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Some breeding and ecological aspects of heronry birds at Soor Sarovar Bird Sanctuary Agra, Northern India

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ABSTRACT

Multi-species heronry at Soor Sarovar Bird Sanctuary, Agra was studied for some breeding and ecological aspects. This is an established heronry in semi-arid region with less than 600 mm rainfall and temperature range of 2ºC to 48ºC. Two near threatened (Black-headed Ibis and Darter) and twelve least concerned species nested in colony during late summer and rainy season. They were categorized as the early arrivers (Black-crowned Night Heron, Little Egret, Cattle Egret, Darter and Grey Heron), late arrivers (Intermediate Egret, Indian Pond Heron, Great Egret, Black-headed Ibis, Purple Heron and Asian Openbill) and very late arrivers (Eurasian Spoonbill, Little Cormorant and Indian Cormorant). Total Nest occupancy at a time followed the rainfall pattern of the locality. Nest occupancy calendar was recorded in the form of pre-egg laying, egg laying and chick rearing dates for all the species. Nesting height-bird size hypothesis was checked as mixed results as the stratum specific birds proved the hypothesis right, while stratum interface birds suggested relook of the hypothesis. Heronry threat, disturbance behavior of the birds and disturbance distance were recorded. Buffer establishment and heronry protection measures are recommended for conservation of the source population. The breeding phenology data could be used as baseline as indicator tool for climate change impact.

Key words: Breeding birds, Breeding phenology, Nesting success, Nesting stratification.

INTRODUCTION

Protected Areas or Bird Sanctuaries are the attraction centers of the tourists resulting in human disturbance to the migratory and resident bird which is increasingly becoming a serious concern for the conservationists due to burgeoning population and fast expanding ecotourism as a source of revenue (Wight, 2002; Christ *et al.,* 2003). Human presence in the vicinity of heronry and repeated intrusion could be detrimental to breeding birds as they tend to abandon the nests at different stages of breeding resulting in possible declining population (Bjorklund, 1975; Parson & Burger, 1982; Tremblay & Ellison, 1979; Carney & Sydeman, 1999).

Heronries, the source of breeding population of Herons, Egrets and other associate aquatic bird species, play very important role in conservation of water birds in general and threatened species in particular. Successful conservation and recovery of water bird species depends on an improved understanding of ecological requirements of these birds (Fellowes, *et al.,* 2001). Breeding ecology, especially the phenology of birds is related to climatic conditions (Jakubas, 2011).

Knowledge of the arrival dates and breeding dates of bird is important for studying long term trends of changes in timing of breeding in the ongoing climate changes (Parmesan & Yohe, 2003).Therefore, such information could be used as an indicator tool and impact assessment on the system.

There are reports of heronries and breeding birds in the Protected Areas of Uttar Pradesh. They are growing in richness and abundance but systematic data is not available on breeding ecology of the colonial birds (Islam & Rahmani, 2008; Kumar, 2011; Rahmani, *et al.,* 2011). Therefore, present effort is an analytical presentation of the collected data on some breeding and ecological aspects of heronry birds from Soor Sarovar Bird Sanctuary situated at Agra in Uttar Pradesh, one of the north Indian states.

MATERIALS AND METHODS

Species identification of the breeding birds in the mixed colony of the heronry was done by using the field guide (Grimmett & Inskipp, 2003). Size of the birds was also taken from this reference book for comparison and hypothesis testing. Birds' nesting in the tree appearing in tier were categorized as lower (drooping lower branches of the tree very close to the ground towards the water body), middle (firm branches of middle part of the tree) and upper (tree top branches) storey birds. Height consideration for these three storeys were <5m, 5-10m and >10m, respectively. Bird residency period and nesting stages were recorded for each bird species inhabiting the heronry. For the present text breeding phenology included different stages of nesting like, pre-egg laying (nest making or repairing and courtship), egg laying and chick rearing.

Nest count is theoretically the best measure of breeding population as per Boyd and King (1959) quoted in (Narayanan & Vijayan, 2007). Nests in the heronry were counted for adult bird's presence with or without activities, egg presence and chick presence. Ground count method (Fasola, *et al.,* 2011) was adopted for breeding bird census in present case. Observation was done in every fifteen days except for few pre-decided days due to the bad weather condition during monsoon or any administrative reason. Counting start date was chosen on 15 April, 2011 and closing date was 15 September, 2011 assuming the earliest and latest possible days respectively, for any activity in the heronry. Since the nest viewing overlapped during peak heronry activity, number of nest was estimated to closest possible for the actual number. This esti-

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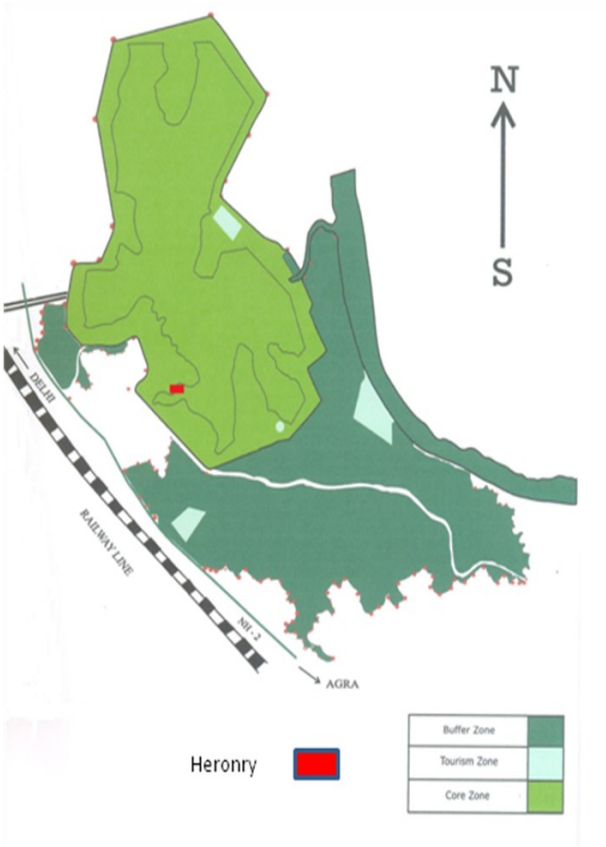
mation may have 5-10% variation from the actual number as confirmed by the data recorder from few sample checking. While approaching the nests for counting, care was taken to go as less close as possible.

Population of breeding birds was derived by simple arithmetical extrapolation of the nests inhabited by a particular species. It was assumed that each occupied nest had a pair of male and female birds. Some qualitative data were also collected by interviewing the field staff working in the Sanctuary for long time.

Study site

The heronry is located within Soor Sarovar Bird Sanctuary (27° 14' 04" and 27° 31' 51"N latitude; 77° 49' 38" and 77° 52' 40"E longitude), Agra in Uttar Pradesh, India (Map 1). The Sanctuary has approximately 240ha water body and around 400ha forest area bordered by river Yamuna on one side and agricultural field in other sides. The heronry was situated at the interface of freshwater lake on one side and semi-arid deciduous forests dominated by *Prosopis juliflora* trees on the other side. All the nests were formed on wide and strong canopy of *Prosopis juliflora* overhanging on water covering an area of about 6ha. The region is semi-arid with average annual rainfall <600mm and temperature between 2 to 48°C in the extreme winter and summer, respectively.



Map 1. Soor Sarovar Bird sanctuary showing location of the Heronry. Dark green and peripheral light green of the core zone is primarily forested (Adopted from Kumar, 2011).

RESULTS AND OBSERVATION

The bird activity like pre egg laying (nest making, courtship), egg laying and chick rearing was confined between late April and early September of 2011. There was no sign of such activity in the heronry on 15 April, 2011 and 15 September, 2011. Time line of some important breeding activities of the breeding species is recorded in Table 1.

Heronry species

All together fourteen species were found breeding during summer- rainy season in 2011. They were Asian Openbill (*Anastomus oscitans),* Black-crowned Night Heron (*Nycticorax nycticorax*), Black-headed Ibis (*Threskiornis melanocephalus*), Cattle Egret (*Bubulcus ibis)*, Darter (*Anhinga melanogaster*), Eurasian Spoonbill (*Platalea leucorodia*), Great Egret (*Casmerodius albus*), Grey Heron (*Ardea cinerea*), Indian Cormorant (*Phalacrocorax fuscicollis*), Indian Pond Heron (*Ardeola grayii*), Intermediate Egret (*Mesophoyx intermedia*), Little Cormorant (*Phalacrocorax niger*), Little Egret (*Egretta garzetta*) and Purple Heron (*Ardea purpurea*). Black Ibis (*Pseudibis papillosa*) and Painted stork (*Mycteria leucocephala*) were also seen nesting in the sanctuary but far from the heronry, therefore not taken into account. Some of these heronry birds with breeding activities are shown in the photo plate 1.

Table 1. Phenology of different activities in the nest in mixed species heronry (day and month of 2011).

Bird species	All activities	Pre egg laying	Egg laying	Chick rearing
Indian Cormorant	18/7-7/9	18/7	5/8	7/9
Little cormorant	18/7-7/9	18/7	5/8	7/9
Eurasian Spoonbill	15/6-7/9	15/6-18/7	30/6-5/8	18/7-7/9
Asian Openbill	31/5-7/9	31/5-30/6	15/6-5/8	30/6-7/9
Purple Heron	31/5-7/9	31/5-30/6	15/6-5/8	30/6-7/9
Black-headed Ibis	31/5-7/9	31/5-18/7	15/6-5/8	30/6-7/9
Great Egret	15/5-7/9	15/5-15/6	31/5-5/8	15/6-7/9
Indian Pond Heron	15/5-7/9	15/5-30/6	31/5-5/8	15/6-7/9
Intermediate Egret	15/5-7/9	15/5-30/6	31/5-5/8	15/6-7/9
Grey Heron	30/4-5/8	30/4-15/6	15/5-18/7	31/5-5/8
Darter	30/4-7/9	30/4-30/6	15/5-5/8	31/5-7/9
Cattle Egret	30/4-7/9	30/4-30/6	15/5-5/8	31/5-7/9
Little Egret	30/4-7/9	30/4-18/7	15/5-5/8	31/5-7/9
Black-crowned Night Heron	30/4-7/9	30/4-18/7	15/5-15/8	31/5-7/9

Photo plate 1: Clockwise from top left : Black-crowned Night Heron chicks temporarily moved away from the nest, Grey Heron chick under parental care, Black-headed Ibis with chicks and eggs, Darter adult with chick at alarm call stage, Asian openbill adult guarding a chick from any predator attack and overview of the water surrounded Heronry having better protection against territorial attack, species in the upper row are from lower and middle storey while bottom row species are from upper storey.

Phased arrival of the population

More than 20,000 potential breeding birds of different species arrived in the heronry of Soor Sarovar Bird Sanctuary in 2011 and were involved in nesting activities during summer and rainy season. By chronology of appearance in the heronry these birds were grouped into (i) Early arriver: late April arriver (Little Egret, Cattle Egret, Darter, Grey Heron and Black-crowned Night Heron), (ii) Late arriver: early May arriver (Great Egret, Intermediate Egret and Indian Pond Heron), late May arriver (Asian Openbill, Black-headed Ibis and Purple Heron), (iii) Very late arriver: mid June (Eurasian Spoonbill) and mid July (Little Cormorant and Indian Cormorant). These arrivals coincided with early summer, late summer, pre-monsoon, early monsoon and mid monsoon period, respectively.

Nesting success

Adult birds occupancy of the nests by above mentioned species during entire period of nesting was ten thousand one hundred seventy nine nests (10,179). Egg occupancy and Chick occupancy of these nests were 96% and 92%, respectively. Only 96% of the eggs occupied nests turned into chick occupied nests. This meant that 4% of the population did not lay the eggs and 4% eggs did not hatch into chicks. Individual species occupancy of nests in decreasing order was: Cattle Egret (22.2%), Black-crowned Night Heron (21.6%), Intermediate Egret (14.5%), Indian Pond Heron (7.9%), Little Egret (5.7%), Grey Heron (5.6%), Great Egret (5.4%), Black-headed Ibis (4.2%), Little Cormorant (3.9%), Darter (3.5%), Indian Cormorant (3.4%), Asian Openbill (1.1%), Purple Heron(0.7%) and Eurasian Spoonbill (0.4%). However, this was the virtual number of nests in the heronry since some of the birds arriving later (Eurasian Spoonbill, Little Cormorant and Indian Cormorant) occupied the nests emptied after fledging by the early colonizing birds (Night Heron, Grey Heron, Little Egret and Cattle Egret), indicating common use of the nests.

Nesting stratification

It was observed that the birds, reaching the heronry, chose different stratum for new nest building or old nest occupying in the crown of *Prosopis* tree (Figure 1). Lower storey birds were Indian Pond Heron, Little Egret, Cattle Egret, Black-headed Ibis, Grey Heron and Black-crowned Night Heron. Middle storey birds included Little Egret, Cattle Egret, Black-headed Ibis, Grey Heron, Black-crowned Night Heron, Intermediate Egret, Purple Heron, Little Cormorant and Indian Cormorant. Upper storey was taken over by Purple Heron, Little Cormorant, Indian Cormorant, Darter, Eurasian Spoonbill and Asian Openbill. There were stratum interface birds for lower and middle, and middle and upper strata. Stratum exclusive birds were Indian Pond Heron (lower), Intermediate Egret and Great Egret (middle), and Darter, Eurasian Spoonbill and Asian Openbill (upper).

Breeding phenology

Chronology of events of nest occupation (Bird arrival date to dispersal date) like pre-egg-laying period (date of arrival to last egg-laying), egg laying and incubation period (first egg-laying to last egg hatching) and chick rearing period (first egg hatching to last chick fledging) varied in the heronry from species to species. The details are described below.

Nest occupation period

The heronry colonies of mixed species like Herons, Egrets, Cormorants, Ibis, Openbill and Spoonbill was found active during April 30 and September 7, 2011. However, for different species this period was different. It was longest for Black-crowned Night Heron, Little Egret, Cattle Egret and Darter (minimum 131 days) followed by Intermediate Egret, Indian Pond Heron and Great Egret (minimum 116 days), Black-headed Ibis, Purple Heron and Asian Openbill (minimum 101 days), Grey Heron (minimum 98 days), Eurasian Spoonbill (minimum 85 days), Little Cormorant and Indian Cormorant (51 days). Relative nesting period is depicted in Chart 1. Over all nest occupancy in the heronry appeared to be regulated by the rainfall in the area. It almost followed the rainfall increase with peaking monsoon in June-July and then gradual decrease (Chart 2).

Pre-egg-laying period

Adults of different species remained in the nests for courtship or egg laying for a minimum period of 80 days from April 30 to July 18, 2011. However, this period also varied from species to species. Minimum adult presence in the nests was 80 days (Black-crowned Night Heron and Little Egret), 62 days (Cattle Egret and Darter), 49 days (Black-headed Ibis) 47 days (Grey Heron), 46 days (Intermediate Egret and Indian Pond Heron), 36 days (Eurasian Spoonbill), 32 days (Great Egret), 31 days (Purple Heron and Asian Openbill),

and 20 days (Little Cormorant and Indian Cormorant).

Egg laying and incubation period

Egg occupancy period of different birds in the colony was minimum 92 days between May 15 to August 15, 2011, both dates inclusive. This period also varied with different species in following decreasing order: 92 days (Black-crowned Night Heron), 82 days (Little Egret, Cattle Egret and Darter), 67 days (Intermediate Egret, Indian Pond Heron and Great Egret), 64 days (Grey Heron), 52 days (Black-headed Ibis, Purple Heron and Asian Openbill), 37 days (Eurasian Spoonbill), and 20 days (Little Cormorant and Indian Cormorant).

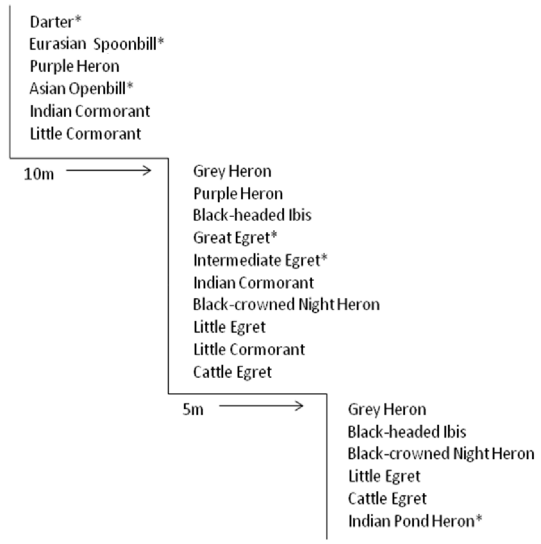


Figure 1. Schematic representation of heronry stratification. Asterisked species are storey specific. Within storey the species are arranged in size increasing order.

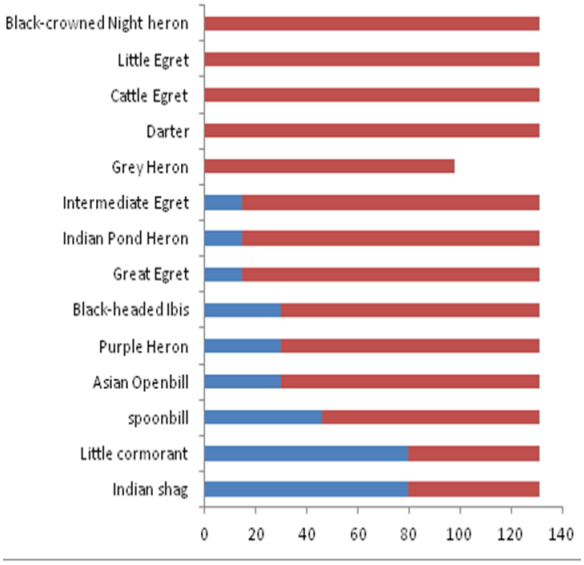


Chart 1. Relative minimum nesting period (Maroon bar) and non arrival period (Blue bar) of different bird species in the Heronry.

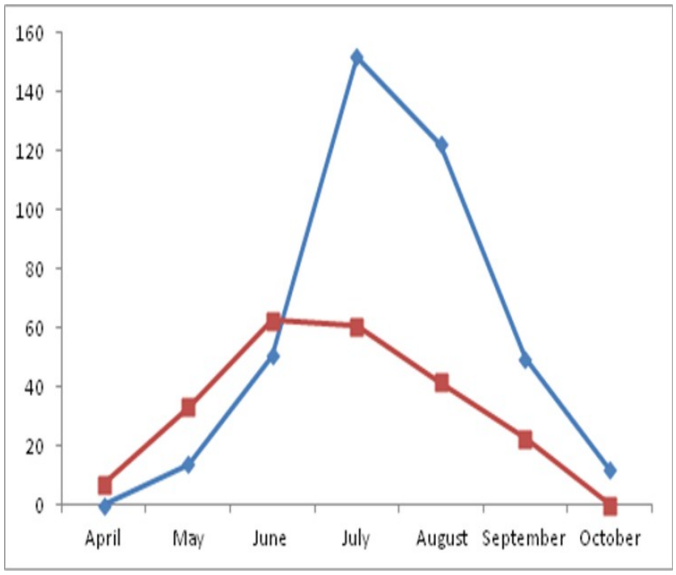


Chart 2. Rainfall in mm (blue line) and nest occupancy (one hundredth of the nest, maroon line) showing a relative pattern of increase and decrease.

Chick rearing period

Chick occupancy period was for maximum period of 100 days in the colony between May 31 and September 7, 2011, both dates inclusive. Like other occupancy phases this also varied with the species. The order was similar to total nest activity period in the case of different species for example, it was longest for Black-crowned Night Heron, Little Egret, Cattle Egret and Darter (minimum 100 days) followed by Intermediate Egret, Indian Pond Heron and Great Egret (minimum 84 days), Black-headed Ibis, Purple Heron and Asian Openbill (minimum 69 days), Grey Heron (minimum 67 days), Eurasian Spoonbill (minimum 52 days), Little Cormorant and Indian Cormorant (20 days).

Threats, Disturbance and Bird behavior

This area received high speed dust storm several times during the season which was detrimental to the nest damage and consequently egg loss and chick mortality. The sanctuary was found to be the refuge of large population of crows (*Corvus sp.*), which was observed to be the worst enemy for egg predation in the heronry when parent birds were absent during incubation or chick rearing for collection of food material. Indian Spotted Eagle (*Aquila hastata),* was also seen as the predator but frequency was very low. On two occasions during the data recording a Monitor Lizard (*Varanus bengalensis*), was also found attacking the nestling.

It was observed that when the data recorder approached the heronry from forest side through walking trail the birds showed quicker and higher disturbance sign as compared to the heronry approach by boat from lake side. Another note worthy observation was that they were more scared by presence of boat rowing erect bamboo pole as compared to standing human being in the boat. However, disturbance signs recorded were making noise (alert call), initial movement by adults as well as chick in the nest, and finally temporary leaving off the nest. Approaching distance of 100m appeared to be negligible in impact but 50m was very sensitive to disturbance.

DISCUSSION

Heronry species

Soor Sarovar heronry supported a mixture of breeding Herons, Egrets, Cormorants, Darter, Eurasian Spoonbill, Asian Openbill and Black-headed Ibis which shared the nesting environment in space and time. Mixed colonial breeding of aquatic birds were also reported earlier from other tropical South Indian (Narayanan & Vijayan, 2007; Subramanya, 2005) and tropical North Indian (Gopi & Pandav, 2011) heronries and elsewhere from Mediterranean (Prosper & Hafner, 1996; Hafner, 1978; Tourenque, *et al.,* 2004; Santoro *et al.,* 2010) and temperate climate (Naugle *et al.,* 1996; Stancill *et al.,*1988; Sallee, 1982). However, these colonies had not been as large in species richness and abundance as the present one which was almost double the size of previously reported largest heronry except (Gopi & Pandav, 2011) report from eastern part of India. This was almost similar in species richness to present heronry but three times larger in species abundance. As regards the conservation status almost all the species colonizing in the present heronry are of least concern except two, Black-headed Ibis (*Threskiornis melanocephalus)* and Darter (*Anhinga melanogaster) which* have near threatened status (IUCN, 2011).

Breeding phenology

This heronry remained very active between May and August as the heronry birds - mostly the wading birds in present case - early nesters started aggregating by the end of April and the late nesters dispersed by the end of second week of September. This coincided with the pre-monsoon and monsoon period or major rainfall (90 % of average annual rainfall) period in the region which provided adequate moisture to feeding ground (Subramanya, 2005; Urfi, 2011). Role of climatic conditions in avian breeding have also been reported by other worker (Jakubas, 2011). This also has indirect evidence from the finding that during drought year breeding activities get almost ceased (Santoro et al., 2010).Climatic condition could be the possible reason for variation in breeding phenology of Egrets and Herons in the present study versus the reports in other regions (Gopi & Pandav, 2011; Narayanan & Vijayan, 2007; Prosper & Hafner, 1996).

Nests occupancy was very high in Cattle Egret, Black-crowned Night Heron and Intermediate Egret in contrast to very low occupancy in Eurasian Spoonbill, Purple Heron and Asian Openbill. This type of heronry structure with dominance of certain birds in mixed colony was reported earlier also (Naugle *et al.,* 1996). This was probably related to colonization timing of the heronry by these birds and competition among themselves. Former group of birds was early colonizers, while latter group was the late colonizer. Early colonizers had less competition for space and resources from other birds using same area; therefore, they might have occupied the nests in higher number. Naugle *et al.*(1996) had also speculated that positioning of nests may be the function of nest initiation timing, nest density and intraspecific competition.

The qualitative report suggested that the heronry is growing day by day as the number of nesting birds as well as the species increased from the past. This observation got support from two of the earlier publications which reported that in the year 1990 there were only 2000 nests (Islam & Rahmani, 2008) while in 2008 it increased to 10836 (Kumar, 2011). Phased settlement of the species in a heronry has been reported earlier also (Santoro *et al.,* 2010). It is expected that it will grow further as the food resource availability in the lake and its vicinity is abundant, nesting trees are in plenty, protection level to the heronry is good and climate of the area is also suitable. Moreover, mixed species heronries often persist for decades and desertion due to competition is slow and gradual (Dusi & Dusi, 1968; Custer *et al.,* 1980; Burger, 1978).

Nest stratification

Vertical stratification is believed to partition resources and thereby reduce competition among co-existing species (Anderson, 1980). Nesting stratification in a mixed breeding colony as a possible strategy of space utilization reported in the present study had been reported earlier by several workers (Burger, 1978; Burger, 1979; Naugle *et al.,* 1996) and a hypothesis had also been proposed that vertical position of the nests are occupied by smaller to bigger birds as the height of nests increase in a homogeneous vegetation (McCrimmon, 1978; Naugle, *et al.,* 1996). This hypothesis was found true in our case when only stratum exclusive birds were taken into account. On the other hand consideration of stratum interface birds for this hypothesis lead to the conclusion that the hypothesis needed a relook. Most significant bird Darter, the largest but early arriver, was found in lower stratum and smaller but very late arriver birds like Cormorants were present in higher stratum. Present finding is in consonance with (Gopi & Pandav, 2011) who found the "height-size" hypothesis contradictory but in heterogeneous vegetation colony. Possibly hypothesis proposed earlier is true for small number of bird species in the heronry not the higher species richness.

Threats, disturbance and bird behavior

Predation of heronry birds, as in present case, by crows, eagles, jays, snakes etc. has been reported earlier (Pratt, 1972; Frederick & Collopy, 1989). In spite of the mixed colony strategy adopted by these birds against the avian predators and moat like isolation of the colony against the territorial attack there were incidents of predation by crows, eagles and lizards indicating continued development of prey-predator mechanism of improving defense and attack cycles. Apart from the natural enemy disturbance during breeding, human activities like tourism and research works in the vicinity, resulting into alarm calls, unusual movement in the nests and flying off the nests, also caused disturbance. Similar type of disturbance response was also reported in foraging water birds (Klein, 1993). Although 100m from the heronry appeared to be the most negligible impact distance in present case, some of the workers have recommended buffer zone

from 50-250m in Herons, Egrets, Ibis and Cormorants (Carney & Sydeman, 1999; Carlson & Mclean, 1996; Rodgers, 1991).

Management recommendation

It is expected that this heronry will continue to act as source population for future heronry. Therefore, proper management is obligatory from the viewpoint of conservation of near threatened and other species. However, past trends of visitors to this Sanctuary indicated regular rise in number (Kumar, 2011). Existing tourism is expected to increase on account of migratory avian attraction and also due to fast popularization of the heronry. Although it is a very good sign of increasing ecotourism and revenue earning, it will always have risk of negative impact on conservation efforts which is the primary objective of the Bird Sanctuary, as the enhanced human disturbance is bound to hamper breeding activities (Tremblay & Ellison, 1979) and in turn diminishing the source population. For reduction of this impact creation of buffer zone and strict implementation of regulation is a must. Moat like structure must be ensured around the heronry to reduce terrestrial predation risk (Carlson & Mclean, 1996). Also recommended is the use of telescopic arrangement on the existing watch towers in the Sanctuary for viewing of aquatic birds in general and breeding heronry birds in particular (Narayanan & Vijayan, 2007).

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