
The significance of Delhi Zoo for wild waterbirds, with special reference to the Painted Stork *Mycteria leucocephala*

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Delhi Zoo, situated close to the Yamuna river, is an important site for wild wetland birds in the Delhi region. In a field study during 1987-1992, eight species of wintering waterfowl and ten species of nesting large waterbirds were observed breeding in its premises. Painted Stork *Mycteria leucocephala* is the most prominent colonial nester of the heronries in the zoo. Its breeding pattern was studied through four seasons. The ecological aspects of the zoo's wild waterbirds are reviewed and from issues arising, ideas for a conservation monitoring programme are presented.

INTRODUCTION

Besides its numerous caged exhibits, an extra feature of the National Zoological Park (Delhi Zoo) in New Delhi, India is its wild waterbirds, which fly freely in and out of the premises. Numerous species of migratory waterfowl winter in its ponds and on some mesquite trees, planted on islands, several species of colonial waterbirds build nests. During the winter months, the most prominent nesters are the Painted Storks *Mycteria leucocephala*, which have been nesting here regularly since 1960 (Desai 1971a).

Delhi Zoo, besides being a zoological park, is also an important site for the conservation of wetland birds in a semi-urban setting. The colonial waterbirds which breed here, i.e. Painted Stork, Black-headed Ibis *Threskiornis melanocephalus* and several species of egrets, herons and cormorants (Table 1), constitute a group of wetland birds important from a conservation point of view. Because of the ease with which these birds can be observed, this site offers a unique opportunity for studying their ecology and behaviour.

This paper is primarily a review of observations made during 1987-1992 (Urfi 1992, 1993a and unpublished information) and other published work on the wild waterbirds of Delhi Zoo. Its objective is to evaluate the significance of the zoo as a repository of wetland birds diversity and discuss pertinent aspects of their ecology and conservation, with special reference to the Painted Stork.

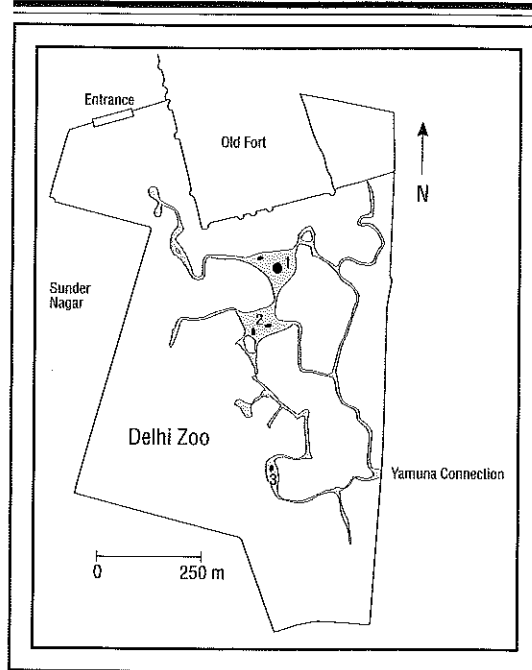


Figure 1. Sketch map of Delhi Zoo showing the main network of interconnected canals. The three ponds having heronries are numbered 1, 2 and 3. Islands planted with mesquite trees are shown as black

STUDY AREA AND METHODS

Delhi Zoo is approximately 85 ha in area and is located between the two famous historical monuments, Humayun's Tomb and the Old Fort, on the western bank of the Yamuna river. Its extensive network of ponds and canals (Figure 1) is fed by the Yamuna river which lies barely 1 km away. During the period 1987-1992 I visited the zoo twice a month, on average (mostly during August-May), and made observations on the wild waterbirds. On each visit the wintering waterfowl were counted in the ponds 1, 2 and 3; those on the ponds close to the zoo entrance and the interconnecting canals, were counted only once each year during 1987-1991. These counts were made on a day in January/February, generally in the afternoon, and the results were transmitted to the Asian Midwinter Waterfowl Census programme (IWRB, *Reports of the Asian Midwinter Waterfowl Census*, 1987, 1988, 1989, 1990). Some other observations on the zoo's wild waterbirds were also made.

From the viewpoint of nesting waterbirds three ponds, each having islands planted with mesquite trees *Prosopis juliflora*, are significant (Fig. 1). The first pond faces the old fort wall and the second one, which is close by and connected, is also known as the 'pelican pond'. Both of them are

approximately 0.8 ha in area and have two islands each. The third pond, which is the smallest and lies in the interior of the zoo, has only one island. In all the ponds the mesquite trees grow quite densely and their canopies merge and appear to be continuous. During 1988-1989, some Painted Storks also built nests on other trees in the vicinity of the ponds. The ponds are also used for the exhibition of the zoo's pinioned waterbirds: Great White Pelican *Pelecanus onocrotalus*, Greater Adjutant *Leptoptilos dubius*, White Stork *Ciconia ciconia*, Black-necked Stork *Ephippiorhynchus asiaticus* and Sarus Crane *Grus antigone*. Primarily for these captive birds, the zoo authorities dump fish (about 60-70 kg of dead fish per day for the three ponds combined) in the ponds. Some of this food is also consumed by the wild waterbirds.

Through 1988-1992, at bi-weekly intervals during the breeding season of Painted Stork (August to May) I made roost counts of adult birds at about 18h00, from a distance of 15-20 m, using binoculars and a hand digital counter. I counted the chicks in all the nests each month. Chicks (birds less than one month old) were identified by white-down, yellow-tipped black bill and their poor motor ability (Shah and Desai 1975).

OBSERVATIONS AND DISCUSSION

Records indicate that, besides other species, Eurasian Wigeon *Anas penelope*, Common Pochard *Aythya ferina*, Red-crested Pochard *Rhodonessa rufina*, Ferruginous Pochard *Aythya nyroca*, Gadwall *Anas strepera* and Garganey *A. querquedula* used to winter in the zoo, and until the 1970s wild Greater Adjutants and Spot-billed Pelicans *Pelecanus philippensis* would sometimes also visit the zoo in small numbers (Bhatia and Desai 1971). On some occasions during 1988-1991, four to nine wild Great White Pelicans were observed. Since the arrival of the wild birds, some Great White Pelicans (pinioned exhibits) have bred - possibly the pinioned females were fertilized by wild males (Urfi 1992). (It is believed that a hindrance to breeding in captivity for such large birds is the inability of the pinioned males to gain a secure balance on the body of the female during copulation). Since Great White Pelicans were seen later in the study period, and also more recently during 1994-1995, it seems that the zoo has become a regular breeding site for this species. Given that its nesting has not been reported from Delhi (Ganguli 1975) this should now be considered as a new breeding record for the region (Urfi 1996).

There is a record of Ruddy Shelduck *Tadorna ferruginea* and Common Pochard having nested in Delhi zoo (Desai 1971b). In this study, Spot-billed Duck *Anas poecilorhyncha*, Common Moorhen *Gallinula chloropus* and White-breasted Waterhen *Amaurornis phoenicurus* were the only waterbirds observed to breed. During March and April Spot-billed Ducks were seen

Species	Status
Indian Cormorant <i>Phalacrocorax fuscicollis</i>	Br
Little Cormorant <i>Phalacrocorax niger</i>	Br
Indian Pond Heron <i>Ardeola grayii</i>	Br
Cattle Egret <i>Bubulcus ibis</i>	Br
Intermediate Egret <i>Mesophoyx intermedia</i>	Br
Little Egret <i>Egretta garzetta</i>	Br
Black-crowned Night Heron <i>Nycticorax nycticorax</i>	Br
Painted Stork <i>Mycteria leucocephala</i>	Br
Black-headed Ibis <i>Threskiornis melanocephalus</i>	Br
Little Grebe <i>Tachybaptus ruficollis</i>	Br/Win
Ruddy Shelduck <i>Tadorna ferruginea</i>	Win
Northern Pintail <i>Anas acuta</i>	Win
Common Teal <i>Anas crecca</i>	Win
Spot-billed Duck <i>Anas poecilorhyncha</i>	Br/Win
Mallard <i>Anas platyrhynchos</i>	Win
Northern Shoveler <i>Anas clypeata</i>	Win
Comb Duck <i>Sarkidiornis melanotos</i>	Win
Common Coot <i>Fulica atra</i>	Win

Br = breeding; Win = wintering/roosting

Table 1. Wintering waterfowl and heronry birds observed in Delhi zoo during 1987-1992

enacting their characteristic 'head-bobbing' courtship display. Their nests and also those of the rails, were seen in several places in the zoo.

Wintering ducks during the study period

Eight species of wintering waterfowl were observed in the zoo ponds (Table 1). The census figures for four species are shown in Figure 2. Little Grebe *Tachybaptus ruficollis*, Ruddy Shelduck, Mallard *Anas platyrhynchos* and Common Coot *Fulica atra* were seen sporadically, and generally in small numbers (less than 5). The population of the resident species, the Spot-billed Duck, was observed to swell during the winter months. Northern Pintail *Anas acuta*, Northern Shoveler *A. clypeata* and Common Teal *A. crecca* start arriving by September and among the earliest arrivals are females, juveniles and males in eclipse plumage. Whereas for Northern Pintail, the numbers wintering in the ponds showed a decline through 1987 to 1991, no clear trend is apparent for the other species, in spite of considerable yearly variations in numbers. Relatively high numbers of Comb Duck *Sarkidiornis melanotos* and Common Teal were seen in 1989 and 1990, respectively. The waterfowl species given above are known to consume vegetable matter and invertebrates of wetlands and agricultural fields (Ali and Ripley 1987). In the zoo they are generally to be seen resting during the day. It appears that the concrete-lined ponds of the zoo, with hardly any rooted vegetation are perhaps less important for the birds as a feeding ground than as a refuge from human or raptorial disturbance outside the zoo.

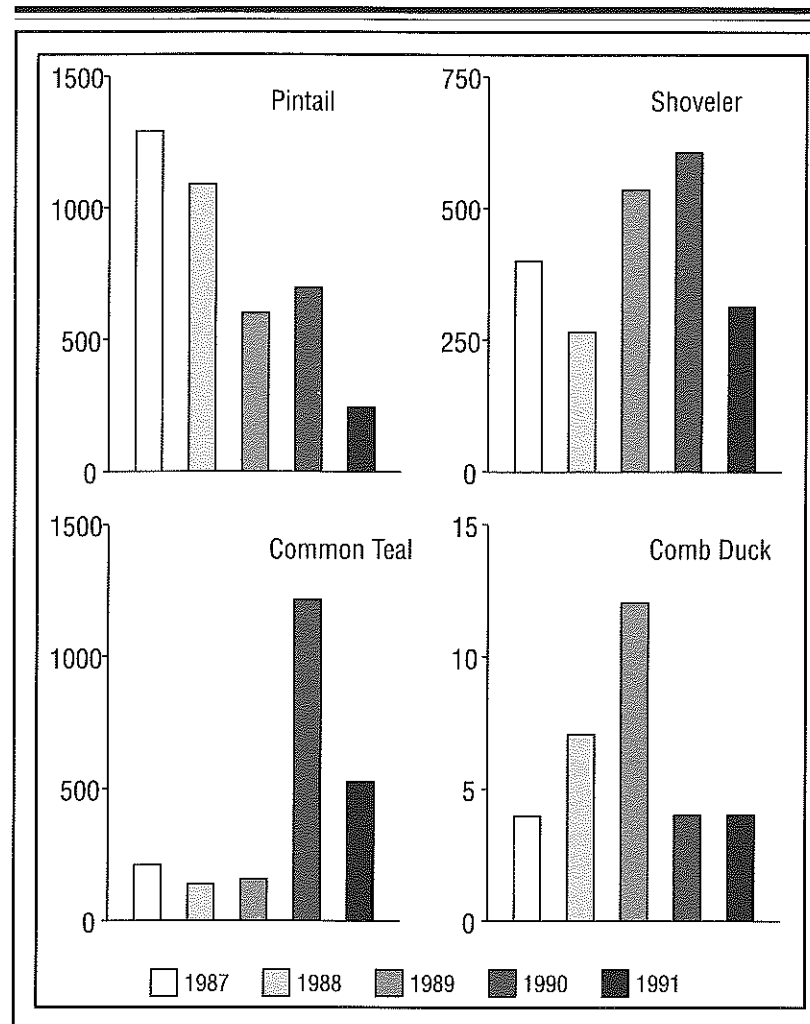


Figure 2. Midwinter counts (1987-1991) for four species of wintering waterfowl in Delhi Zoo.

Heronries

The birds nesting in Delhi zoo heronries are given in Table 1. Although these birds have been nesting regularly in the zoo since 1960, Black-headed Ibises joined this list only in 1989. According to the zoo officials the Black-headed Ibis started breeding in the zoo thanks to their programme of releasing some captive-bred birds (Urfi 1992). Great Cormorant *Phalacrocorax carbo* and Darter *Anhinga melanogaster* were observed to use the zoo only for roosting.

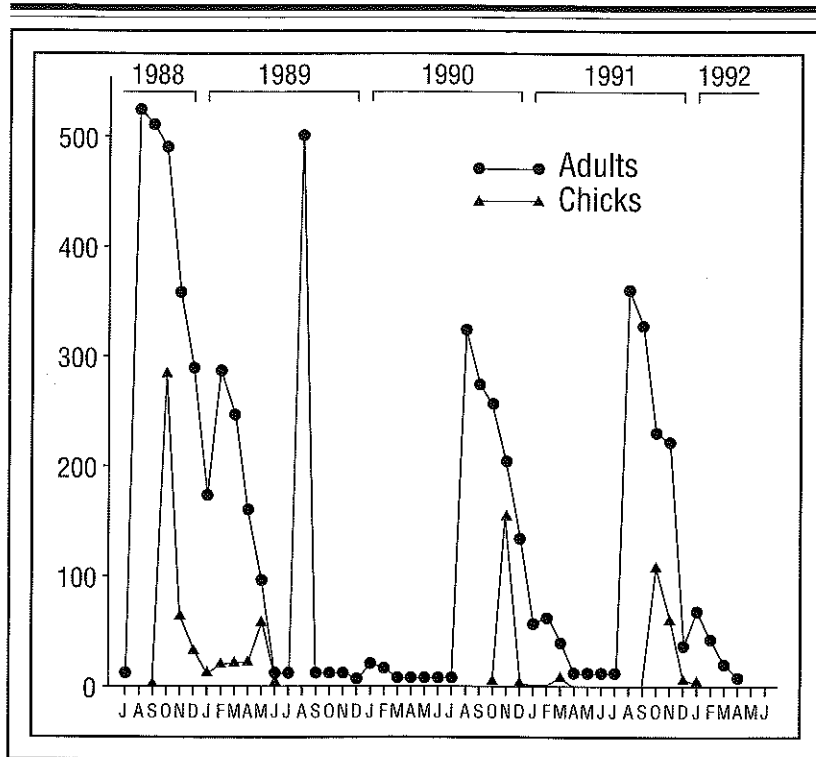


Figure 3. Monthly numbers of adult Painted Storks and new chicks produced in Delhi Zoo during 1988-1992. The season 1989-1990 was a zero recruitment year for the population. For explanation see text.

The different species nesting in the zoo heronries use the same mesquite trees. From published literature (Table 2), and from a year's observations during the study period it is clear that there is considerable natural variation in the nesting season of the different birds. Observations indicate that there is also variation in the location of the nests on the mesquite trees by the different species. Painted Storks, being the largest birds, generally build nests on the topmost parts of the canopy, while Black-headed Ibises occupy the lower and middle parts. Cormorants, herons and egrets build nests in the inner parts of the trees. However, more field studies are required to establish this spatial and temporal variation in nesting.

It will be useful to classify the Delhi zoo heronries according to a standard system, so that this heronry can be directly compared with others in the Indian subcontinent. Singh and Sodhi (1985) used a system which is based on five sets of characteristics as follows:

Species	Delhi zoo (Bhatia & Desai 1971)	Nesting period Delhi zoo (1988-1989 Urfi unpublished)	Roshanara Gardens (Ganguli 1975)
Indian Cormorant <i>Phalacrocorax fuscicollis</i>	June-August	?	
Little Cormorant <i>Phalacrocorax niger</i>	June-August	July-April	
Indian Pond Heron <i>Ardeola grayii</i>	July-December	?	
Cattle Egret <i>Bubulcus ibis</i>	June-October	May-October	May-August
Intermediate Egret <i>Mesophoyx intermedia</i>	June-August	?	May/June-August
Little Egret <i>Egretta garzetta</i>	May-August	January-June	June-August
Black-crowned Night Heron <i>Nycticorax nycticorax</i>	July-December	January-June	June-September
Painted Stork <i>Mycteria leucocephala</i>	August/September- March/April	August-May	
Black-headed Ibis <i>Threskiornis melanocephalus</i>		January-February; June-September	

Table 2. Temporal variations in the nesting period of colonial waterbirds in the Delhi region

- 1 location (whether inside or outside human habitation);
- 2 general plant type of the heronry (tree, reed or bush);
- 3 breeding species of birds (pure or mixed heronry);
- 4 physiognomy (whether the heronry is compact or loosely structured; and
- 5 whether the plants used are of one or more than one species.

According to this system the Delhi zoo heronries are 'Associated', i.e. within human habitation; 'Tree Heronry' and 'Mixed', since several species of colonial waterbirds use this site. In 1990-1991 and 1991-1992 all of the Painted Storks nested only on mesquite. However, during 1988-1989, when many more birds nested (Table 3), nests were also built on other trees. Of 202 nests in that season, 138 nests (68%) were in mesquite trees, 41 (20%) were in *Ficus religiosa*, 11 (5%) were in *Azadirachta indica*, 7 (4%) were in *Bombax ceiba* and 5 (3%) were in *Pongamia pinnata* trees in the vicinity of the ponds. Taking these observations into account, the classification of the Delhi zoo heronries, with respect to the last two characteristics in Singh and Sodhi's scheme, will vary considerably. Depending upon how many birds are nesting, the heronry can be classified as 'Compact' or 'Loose', and 'Homogeneous' or 'Heterogeneous' with respect to physiognomy and tree species, respectively.

Year	Maximum number of adults	Number of nests	Number of chicks ¹
1988-1989	550	202	523
1989-1990 ²	500	-	-
1990-1991	325	81	166
1991-1992	366	87	175

¹ Number of chicks per season is estimated as the sum of the monthly new chicks produced
² Zero recruitment year (see text)

Table 3. Breeding data of Painted Storks *Mycteria leucocephala* at Delhi zoo during 1988-1992 (from Urfi 1993a)

For Painted Stork and a few other species the zoo has been their only recorded breeding site in the Delhi region (Ganguli 1975). Although, in recent surveys, some new and hitherto unreported heronries were discovered (Urfi and Sharma 1992) the zoo is certainly the largest and the most consistent heronry in the Delhi region (Urfi 1993b). Indeed for a large part of north-western India, this site is perhaps the only major breeding ground for colonial waterbirds, second to the famous heronries of the Keoladeo Ghana National Park at Bharatpur, about 170 km away.

Painted Storks

In the area around Delhi, the Painted Stork lives singly or in small flocks in the non-breeding season, and starts flocking to the zoo for breeding in late August. The seasonal changes in the size of the adult Painted Stork population at the zoo, and the monthly production of new chicks in the three breeding seasons during 1988-1992 are shown in Figure 3. During 1989 the birds began nesting as usual but stopped abruptly around 25 September. This may have resulted from disturbance due to an exceptionally large number of visitors to the zoo, who had come to Delhi that day for a political rally (Urfi 1990). Although the maximum yearly number of the incoming adult storks varied, ranging from 325 to 550 (Table 3), the following pattern is constant: after September the number of adults in the zoo declines, probably because competition for nesting sites or mates forces some birds to leave. Around January the number of adults increases again, due to a fresh influx, although this time the increase in number is not as much as initially. The pattern of recruitment of chicks corresponds to the pattern of adult movements in that there is a major bout of recruitment during October-November, just after the initial influx. During 1988-1989 there was a distinct second but smaller recruitment bout in May, corresponding to the second arrival of adults in January. It is unclear whether this represents a second breeding attempt by some individuals, or a prolonged breeding effort in that year. In 1990-1991, although the breeding season extended into May, there was not a definitive second peak.

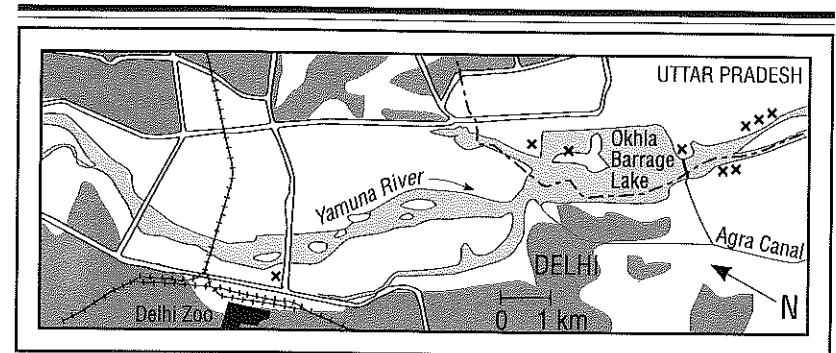


Figure 4. Sketch map to show the location of Delhi Zoo in relation to the river Yamuna. Sites where Painted Stork feeding parties were encountered are denoted by X. Shaded areas show the expanse of urbanization.

The Painted Stork, which is largely piscivorous (Ali and Ripley 1987), is believed to breed at a time of year when food is plentiful in the wetlands (Desai *et al.* 1974, Kahl 1971) in accordance with the food availability-breeding time hypothesis (Perrins 1970). The major recruitment bout in October is, therefore, timed in relation to the spawning of fish during the monsoon rains in July-August. However, a correlation should be expected between monsoon performance each year and an index of Painted Stork breeding. Unfortunately, the data in this study are too meagre to test this hypothesis. Secondly, is the second recruitment bout as during 1988-1989 and to a lesser extent during 1990-1991, real? If so, what is its ecological basis? Finally, to what extent does the breeding time of other heronry birds relate to food availability in the environment?

Since the ponds which the Painted Storks use are also used by the pinioned waterbirds, for which food is added, the question is: what is the significance of this food for the storks? It has been observed that when fish for the exhibits is dumped in the ponds each morning, several Painted Storks rush forward to grab this free and easy meal. However, the Painted Stork colony of about 100 nests would consume approximately 24 tonnes of fish in the breeding season. The concrete-lined zoo ponds and the dead fish which are dumped in them are unlikely to meet these demands. So, the majority of the food requirements of the breeding storks are presumably met by foraging in wetlands associated with the nearby Yamuna river (Figure 4).

During the breeding season, adult Painted Storks were observed flying directly from their nests out of the zoo, or climbing on thermals (Desai 1971a), which is strongly indicative of preparation for a long-distance food-finding mission. There is also another line of reasoning which suggests that the majority of the food for the breeding storks and their chicks is likely to be met by catching fish from the natural wetlands of the Yamuna outside the zoo. There is evidence (O'Connor 1984) that the food requirements of

chicks, in many species, are different from those of adults. Because of their smaller gape size, Painted Stork chicks probably need to be fed by relatively small-sized fish and the appropriate size class is likely to be abundant in natural wetlands of the Yamuna where the fish have spawned after the monsoon rains. However, this hypothesis has to be tested in the field. Also, more field studies are required to locate the favourite feeding areas of Painted Storks on the Yamuna, across a much larger area than shown in Figure 4.

CONSERVATION

Since the wild waterbirds of Delhi zoo are dependent on the Yamuna river, any change in the quality of the river is bound to affect the zoo's birds. On the other hand, events or habitat changes in the zoo will also affect the bird populations of Delhi's wetlands. A case in point is the unusual human disturbance during 1989, making this year one of zero recruitment. A problem in recent years, which is now getting quite noticeable, is siltation of the ponds. Although this is bound to affect the zoo's wild waterbirds, the time scale on which the changes will take place will be best understood by a population monitoring programme, which will also help to ring alarm bells and goad conservation bodies into action if the habitat quality deteriorates sharply. It has to be borne in mind that the conservation of the wetland habitats associated with the Yamuna in Delhi will depend on our ability to check the increasing levels of pollution in the river, and the growth of urbanization in the surrounding areas.

Since the initiation of the 'Asian Waterfowl Census' in 1987 by the IWRB, the importance of monitoring bird populations is being realized in India (Urfi 1995). However, there are not many bird population monitoring projects going on in India yet. In this regard, a long-term bird population monitoring programme at the Delhi zoo, and perhaps other Indian zoos which provide a habitat for wild waterbirds, is likely to prove worthwhile. One advantage of such sites is that being located in urban areas they are easily accessible to counters.

A long-term monitoring programme of the zoo's wild waterbird populations should be structured along the following lines:

- 1 an annual waterfowl count complemented by a parallel counting event at a constant site (such as Okhla barrage and environs) on the Yamuna river;
- 2 a monthly count of adults, juveniles, nests etc. for all the heronry birds; and
- 3 an annual sample of Painted Stork nests should be monitored for clutch size and breeding success parameters.

Given that the wild waterbirds use Delhi zoo premises opportunistically,

in a certain sense the zoo authorities may not consider their care and management as among their formal responsibilities. However, the crucial role which the Delhi zoo can play in the conservation of wetland birds requires a major shift in their attitude.

I thank Professor T. R. Rao and Dr N. Iyer for commenting on earlier versions of the manuscript. This paper was written while I was a CSIR Pool Officer at the Department of Zoology, University of Delhi.

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