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Urban Heronries of Kolkata Metropolitan: An Insight to Nest Stratification, Resource Based Guilds and Conservation Priorities

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ABSTRACT

Kolkata Metropolitan harbors a total of 13 out of 26 communal nesting water bird species found in Indian subcontinent. They are found to aggregate in six major heronries located within and adjacent to the urban landscape. Among these heronries, two artificial lakes located inside the city area support highest number of water bird species. These communal breeding water birds were seen to segregate into two groups namely stratum exclusive and stratum interface species to reduce competition for resource among them. Wading Ichthyophagous was the predominant resource-based guild among the 13 species recorded from the study sites. Three species sited here belongs to near threatened category; four local migrants and one winter migrant and rest were resident birds of this area. Necessity to restrict vegetation cleanup around nest trees during breeding season to keep provision of adequate nesting materials, creating alternative nesting habitat blocks wherever possible, periodical cleaning of uric acid rich fecal depositions, restricting human access and introducing bird-safe building norms were identified as important conservation strategies.

Key words: urban heronries, Kolkata, urbanization, waterbirds

INTRODUCTION

Heronries are communal nesting and breeding habitat for water bird populations such as of storks, spoonbills, ibis, herons, egrets and other associate species which play an important role in an ecosystem. Usually in all heronries waterbirds aggregate in spectacular proportion characterized by mixed species colonies during and beyond breeding seasons. Heronry birds vary in ecological requirements such as diet, habitat preferences, behaviour and seasonality but they show strong resemblance in nesting requirements (Ludwig *et al.,* 1994, Kazantzidis *et al.,* 1997, Hilaluddin *et al.,* 2003) and fledging success (Buckley and Buckley, 1980). A good nesting site generally means low predation pressure; densely foliaged trees, adequate supply of nesting materials and feeding options, lower pollution level and overall undisturbed ambience (Gibbs *et al*., 1987, Hafner *et al.,* 1987, Jha, 2012).

In India about 26 species of waterbirds were reported to nest colonially which include Storks, Herons, Ibis, Pelicans, Egrets, Cormorants etc. Among the storks, four of six breeding species found in India (Kahl 1971) are colonial; the Asian Openbill (*Anastomus oscitans*), Painted Stork (*Mycteria leucocephala*), Lesser Adjutant Stork (*Leptoptilos javanicus*), and Greater Adjutant Stork (*Leptoptilos dubius*) (Hafner 2000). Asian Openbill forms the largest population of all the stork species to congregate in Gangetic Bengal plains with sprawling riverbed and paddy fields supporting *Pila globosa* - the primary food in large amounts. Records suggest that almost 32 %–40 % of South Asia population visits singularly in Raiganj Kulik Bird Sanctuary for nesting, making it a globally significant record (Sharma, 2007). Spot-billed Pelicans also visit and breed in large numbers in the southern parts of Indian subcontinent. Moreover, five species of herons - Grey heron (*Ardea cinerea*), Black-crowned night heron (*Nycticorax nycticorax*), Purple heron (*Ardea purpurea*), Striated Heron (*Butorides striata*) and Indian Pond heron (*Ardeola grayii*) and four egret types – Cattle Egrets (*Bubulcus ibis*), Little Egret (*Egretta garzetta*), Intermediate Egret (*Mesophoyx intermedia*) and Greater Egret (*Casmerodius albus*) were reported in India and all are more or less colonial. Three cormorant species – greater cormorants (*Phalacrocorax carbo*), Little Cormorants (*Phalacrocorax niger*), Indian Cormorants or Shag (*Phalacrocorax fuscicollis*) along with Oriental Darter (*Anhinga melanogaster*) are common in Indian wetlands and often nests together. According to Patel et al., 2000; Subramanya, 1996 and 1997, there are over 553 nesting sites in India and most of them are wetlands or in any place close to an waterbody. In spite of this, very little has been published on the nesting habits of the colonially nesting waterbirds.

Colonial waterbirds, for example, use cities for nesting and foraging (Parasharya and Naik 1990; Jamgaonkar *et al.,* 1994; Subramanya 1996; Urfi 1997). Many Indian cities also offer foraging and nesting habitat for colonial waterbirds like Piele Gardens in Bhavnagar city (Parasharya and Naik 1990), Karanji Tank in Mysore (Jamgaonkar *et al.,* 1994) and the National Zoological Park (hence forth Delhi Zoo) in India's capital city New Delhi (Urfi 1997). However, only a few works have actually attempted to study the impacts of

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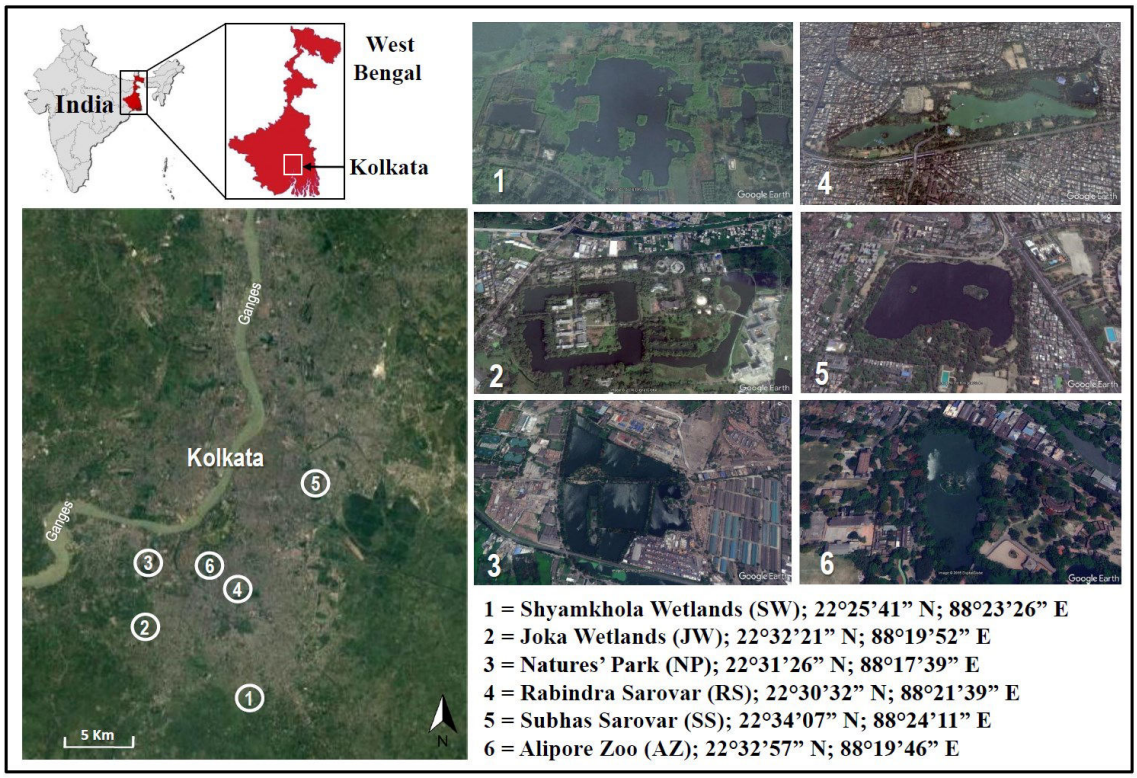

Figure 1. Map showing study sites in and around Kolkata, their respective land cover (ha.) and geographical location. 1. Shyamkhola wetlands; 2. Joka Wetlands; 3. Nature's Park; 4; Rabindra Sarovar; 5. Subhas Sarovar; 6. Alipore Zoo.

urbanization on birds. Kolkata, being one of the busiest and third largest metropolis in India and the capital of West Bengal with a population of 14.1 million, also supports a moderate bird species assemblage (Sengupta *et al.,* 2014) even though the total 46 % of water bodies has been lost in last one decade (SAFE Annual Report, 2011-12) and green cover has drastically fallen down to 4.79 % from 23.4 % over two decades (Ramachandra *et al.,* 2016). Existing wetlands in lie within a mosaic of multiple human land uses and function as disjunct patches of habitat. Even so published documents on the distribution and nesting ecology of waterbirds in this rapidly urbanizing city are inadequate and furthermore there has been no comprehensive work on the heronries of Kolkata. Detail understanding of breeding ecology of heronry birds under ongoing climate change is essential for formulating species and habitat conservation strategies (Parmesan & Yohe, 2003; Jakubas, 2011). According to Subramanya (1996) there is a need to develop a more detailed inventory of heronries at the district or state level by concerned groups. Close monitoring of the stress affecting the heronry birds is particularly useful to understand the impact of urbanization (Urfi 2010). This present study also aims to document the heronries situated in around Kolkata. Habitat feature analysis, urban stress profile of each site was considered as key attributes in implementing conservation strategy.

MATERIALS AND METHODS

***Study Area*:** Authors had visited six sites located within the metropolitan boundaries of Greater Kolkata where waterbirds aggregate and breed regularly (Figure 1). Following are the wetland habitats and their salient features discussed in detail. Team has also catrgorized the following urban wetlands according to their origin which may either be natural or artificial, in order to identify their potential as habitat for waterbirds. The area of study sites where the heronries are located or heronry birds use for roosting and foraging were estimated by demarcating the area with polygon in GIS enabled software Google Earth Pro. The study site total area thus covers the islands with colonies, surrounding water body and vegetation integral to the site.

Shyamkhola Wetlands (SW – natural; 13.5 ha) - This area to the west of Narendrapur consists of villages with dense orchards, open croplands and ponds of different sizes. There are several old bamboo groves which attract many birds. Trees are mostly old ones; palm and coconut trees are old and fairly tall. It also has recently formed wetlands created owing to removal of soil from croplands for brick fields. The small and medium sized ponds and a few large pools attract waterbirds.

Rabindra Sarovar (RS - artificial; 78.6 ha) - amidst the pollution and concrete jungle of the city, it is an artificial lake located in south Kolkata. It was dug in 1920s by Calcutta Improvement Trust (CIT), to provide soil for filling up the low lying areas of Ballygunge that were being made habitable by them. It is Kolkata's only national lake.

Joka Wetlands (JW - artificial; 38.5 ha) - The area studied is the compound and adjoining area of the Indian Institute of Management, Kolkata located in Joka. The IIM campus has many wetlands and

densely planted areas with good ground cover but lot of buildings are coming up, decreasing the area of vegetation. Some of the wetlands are leased out for intensive fishery. This unique Typha bed does not exist anywhere else in the city particularly where we have conducted our study. Behind the campus, the area is also a marshy land which not only attracts migratory ducks, storks to roost, but birds of prey also congregate there for hunting in winter.

Nature's Park (NP - artificial; 59.1 ha) - The marsh west of the Brace Bridge railway station is now a very changed environment from what it was twenty years back. The Mudiali Ecological Park or the Nature Park, as it is now known, is under intensive fish culture so most of the water body is devoid of any vegetation, either floating or emergent. There are embankments crisscrossing the whole area, which have dense plantation of trees. There is no shallow water habitats left which the waders used to visit. However, the trees do attract many arboreal birds, which were not present in such numbers and variety in the past.

Subhas Sarovar (SS - artificial; 28.7 ha) - The urban artificially built lake is located just beside heavily traffic crowded E.M. Bypass. Salt Lake Stadium and other tall buildings around. The lake is surrounded with trees and shrubs, some of which are more than a hundred years old and two islands are located in the middle of the lake.

Alipore Zoo (AZ - artificial; 13.4 ha) – Alipore zoological garden is situated in the heart of the densely populated Alipore area. The site supports few wetlands and old trees along with a island in between. Trees within the island and in the surroundings reportedly used by waterbirds for nesting as well as the source of nesting materials.

Water Bird Survey Methodology: the authors had visited each heronries on regular interval of 15 days i.e. twice in a month for a period of eight consecutive months (September, 2016 to April, 2017). Following the guidelines of other wetland landscape studies (e.g. Brown and Dinsmore 1986), numbers of individuals of each species was not recorded but rather only presence was marked. Birds were observed with unaided eye or using Olympus 10 x 50 DPSI binoculars. Prior to every counting episode, each observer limited their focus on single species or two to attain best outcome. Species identification in the mixed colony of the heronries was done by after referencing standard field guides (Grimmett *et al.,* 2011; Kazmierczak and Perlo, 2012). The taxonomy and nomenclature has been followed as per Inskipp *et al.,* (1996). The bird nests were observed in the two time slots in morning (8.00 – 11.00 am) before they depart for daily forage and in afternoon (2.00 - 5.00 PM) when most of the birds stay close to the heronry or start to arrive from the foraging sites back to their nesting locations. Information such as resource based guilds; movement status and nesting preferences were noted for each bird species. Site-wise assemblages of water bird species were recorded in order to determine communal structure of the heronries. Habitat features of each heronry along with its stress factors were identified so that site wise conservation prioritization can be done.

The parameters associated with the functioning of the urban heronries such as urbanization related stresses and existing habitat features were assessed during the routine visits includes land use, traffic load determination, population density, high rise numbers, foraging and nesting resource availability, colony localization in relation to water body, human encroachment probabilities etc. Municipal corporation ward-wise population densities were determined using the available data from District Census Handbook of Kolkata (2011). Traffic load per hour were calculated by averaging counts at different time slots of three visits and then those values were ranked into very low to very high scale. Numbers of high -rises apartments within a radius of 1.5 Km were counted from Google Earth satellite maps and ranked into absent to very high scale. Habitat features such as foraging options, nesting material availability were again visually approximated. The localization of most colonies was either confined within the islands or at the fringes facing low or high anthropogenic disturbances respectively.

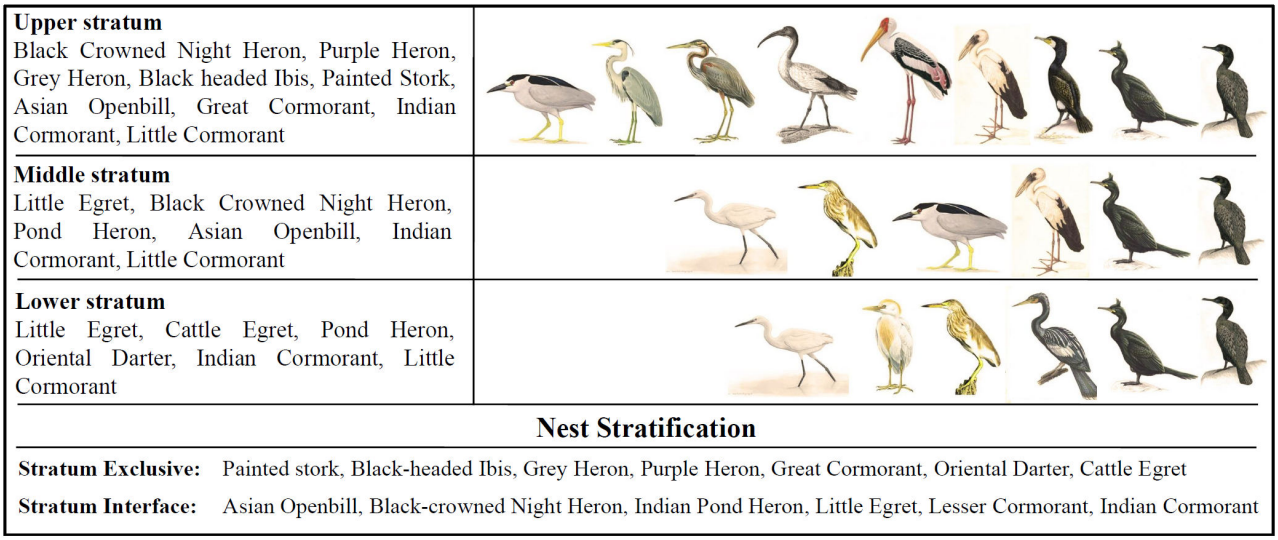

Figure 2: Schematic representation of nest stratification in waterbirds for nesting strata.

RESULTS

Thirteen species of colonial nesting water birds were reported during our survey conducted at six heronries located within Kolkata Metropolitan area (Table 1). The number of nests by individual species was visually approximated and shown into four differently colour coded levels (Table 2). As per IUCN Redlist (2014) of threat categories, three species sited here belongs to near threatened category. Among the listed species, four were local migrants, one was winter migrant and rest was resident birds. Report also shows that the Wading Ichthyophagous is the major resource based guild followed by the Swimming Ichthyophagous made of six and four species respectively. Among the six heronries, SS is the most species rich (ten species) followed by RS (nine species) and SW (eight species) (Table 2). The species abundance at each sites were shown in colored codes representing four categories (absent or 0, rare or 1 - 10, common or 10 - 100 and abundant or > 100). The permanent nesting ground of small groups of Painted Storks was observed only at the two urban lakes namely RS and SS. An extraordinarily vibrant breeding colony of Grey Herons with above 500 nests was reported only at SS. Asian Openbills were found to nest at SS, RS, NP and SW and Black crowned Night Herons were reported at JW in addition to both the urban lakes. Little Cormorants, Pond Herons, Little Egrets and Cattle Egrets were seen to nest more or less in all these heronries. Great Cormorant, Oriental Darters also visits at SS for nesting and breeding purpose.

Waterbirds are seen to nest at different vegetation strata to minimize competition for resources (Figure 2). The Painted Storks build nest exclusively at the upper storey while Asian Openbills are less selective and nests at any height in mixed colonies. Grey Herons and Purple Herons confine themselves in the upper branches and arrive late to the heronry as an when the painted storks had completed their nesting. Great Cormorants nest at upper storey unlike the other cormorant species, which have no such inclination for nesting strata. The Oriental Darters although larger than Great Cormorants, arrives much earlier to other visitors and also demands wider nest space yet they nest in lower stratum.

The parameters associated to the urban heronries indicates that both RS and SS are high stressed heronries even if they are quite species rich and heavily occupied by waterbirds (Table 3). Rest all the heronries are considered to be under moderate to less stress, based on the existing parameters.

DISCUSSION

Urban heronries are interesting habitats and are known to support nesting and breeding population of waterbirds. Worldwide, urban heronries are flagships of nature's resilience against indiscriminate urbanization processes. During our study, we were rewarded with nesting populations of 13 out of 26 water bird species overall reported all over the country (Subramanya 1996). Communal structure characterization of each heronry was done to find out the overall aggregation. Sites like SS, RS are highly unique in terms of species composition as we record Painted Stork, Grey Heron, Asian Openbill, Great Cormorants and Oriental Darters; which found nowhere else in the city. Nest stratification is thought to partition resources and reduce competition among communal breeding species (Anderson, 1980) thus considered to be a stable strategy of utiliziting limited space (Naugle et al., 1996). We found two groups of birds one is stratum interface birds those use all possible heights for constructing nests and not just crowd at any one strata, whereas another is stratum exclusive birds which restrict themselves into one stratum (Jha 2012). Such observations may suggest these birds to some extent obey the "height-size" hypothesis proposed by Gopi & Pandav, 2011 with occasional deviations. During the study period we encountered direct and indirect urban influences on these heronries among them most are negative. Perhaps as a response we find some inconsistencies in the Painted Stork occurrence in successive years at sites where their nesting was recorded in earlier periods unlike in most other heronries where same species continues to visit or reside year after year.

Resource-based Guilds are groups of species that exploit the same group of environmental resources in a similar way (Melles *et al.,* 2003). Our observation demonstrates Wading Ichthyophagous followed by Swimming Ichthyophagous guilds were predominant in these urban wetlands which are primarily used for fisheries and recreational purposes. The wetlands also sustain two species of Wading Omnivores – Painted Stork and Asian Openbill which forage on the abundant vertebrate and invertebrate macrobenthic non-piscine fauna.

The East Kolkata Wetlands (EKW) serve predominantly as foraging ground for the waterbirds due to its strategic location - a short daily flight away from the heronries discussed here. Moreover, EKWs are naturally occurring water bodies of shallow depth ideally suited aquaculture practice. Studies have shown EKW also support notable diversity of invertebrate macrobenthic community (Basu *et al.,* 213). All these features make this place wonderful foraging paradise for waterbirds.

Conversion of naturally occurring green cover to human used lands crucially damages the nearby wetlands supporting waterbirds (Newbold and Eadie 2004, Datta, *et al.,* 2011). Urban heronries are always vulnerable to man-made stresses such as occurrence of close high-rise apartments, noisy streets, light pollution from high mast lighting towers (Figure 3), vehicular emissions, effluent discharge and direct human access to nesting location (Table 3). This study put forward outline recommendations (Table 4) for these urban heronries for protecting them from different stress factors and to attract more nesting in coming years.

CONCLUSION

Through this study we are able to document an inventory of urban heronries located in and around the urbanizing city of Kolkata along with its essential community features such as nesting stratification, resource-based guild structures. This study also looked into the various parameters associated with the functioning of these heronries and also recommends conservation priorities. Further study may be required to reveal the implications of

Table 1. Checklist of waterbirds recorded from various heronries of Kolkata Metropolitan during the study period with notes on their movement status, feeding-habitat guild and conservation status.

Common Name	Scientific Name	Resource based Guild	Movement Status	IUCN Status
Order: Ciconiiformes **Family: Ciconiidae**				
Painted stork (PS)	*Mycteria leucocephala*	WO	LM	NT
Asian Openbill (AO)	*Anastomus oscitans*	WO	LM	LC
Order: Pelecaniiformes **Family: Threskiornithidae**				
Black-headed Ibis (BHI)	*Threskiornis melanocephalus*	WI	LM	NT
Family: Ardeidae				
Grey Heron (GH)	*Ardea cinerea*	WI	R	LC
Purple Heron (PH)	*Ardea purpurea*	WI	R	LC
Black-crowned Night Heron (BNH)	*Nycticorax nycticorax*	WI	R	LC
Indian Pond Heron (IPH)	*Ardeola grayii*	WI	R	LC
Little Egret (LE)	*Egretta garzetta*	WI	R	LC
Cattle Egret (CE)	*Bubulcus ibis*	HI	R	LC
Order: Suliformes **Family: Phalacrocoracidae**				
Great Cormorant (GC)	*Phalacrocorax carbo*	SI	WM	LC
Lesser Cormorant (LC)	*Phalacrocorax niger*	SI	R	LC
Indian Cormorant (IC)	*Phalacrocorax fuscicollis*	SI	LM	LC
Oriental Darter (OD)	*Anhinga melanogaster*	SI	R	NT

Abbreviations:
Resource based Guild - WO: Wading Omnivores; WI: Wading Ichthyophagous; HI: Hard-ground Invertebratophagous; SI: Swimming Ichthyophagous. **Movement Status** - LM: Local migrant; R: Resident; WM: Winter migrant.
IUCN Status - NT: Near threatened; LC: Least concern.

Table 2. Communal structure and species abundance at the heronries

Study sites	Species-wise Avifaunal Assemblage during the study period													No. of species
	PS	AO	BHI	GH	PH	BNH	IPH	LE	CE	LC	IC	GC	OD	
SW														**7**
RS														**9**
NP														**5**
JW														**7**
SS														**11**
AZ														**7**
Avifaunal abundance ranges:		Absent		Rare (0-10)		Common (10-100)		Abundant (>100)						

Abbreviations: **Study sites** – SW: Shyamkhola wetlands; JW: Joka wetlands; NP: Nature's Park; RS: Rabindra Sarovar; SS: Subhas Sarovar; AZ: Alipore Zoological Garden.

Table 3. Parameters associated with the functioning of urban heronries

Heronries	Land use	Traffic load	Population density*	High rise Apartments	Nesting materials	Foraging options	Colony location
SW	Fisheries	Very low	Low	None	Adequate	High	Fringes
RS	Recreational	High	Very High	Very High	Adequate	High	Islands
JW	Fisheries	low	High	High	Adequate	High	Fringes
NP	Fisheries	High	High	Low	Adequate	High	Fringes
SS	Recreational	High	Very High	Very High	Adequate	High	Islands
AZ	Recreational	Medium	High	High	Adequate	High	Islands & Fringes

*ward wise population density were obtained from the District Census Handbook, Census of India 2011

Figure 3. Pictorial documentation of stress on the heronry birds

vegetation complexity on the availability of nesting materials and subsequent survival of heronries.

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