda quadrivalvis</i> (L.) Kuntze
115	<i>Tridax procumbens</i> L.
116	<i>Typha angustifolia</i> L.
117	<i>Uraria picta</i> (Jacq.) DC.
118	<i>Utricularia stellaris</i> L. fil.
119	<i>Vallisneria spiralis</i> L.

120	<i>Vigna trilobata</i> (L.)Verdc.
121	<i>Xanthium strumarium</i> L.
122	<i>Ceratopteris thalictroides</i>
123	<i>Marsilea quadrifoliata</i> L.
124	<i>Marsilea minuta</i> L.
125	<i>Chara zeylanica</i> Willd.
126	<i>Nitella globulifera</i> B.P.Pal

The total 100 species were analysed, out of which 22 species were Aquatic(A), 45species were Near Aquatic(NA), and 33 species were Waders(W).

Of the total 100 species they were categorized as per the bird guild behavior, 31(31 %)species were Insectivorous, 36 (36%) species were Carnivorous, and 33 (33%) species were Omnivorous. Following Ali & Ripley (1987) and Patten (1906) description, we categorized the guild/ feeding behavior as **Omnivorous**- feeding on animal and /or primarily Vegetable matter. Obtained in water marshes, or meadows and fields, by dabbling diving or grazing. **Carnivorous**-feeding on shrimps, mollusc, fishes, crabs, mice and rodents, amphibians, reptiles etc. **Insectivorous**- feeding on both aquatic and non-aquatic insects viz., Dipterans, Hemipterans, Stoneflies, Odonates, Skimmers and Gliders etc.

We undertook **Omnivorous** guild behavior in a diverse range (which includes sightings of), feed on Aquatic plants like phytoplanktons, parts of plants like *Vallisneria spiralis* L., *Typha angustifolia* L., *Ipomoea aquatica* Forsk., *Eleocharis dulcis* (Burm.f.) Trin.ex Hensch and/or animal feed like zooplanktons, shrimps, Hemipterans, fishes, molluc, crustaceans, lizard, etc.. Of which ANATIDAE were prominently more inclined towards aquatic plants' feed which includes plant parts viz. grains, seeds, shoots, flowers, tubers, tender leaves etc. and certainly to an extent on aquatic animal/animal matter. PODICIPEDIDAE were observed perhaps feeding on fish, tadpole, frogs, aquatic insects, larvae, feathers, etc. RALLIDAE were observed probably feeding on aquatic plant parts- shoots and seeds, mollusc, insects, worms, etc. THRESKIORNITHIDAE were observed preferably feeding on fish, frog, mollusc insect, worm, grass grains, algae matter. RECURVIROSTRIDAE was seen feeding on mollusc, small insects, seeds of grasses, parts of aquatic plants. Few speices of CHARADRIIDAE were found feeding on ants, beetles, and other insects, with parts of aquatic plants. JACANIDAE chiefly vegetable matter, aquatic insects, larvae, and molluscs (Ali & Ripley, 1987 and Patten, 1906).

Carnivorous- The birds of this category were apparently found feeding on fishes, reptiles, crustaceans, aquatic insects, to minor extent --crabs, frog, lizards, small rodents (Ali & Ripley, 1987 and Patten, 1906). Asian Openbill (*Anastomus oscitans*, Boddeart,1783) was found being very fond of *Pila globosa* and *Lamellidens marginalis*.

Insectivorous—Insects, larvae of insects, weevils, minor crabs, mollusc. Little stint which is primarily insectivorous but occasionally feeds on seeds of different aquatic plants (Ali & Ripley, 1987 and Patten, 1906).

Overall 126 species of Aquatic macrophytes , including 71 species (Bux and Acharya, 2017), occurs in these three ponds of Naya Raipur. All these 126 species of Aquatic macrophytes, also mark their prescence in Jhanj Pond (Table 2) (Biswas & Calder,1937; Subramanyam, 1962; and Verma *et. al.*,1985).

The aquatic vegetation serves as good food supermarket as found during the study, the root stocks of *Vallisneria spiralis* L., *Typha angustifolia* L., *Ipomoea aquatica* Forsk. sometimes *Ipomoea carnea* Jacq., *Nymphaea caerulea* Savigny., *Nymphaea pubescens* Willd., *Nymphaea rubra* Roxb., serves as fish spawning centre, and habitat centre for insects. The root tuber/stock of plants like *Marsilea minuta* L., *Marsilea quadrifoliata* L., fruits and seeds of *Nymphaea pubescens* Willd., *Nymphaea rubra* Roxb., and *Nymphaea caerulea* Savigny., stem, leaves and flowers of *Ipomoea aquatica* Forsk, including vegetative parts of *Scirpus articulatus* L, *Eleocharis dulcis* (Burm.f.) Trin.ex Hensch., *Eleocharis congesta* D.Don , *Eleocharis acutangula* subsp. *acutangula*, *Najas marina* L. , *Najas indica* (Willd.) Cham., *Potamogeton pectinatus*, *Vallisneria spiralis* L., *Oryza rufipogon* Griff., etc. creates appropriate meals for different guild preferring birds.

Most of the Omnivorous species observed, were found feeding on these food resources, suiting to their diet. *Jussiaea repens* (L.) tender stem and root, shoot, leaves and flowers of *Hydrilla verticillata* (L.f.) Royle, leaves and seeds of *Najas indica* (Willd.) Cham., leaves and seeds of *Vallisneria spiralis* L., *Potamogeton pectinatus* L. and *Potamogeton nodosus* Poir.. Flowers and seeds of *Alloteropsis cimicina* (L.) Stapf, roots of *Commelina benghalensis* L., New leaves and fruit *Cyperus alopecuroides* Rottb., Seeds of *Echinochloa colona* (L.) Link, roots and soft shoots of *Eleocharis dulcis* (Burm.f.)Trin. Ex. Hensch. and *Eleocharis congesta* D.Don, grains of *Oryza rufipogon* Griff., seeds of *Scirpus articulatus* L., New soft shoots of *Typha angustifolia* L.

Sendh Pond:

It harbours good aquatic vegetation (Bux and Acharya, 2017) with diverse bird food resources, ambient water quality and maximum water spread area of 171 Hectares (Bhuvan, WBIS 2.0). A total of 9 orders, 21 families, 96 species of aquatic birds were recorded in this pond during our whole study period. Out of these 96 species, 47 species were Resident(R), 45 species were Migratory(M), and 4 Local Migratory(LM) (Fig. 3). Further analysis revealed, 20 species were Aquatic(A), 43 were Near Aquatic(NA) and 33 species were categorised as Waders(W). The IUCN (2017) categories for the species recorded was also worked out, Common Pochard *Aythya ferina* (Linnaeus, 1758), Ferruginous Duck *Aythya nyrogra* (Guldenstadt, 1770), Painted Stork *Mycteria leucocephala* (Pennant, 1769), Black-headed Ibis *Threskiornis melanocephalus* (Latham, 1790), Pallid Harrier *Circus macrourus* (S.G. Gmelin, 1770) belonged to Near Threatened (NT) category. Only one species, Indian Spotted Eagle *Clanga hastata* (Lesson, 1831) belonged to Vulnerable (VU) category. Rest 90 species were of Least Concern(LC) category.

Of the total 96 species they were categorized as per the bird guild behavior, 31 species were Insectivorous, 33 species were Carnivorous, and 32 species were Omnivorous.

Abundance percentage with respect to total species of a family in relation to the total number of species recorded and represented by all families was worked out (Fig. 4). Anatidae- 15 species (15.6%) and Ardeidae – 12 species (12.5%) were the most abundant family as found. The Northern Goshawk *Accipiter gentilis* (Linnaeus, 1758) was recorded only once in 2015.

The Shanon-Weiner diversity index (Fig. 2) for year 2015 was calculated and found to be $H=3.72$, and H_{max} was established to be 4.54. The Evenness index $J'=H/H_{max}$ was calculated as 0.81. For year 2016 the diversity index revealed 3.65 and H_{max} 4.52 with Evenness index $J'=0.80$, and for 2017 the H' was 3.68, and H_{max} 4.51 with $J'=0.81$. The diversity for 2015 was of good score, as compared to years 2016 and 2017.

Major aquatic plant species found during study were *Vallisneria spiralis* L., *Typha angustifolia* L., *Ipomoea aquatica* Forsk., *Ipomoea carnea* Jacq., *Nymphaea caerulea* Savigny., *Nymphaea pubescens* Willd., *Nymphaea rubra* Roxb., *Marsilea minuta* L., *Marsilea quadrifoliata*, *Oryza rufipogon* Griff., *Najas marina* L., *Eleocharis dulcis* (Burm.f.) Trin.ex Hensch. We also found insects, certain species of mollusc Unio, in the reptiles Chequered Keelback and Common Rat Snake, Amphibians- Common Toad, Indian Bullfrog, Indian Tree frog, India Skipper frog were abundant which correlate with defined food of birds. Because of the kind of food required by a particular avian family/genus, their population abundance was noticed and observed.

It is disturbed due to continuous anthropogenic and cattle pressure. Including few amusement activities, extensive fishing, encroachment for agriculture, snaring and trapping of birds to some extent, diverse utilization of water for construction works around. All these factors have widely contributed to overall declination in the good-state of the Pond.

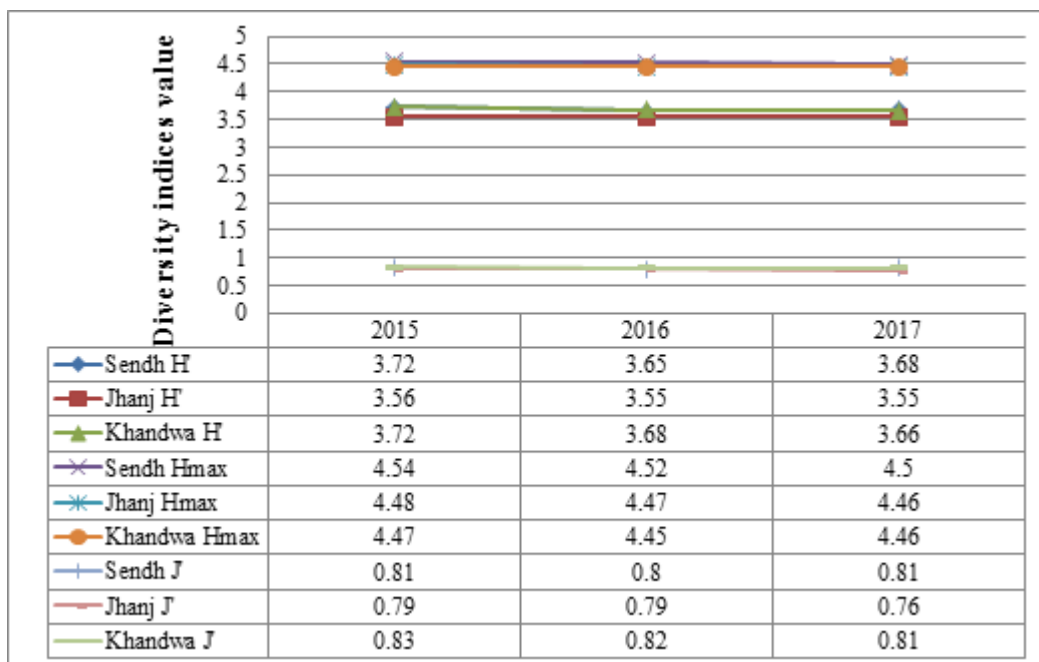


Fig 2: The diversity indices H' , H_{max} , & J' for aquatic avian in three ponds of Naya Raipur

Jhanj Pond:

A total of 92 species belonging to 9 orders and 20 families were recorded. Of which 45 species were Resident(R), 43 species were Migratory(M), and 4 species were Local Migratory(LM). According to the IUCN status (2017) 1 species Indian Spotted Eagle *Clanga hastata* (Lesson, 1831) belonged to Vulnerable(VU) category, 4 species Common Pochard *Aythya ferina* (Linnaeus, 1758), Painted Stork *Mycteria leucocephala* (Pennant, 1769), Black-headed Ibis *Threskiornis melanocephalus* (Latham, 1790), Pallid Harrier *Circus macrourus* (S.G. Gmelin, 1770) belonged to Near Threatened (NT) category, and rest 87 species were of Least Concerned (LC) category. Also 1 species, Osprey, belonged to Schedule I of Wildlife (Protection) Act, 1972.

The family-wise analysis for the approximate Abundance percentage (Fig. 4) with respect to total species was worked out as Anatidae- 14 species (15.2%) and Ardeidae – 12 species (13%) being the most abundant, with respect to high scores of different species records. Rest of the species belonging to 21 families were with much lower counts. Further analysis revealed, 19 species were Aquatic(A), 43 species were Near Aquatic(NA), and 30 species were Waders(W). Of the total 92 species they were categorized as per the bird guild behavior, 31 species were Insectivorous, 33 species were Carnivorous, and 28 species were Omnivorous.

The Shannon-Weiner diversity index (Fig. 2) for year 2015 was calculated and found to be $H=3.56$, and H_{max} was established to be 4.48. The Evenness index $J'=H/H_{max}$ was calculated as 0.79. For year 2016 the diversity index revealed 3.55 and H_{max} 4.47 with Evenness index $J'=0.79$, and for 2017 the H' was 3.55, and H_{max} 4.46 with $J'=0.76$.

Dominant aquatic plant species found during study were *Vallisneria spiralis* L., *Typha angustifolia* L., *Ipomoea aquatica* Forsk., *Ipomoea carnea* Jacq., *Najas marina* L., *Eleocharis dulcis* (Burm.f.) Trin.ex Hensch., *Nymphaea pubescens* Willd., *Aponogeton crispus* Thunb. *Aponogeton natans* L., *Panicum repens* L., *Paspalum distichum* L., *Paspalum plicatulum* Michx., *Pennisetum pedicellatum* Trin., *Polygonum glabrum* Willd., *Portulaca oleracea* L., *Potamogeton crispus* L., *Potamogeton nodosus* Poir. We also found insects, certain species of mollusc, in the reptiles Chequered Keelback and amphibians- Common Toad, Bullfrog were abundant, correlating with defined food of birds as discussed. Because of the kind of food required by a particular avian family, their population abundance was found, which also accounts for the maintenance of overall diversity.

It is mainly disturbed due to amusement activities like construction of Hotels /Resorts around, other anthropogenic pressure. Including extensive fishing, diverse utilization of water for construction works around and for irrigation. All these factors have widely contributed to overall but moderate declination in the state of the pond.

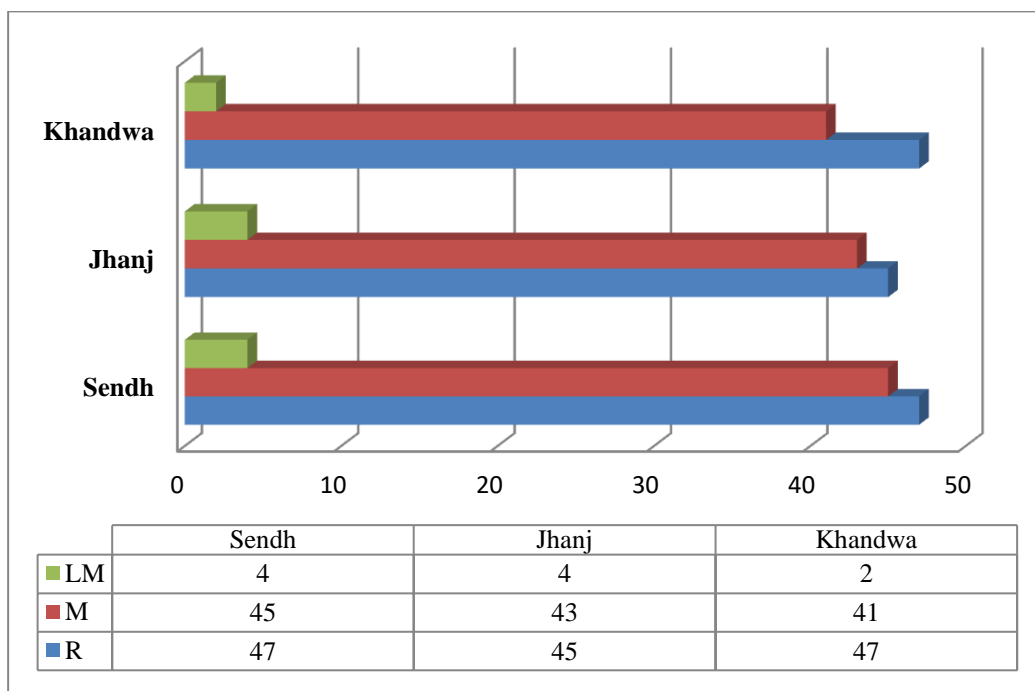


Fig 3: Resident Status of birds in the ponds of Naya Raipur

Khandwa Pond:

A total of 90 species belonging to 9 orders and 21 families were recorded in this protected area. Of which 47 species were Resident(R) 41 species were Migratory(M) and 2 species were Local Migratory(LM). According to the IUCN status (2017) 1 species Indian Spotted Eagle *Clanga hastata* (Lesson, 1831) belonged to Vulnerable(VU), 5 species like Common Pochard *Aythya ferina* (Linnaeus, 1758), Ferruginous Duck *Aythya nyroca* (Guldenstadt, 1770), Painted Stork *Mycteria leucocephala* (Pennant, 1769), Black-headed Ibis *Threskiornis melanocephalus* (Latham, 1790), Pallid Harrier *Circus macrourus* (S.G. Gmelin, 1770) belonged to Near Threatened (NT), and rest 84 species were of Least Concerned (LC) category.

The family-wise analysis revealed (Fig. 4), the approximate Abundance percentage with respect to total species was worked out as Anatidae- 13 species (14.4%) and Ardeidae – 12 species (13.3%) being the most abundant, with respect to high scores of different species records. Rest of the species belonging to 19 families were with lower counts. Further analysis revealed, 18 species were Aquatic(A), 43 species were Near aquatic(NA), and 29 species were Waders(W). Of total 90 species, 31 species were Insectivorous, 35 species were Carnivorous, 24 species were of Omnivorous guild.

The Shannon-Weiner diversity index (Fig. 2) for year 2015 was calculated and found to be $H' = 3.72$, and H_{max} was established to be 4.47. The Evenness index $J' = H/H_{max}$ was calculated to be 0.83. For year 2016 the diversity index H' revealed 3.68 and H_{max} 4.45 with Evenness index $J' = 0.82$, and for 2017 the H' was 3.66, and H_{max} 4.46 with $J' = 0.82$.

Dominant aquatic plant species found during study were *Vallisneria spiralis* L., *Typha angustifolia* L., *Ipomoea aquatica* Forsk., *Ipomoea carnea* Jacq., *Najas marina* L., *Eleocharis dulcis* (Burm.f.) Trin. ex Hensch., *Nymphaea pubescens* Willd., *Aponogeton crispus* Thunb. *Aponogeton natans* L., *Panicum repens* L., *Paspalum distichum* L., *Paspalum plicatulum* Michx., *Pennisetum pedicellatum* Trin., *Polygonum glabrum* Willd., *Potamogeton crispus* L., *Ammannia baccifera* L., *Utricularia stellaris* L., *Nitella globulifera* B.P. Pal. We also found insects, certain species of mollusc viz. *Bellamaya benghalensis*, *Lamellidens marginalis*, in the reptiles Chequered Keelback and Amphibians- Common Toad, Bullfrog were abundant, correlating with defined food of birds as discussed. Because of the kind of food required by a particular avian family, their population abundance was found, accounting for the sustenance of overall diversity.

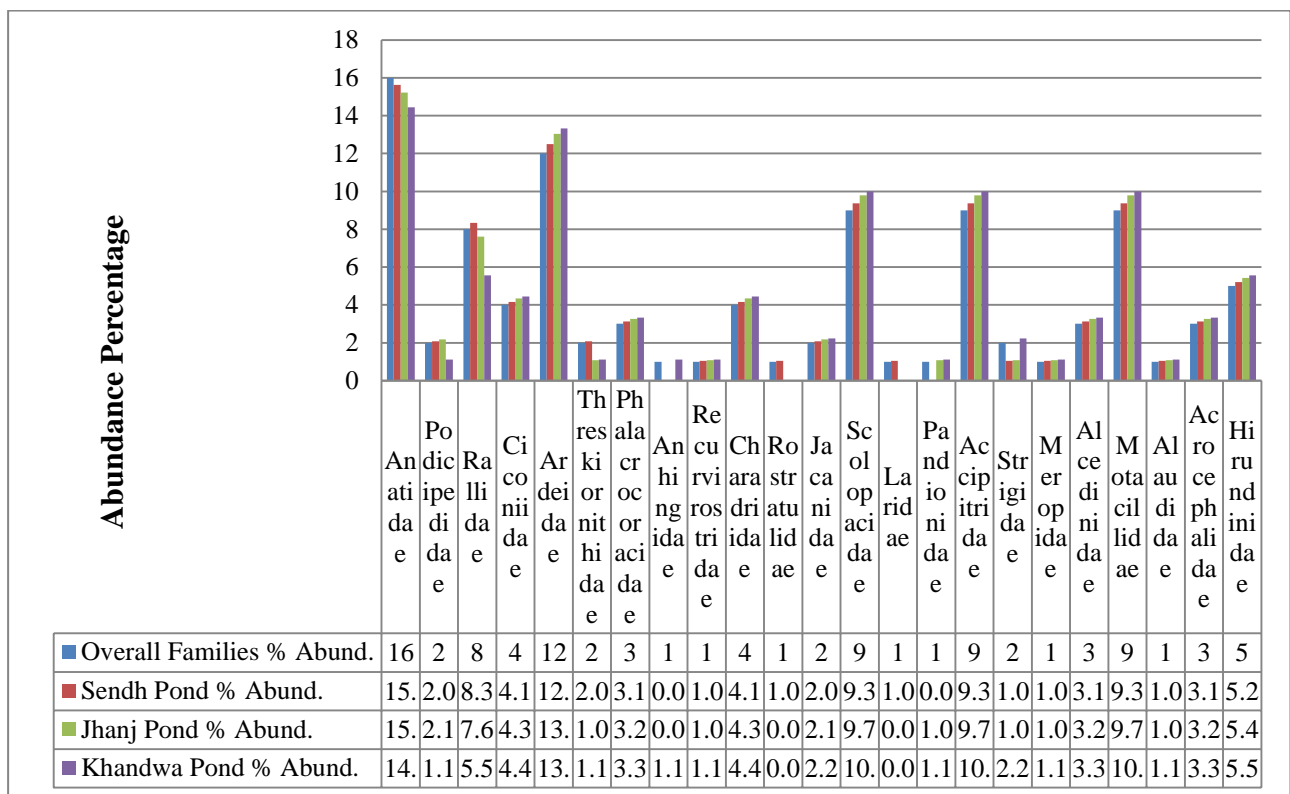


Fig 4: Family wise Percentage Abundance of Aquatic Avian

4. DISCUSSION

The overall study revealed 9 orders and 23 families 100 species of aquatic avian, in the selected ponds of study. Sendh Pond records 9 orders, 21 families, 96 species, Jhanj Pond records [9 orders and 20 families 92 species], while Khandwa Pond records [9 orders and 21 families 90 species]. The Shannon-Weiner diversity index for Sendh Pond was 3.72 (year 2015) 3.65 (Year 2016) 3.68 (Year 2017); Jhanj Pond was 3.56 (year 2015), 3.55 (Year 2016), 3.55 (Year 2017); Khandwa Pond was 3.72 (year 2015), 3.68 (Year 2016), 3.66 (Year 2017).

The slight variations in the calculated diversity indices were due to development activities for amusement, anthropogenic pressure, irrigation and construction-work water use. Which in turn reduced the span of natural vegetation cover in and around the pond in years 2016 and 2017 at Sendh Pond, years 2015 and 2016 at Jhanj Pond, years 2015 and 2016 at Khandwa Pond. Which is well substantiated by the species recorded at Sendh Pond (96 species) Jhanj Pond (92 species), and Khandwa Pond (90 species).

We observed Northern Pintail (*Anas acuta*) and Common Teal (*Anas crecca*) mainly dabbled for foods in water areas optimal for their body size with, we approached the shoreline area where the Pintail, Garganey, Common Teal dabbled probably for food at feeding depths observed and subsequently depth was measured (by cm scale) when the ducks shifted away. The recorded depth was varying from 5cm-11cm, these dabbling ducks were often observed submerging 1/3rd of their whole body including the beak and partially the neck.

The aquatic vegetation was very supportive for birds at Sendh Pond, to the lesser degree at Khandwa Pond (Bux and Acharya, 2017) and Jhanj Pond. Which were found to augment the food base including seeds, grains, tubers, roots, etc. whilst inhabiting variety of insects, fishes, molluscs, etc. in general. The most abundant aquatic plants found at Sendh Pond were *Vallisneria spirallis*, *Najas marina* etc.; at Jhanj Pond were *Potamogeton pectinatus*, *Aponogeton natan* etc., and at Khandwa Pond were *Vallisneria spirallis*, *Oryza rufipogon*, *Eleocharis dulci*, *Eriocaulon sp.* etc. Which commensurate with the feed of aquatic avian recorded.

The arrival period of Migratory species vary greatly; Waqtails, and Pallid Harrier and few waders like Common Sandpiper, Little ringed Plover, Wood Sandpiper are the first to arrive in August as seen, followed by Garganey and other duck species from September-October. The peak count duration is recorded from November to February. Thereafter they start aggregating / congregating preparatory to departure from March Onwards. The Passerby species like Lesser Sand Plover has been also recorded in the pocket, returning in the month of April from their coastal wintering grounds (Bharos *et al.*, 2016).

The aquatic plant species found in the ponds of Naya Raipur, mostly start to appear for flowering and fruiting from October continues till March, thereby coinciding with the arrival and departures of migratory bird species. The plant composition and suitable habitat lures the migratory species. The plants discussed above forms a good part of major omnivorous feeding species which feeds on these plant parts too. When the temperature rises with the advent of summer, due to receding of water level/spread the emergent plants no longer support the feed for the aquatic migratory birds. The Bar headed Geese entirely vegetarian feeds on grass, tubers, tender shoots of *Oryza rufipogon*.

Even for the late departing migratory species like Northern Pintail, Greylag Goose, Bar headed Geese, Garganey, Tufted Ducks remnant populations prolong their stay. This stay is supported by food range of certain invertebrates and aquatic plants like *Vallisneria*, *Najas indica*, certain species of *Cyperus*. etc.

The resident species which continues to utilize these habitat for all the seasons with nearly same or different food fashion from migratory ones, suffice themselves with *Vallisneria* tender leaves, *Hydrilla* leaves shoot, , root stocks of species of Poaceae, Hydrocharitaceae, Convolvulaceae, Nymphaeaceae families of plant, also supported by frog, fishes- with augmented population post spawning, reptiles Snake- Chequered keel back, Rat snake, Smooth snake, insects- water beetle, Pond skater; spiders, flies, snail, worms, and other drifting insects as observed were apparently more abundant in monsoon and post monsoon months depleting with approaching summer. Mollusc such as *Pila globosa*, *Lamellidens marginallis*, *Bellamya bengalensis*, *Achinata sp.* were also a good feed, we found the mollusc at shore line with density of *Pila globosa*- 38 numbers and *Lamellidens marginalis*- 17 numbers per square metre..

The food load as discussed above in the respective ponds thus support different guild behavior of birds with habits of Omnivorous, Insectivorous, and Carnivorous.

More or less all the three Ponds are near to each other in geographic feature. But the changes in aquatic vegetation is worst effected at Khandwa Pond, Jhanj Pond, and then Sendh Pond, in this order.

The three year (2015, 2016, 2017) count at three ponds of study revealed presence of total population, Sendh Pond- **47887** individuals (96 species) , Jhanj Pond- **56670 individuals** (92 species) , Khandwa Pond **42983 individuals** (90 species), respectively. The major cause for these count variations at different ponds is perhaps due natural movement and shifting of birds from one pond to other wetland of their choice as per their food resource and habitat needs. There are more than 100 large and small ponds at and around the Naya Raipur, which the birds frequent. The factors which affect the bird diversity and populations in these studied ponds are anthropogenic disturbances like construction, irrigation, destruction of habitat- cutting of stiff *Ipomoea carnea* clusters by truck men to later use them under the tyres of truck (managing truck weight) at wet sand mine beds on the riverside regions, excessive cattle grazing on *Scirpus articulatus*, *Cynodon dactylon*, *Panicum sp.*, *Eleocharis dulci* etc., encroachment for agriculture, fishing activities, agri-field discharge, plastic and glass waste of diverse range, immersion (sanctification) of plaster of paris (POP) effigy and other articles of religious values, in Sendh and Jhanj pond to some extent at Khandwa Pond.

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REFERENCES

- [1] Ali, S. and Ripley, S.D. (1987) *Compact Edition of the Birds of India and Pakistan*. Oxford University Press, New Delhi.
- [2] Anderson, J. T., Muehl, G. T., Tacha, T. C. (deceased) and Lobpries, D. S. (2000). Wetland use by non – breeding ducks in coastal Texas, U.S.A. *Wildfowl*, 51: 191-214.
- [3] Bharos, A.M.K. (2003). Occurrence status of Bar Headed Goose in Chhattisgarh and Sidhi Dist. M.P., *PIITA, bulletin of BSAP*, 113
- [4] Bharos, A.M.K., Bharos, Akhilesh, and Bharos, Ajeet (2016). Sighting of Lesser Sand Plover (*Charadrius mongolus*) in Chhattisgarh, India., *NLBW*, 56(3):34.
- [5] Bhuvan(WBIS). National Remote Sensing Centre, ISRO, Government of India, Hyderabad, India. <http://bhuvan.nrsc.gov.in/gis/thematic/wbis/> (last accessed on 18 June, 2018)
- [6] Bibby, C.J., Burgess, N.D., and Hill, A. (1992). *Bird Census Techniques*, Academic Press, U.K..
- [7] Biswas & Calder (1937). *A Handbook of Common water and marsh plants of India & Burma*, Govt. Press, Delhi.
- [8] Bolen, E. G. & Rylander, M. K. (1983). Whistling ducks: Zoogeography, ecology and anatomy. Spec. Pubi. Mus. Texas Tech Univ. 20, Lubbock, Texas.
- [9] Bolen, E.G. and Forsyth, B.J. (1967). Foods of the black-bellied tree duck in South Texas, *Wilson Bulletin*, 79: 43-49.
- [10] Bux, F. and Acharya, V. (2017). Aquatic Macrophytes of Khandwa Pond and Sendh Pond, Naya Raipur, Chhattisgarh, *Indian J. Applied & Pure Bio.*, 32(2): 245-254.
- [11] D'Abreu, E. A. (1935). A list of the Birds of the Central India Province, *JBNHS*, 38(1): 95-116.
- [12] Dunn, J. L. and Alderfer, J. (2006): *FIELD GUIDE TO THE BIRDS OF NORTH AMERICA*, National Geographic, Washington D.C., 5th Ed.
- [13] Euliss, N. H. Jr. (1989). Assessment of Drainwater Evaporation Ponds as Waterfowl Habitat in the San Joaquin Valley, California, *Ph.D. Thesis*, Oregon State University.
- [14] Fretweil, J. D., Williams, J.S and Redman, P. J. (1996). National Water Summary on Wetland Resources, *United States Geological Survey Water Supply Paper 242*, ISBN- 0607856963
- [15] Grimmett, R, Inskipp, C & Inskipp, T (2011). *Field Guide-Birds of the Indian Subcontinent*, Oxford University Press

- [16] Hewetson, C. E. (1956). Observations on the Bird Life of Madhya Pradesh, *JBNHS*, 53 (4): 595-645.
- [17] Hohman, W. L., Stark, T. M. & Moore, J. L. (1996). Food availability and feeding preferences of breeding Fulvous Whistling-ducks in Louisiana rice-fields, *Wilson Bulletin*, 108: 137-150.
- [18] Hora, S.L. (1949). Satpura Hypothesis of the distribution of the Malayan fauna and flora to peninsular India, *Proc. Natl. Inst. Sci. India*;15: 309-314
- [19] Hoyer, M. V. (2013) Lake Management and Aquatic Birds, Fish and Wildlife Management, *LAKELINE*, 17-20.
- [20] IUCN (2017): The IUCN Red List of Threatened Species. Version 2017-3. <www.iucnredlist.org>. Downloaded on 10 June 2018.
- [21] Jha, K.K. (2013). Aquatic Food Plants and their Consumer Birds at Sandi Bird Sanctuary, Hardoi, Northern India, *Asian Journal of Conservation Biology*, 2(1): 30-43.
- [22] Klaassen, M. and Nolet, B.A. (2007): The role of herbivorous water birds in aquatic systems through interactions with aquatic macrophytes, with special reference to the Bewick's Swan-Fennel Pondweed system, *Hydrobiologia*, 584(1): 205-213.
- [23] Kramer, G.W. & Euliss, N. H. Jr. (1986). Winter foods of Black-bellied Whistling-ducks in northwestern Mexico. *Journal of Wildlife Management*, 50: 413-416.
- [24] LaMontagne, J.M., Jackson, J.L., and Barclay, R.M.R. (2003): Compensatory growth responses of *Potamageton pectinatus* to foraging by migrating trumpeter swans in spring stop over areas, *Aquatic Botany*, 76: 235-244.
- [25] Mukherjee, A., Borad, C. K. and Parasharya, B. M. (2002). A study of the ecological requirements of waterfowl at manmade reservoirs in Kheda district, Gujrat, India with a view towards conservation, management and planning. *Zoos' Print Journal*, 17:775-785
- [26] Mukherjee, Ajit K. (1971a) Food-habits of water-birds of the Sundarban, 24-Parganas District, West Bengal, India, *JBNHS INDIA-II*. 68 (1): 37-64
- [27] Mukherjee, Ajit K. (1971b) Food-habits of water-birds of the Sundarban, 24-Parganas District, West Bengal, India, *JBNHS INDIA-III*. 68 (3): 691-716
- [28] Mukherjee, Ajit K. (1974) Food-habits of water-birds of the Sundarban, 24-Parganas District, West Bengal, India, *JBNHS INDIA-IV*, 71 (2): 188-200
- [29] Mukherjee, Ajit K. (1975) Food-habits of water-birds of the Sundarban, 24-Parganas District, West Bengal, India, *JBNHS, INDIA-V*, 72 (2): 422-447
- [30] Mukherjee, Ajit K. (1976) Food-habits of water-birds of the Sundarban, 24-Parganas District, West Bengal, India, *JBNHS, INDIA-VI*, 73 (3): 482-486
- [31] Mukherjee, Ajit K. (1969) Food-habits of water-birds of the Sundarban, 24-Parganas District, West Bengal, India, *JBNHS*, 66 (2): 345-360
- [32] Oomen, P. J. (2008): *Naya Raipur Development Plan-2031*, Naya Raipur Development Authority(NRDA)
- [33] Patten, C. J. (1906). *The Aquatic Birds of Great Britain and Ireland*, R.H. Porter, London.
- [34] Perrow, M.R. Schutten, J. H., Howes, J. R., Holzer, T., Madgwick, F. J. and Jowitt, A. J. D. (1997): Interactions between Coot (*Fulica atra*) and submerged macrophytes: The role of birds in the restoration process, Shallow Lakes '95, *Developments in Hydrobiology*, 119: 241-255.
- [35] Praveen, J, Jayapal, R & Pittie, A (2016). A Checklist of the Birds of India, *Indian Birds*, 11 No. 5 & 6.
- [36] Rahmani, A.R. and Islam, M.Z. (2008). *Ducks, Geese and Swans of India : Their Status and Distribution*. IBCN: BNHS, RSPRB, Birdlife International. Oxford Univ. Press. Pp.374
- [37] Reid, K. G. (1967). *POND LIFE*, Western Publishing Company Inc., Golden Press, New York.

- [38] Robert Jr., E. S. (1996) Technical Aspects of Wetlands: Wetlands as Bird Habitat, National Water Summary on Wetland Resources, *United States Geological Survey Water Supply Paper*, 49-56.
- [39] Shanon, C. and W. Weiner (1963). *A Mathematical Theory of Communication*, Univ. of Illinois Press, Chicago.
- [40] Subramanyam (1962): *Aquatic angiosperms: A systematic account of common Indian aquatic angiosperms*, CSIR Publications, New Delhi.
- [41] Todd, F. S. (1997). Natural history of the waterfowl. *Ibis*, Vista, California, pp 490.
- [42] Urfi, A.J. (2003). The birds of Okhla Bird Sanctuary, Delhi, India. *Forktail*, 19:39-50.
- [43] Verma, D.M., Pant, P.C. and Hanfi M.I. (1985): *Flora of Raipur, Durg and Rajnandgaon*, BSI, Howrah