Using Heronry Birds to Monitor Urbanization Impacts: A Case Study of Painted Stork *Mycteria leucocephala* Nesting in the Delhi Zoo, India

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Although urbanization is a frequently cited cause of biodiversity loss (Czech and Krausman 1997) our understanding about urban ecology is severely limited (Marzluff et al. 2001). Birds are popular bio-indicators of environmental change because they are ecologically versatile, their populations as well as select fitness parameters can be conveniently monitored, often with the voluntary involvement of local nature enthusiasts across large geographical scales, and their presence/absence in a particular area is consequential (Bibby et al. 1992; Urfi 2004). In India, while several studies have focused on changes in bird populations and distributions in natural habitats (Urfi et al. 2005), very few have actually attempted to study either the impacts of urbanization on birds or how different species have adjusted to environmental change. However, many Indian cities offer foraging and nesting habitat for birds, especially colonial waterbirds such as stork, ibis, spoonbill, heron, egret, cormorant, and spoonbill. Some notable examples in this regard are 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). In this article, I focus on the opportunities for meaningful ecological research offered by the wild waterbirds nesting in the Delhi Zoo premises and discuss the significance for initiating novel, long term conservation monitoring programs, involving volunteers and bird watchers, to create data bases that will be useful for understanding urbanization and climate change impacts on biodiversity.

PAINTED STORK OF DELHI ZOO

The Delhi zoo, spread over 85 ha, on the western bank of the river Yamuna in Delhi was created in 1959 as a national zoo. Lying between two famous monuments, Old Fort and Humayun's Tomb, the zoo also has several historical structures scattered all over its premises. A "Kos Minar", a small tower which served the purpose of distance markers between towns in mediaeval times, still stands in the zoo campus as a relic of bygone times. However, from a biodiversity standpoint the unique feature of this zoo is the hundreds of wild waterbirds breeding in its four large ponds (Fig. 1, inset), making it virtually a waterbird sanctuary for most months of the year. A wild population of Painted Stork (*Mycteria leucocephala*) established itself here in ca 1960 and have been nesting more or less uninterruptedly since then (Urfi 1997). Every year after the closure of the Summer Monsoon these storks start congregating in the zoo and by March or April they leave, dispersing in the countryside around Delhi (Urfi 1998). Besides these, several other species, including cormorant, egret, heron, and ibis also nest in the same ponds utilizing the same nesting substrate (Urfi 1997). While these birds are no doubt opportunistic nesters, their annual visitation to the zoo could be indicative of, among other factors, the shortfall of natural nesting habitats in the countryside besides an environment of safety prevailing within the confines of the zoo.

The Delhi Zoo Painted Stork population has been studied sporadically, though in fair amount of detail, over the past five decades, chiefly during 1966–1971, 1988–1992 and 2004–2006. First, Desai and co-workers studied its general biology, covering nesting ecology (Desai et al. 1977), diet and foraging (Desai 1971; Desai et al. 1974)

Fig. 1 Satellite imagery, generated by Google Earth, to show the location of the Delhi Zoo in relation to the Okhla Barrage Bird Sanctuary, the principal foraging ground for Painted Stork nesting in the zoo. Note built up areas all around Okhla and several encroachments, bridges and flyovers on the river Yamuna floodplain. *Inset* shows the layout of the four inter-connected ponds in the zoo campus where colonial waterbirds nest. Each pond, having islands (shown in black) with *Prosopis juliflora* trees planted on them, provide the nesting substrate for these birds. In recent years, Painted Stork has been nesting in four colonies (the four islands) of Ponds 1 and 2. Pond number 1, for which nesting data is discussed in the text is located just opposite the walls of the Old Fort

and growth and development of nestlings (Shah and Desai 1975a, b). Thereafter, more or less coinciding with the popular interest in India generated by the Asian Waterfowl Census in counting waterfowl (Urfi et al. 2005), studies on populations and colonization patterns of Painted Stork were undertaken (Urfi 1993). Subsequently, investigations on foraging ecology and behavior (Kalam and Urfi 2008), sexual size dimorphism and its consequences (Urfi and Kalam 2006) and inter-colony variations in nesting parameters in the zoo colonies (Meganathan and Urfi 2009) were investigated.

CHANGES IN THE URBAN LANDSCAPE AND ITS IMPACTS ON BIRDS

The river Yamuna which lies about a kilometer away from the Delhi Zoo is an important feeding ground for Painted Stork and other birds nesting in the zoo. The stretch of the Yamuna passing through Delhi, though it is only 22 km long and constitutes only 2% of its catchment area, contributes about 80% of the river's total pollution load. This is because at least 16 major drains discharge untreated municipal sewage daily in the Delhi segment. Several studies have documented high concentrations of heavy metals and also pesticide residues (for details see Urfi 2006). Casualties of dead birds and fishes have been

reported from this stretch of the river. Furthermore, over the past 5 years encroachments on the Yamuna have increased exponentially, as new bridges and flyovers have been constructed. The construction of the controversial Games Village, for housing athletes during the Commonwealth Games to be held in New Delhi in 2010, have also contributed to the problem of encroachments on the river Yamuna floodplain. Due to these reasons both the nesting as well as the foraging grounds of Painted Stork, are becoming increasingly isolated (Fig. 1).

There are fears that these changes are already impacting birds. Our own studies have demonstrated that at downstream sites, such as Okhla Barrage, an important feeding ground for the Painted Stork, located about 9 km away from the zoo, there has been a marked reduction in the diversity of waterfowl over the past decade (Urfi 2006). Indeed, indicator species such as the Sarus Crane (*Grus antigone*) have not been sighted at Okhla since 1992. However, to develop appropriate conservation strategies the primary requirement is to establish scientifically and conclusively the adverse impacts of urbanization. This is something which can be done only if there is good data, across a long time period and it is here that the Delhi Zoo Painted Storks can prove to be an extremely useful model for scientific studies.

From the available information, it seems that the Delhi Painted Stork population has responded in a complex pattern to changes in its habitat. The data on numbers flocking to the zoo each year, for nesting for the three periods mentioned above, does not indicate a declining trend in Painted Stork populations (Urfi 2006). Infact there seems to be a slight increase in total numbers recorded in the zoo each year, from 438 in 1966 (Shah and Desai 1975b) to over 500 in 2004 (Urfi 2006). Whether this is due to traditional nesting colonies outside the zoo, in the countryside around Delhi, having come under the axe, leading the Painted Stork with little option but to continue nesting in the Delhi zoo, is difficult to say. However, the variations in fitness parameters, notably clutch size, for the above periods suggest a different trend. Here, we have to tread with caution. Since our previous studies (Meganathan and Urfi 2009) conclusively demonstrated that there are considerable inter-colony variations in clutch sizes of the Painted Stork of Delhi zoo each year our examination needs to be restricted to only colony 1 in Pond 1 (Fig. 1 inset), which has been consistently studied since 1960's. Here, the mean clutch size for each of the years from 1966 to 1971 ranged from 2.2 to 2.8 (mean = 2.49) (as recorded in Shah and Desai 1975b). Interestingly, our studies during 2005 and 2006 (Meganathan and Urfi 2009) recorded a considerably lower mean value (1.99) and range (1.75–2.42) for Pond 1, although for the zoo as a whole the mean clutch size still ranged from 2.09 to 2.43. So, is there a decline in fitness in

this population and can it be linked to habitat deterioration? For the moment it is difficult to say unless this population is studied on a long term basis and some habitat parameters also monitored simultaneously.

CONCLUSIONS AND RECOMMENDATIONS

Although the policy issues of zoo's and their management have been detailed in various vision documents (Central Zoo Authority 2009), an aspect of zoo's which has been largely ignored is their existence as open spaces and veritable habitat islands, in an ever growing sea of concrete, in many cases affording excellent habitats for endangered wildlife. For the Delhi region of North India, the Delhi zoo is an important breeding ground for the near Threatened Painted Stork (Birdlife International 2001). This is a flagship species and being exclusively piscivorous (Kalam and Urfi 2008) its nesting is strongly tied to the performance of the monsoon, since fish production in local rivers and wetlands is itself monsoon dependant (Urfi 1998).

Unfortunately, there seems to be no official recognition of value of zoo premises as a refugia for endangered wildlife (as well as repositories of architectural heritage, as in the case of Delhi zoo) in policy documents. Clearly there is a need to recognize the significance of these assets and also devise programs to monitor them for the benefit of the larger environmental issues they help us to address. Also, there is no availability of any sort of printed material about the wild waterbirds of the zoo. Facilities for the interpretation of the Painted Stork colonies are virtually non-existent. These should be developed for achieving the objectives of nature education and a proper research wing established.

The Delhi zoo Painted Stork population has been studied in a fair amount of detail by individual scientists, albeit sporadically, since 1960's. It probably affords the best example of a detailed study on a single population of a wild bird, from anywhere in India. It is recommended that a program to monitor this population should be initiated and built into the operational machinery of the zoo. While being coordinated by the zoo authorities, under the guidance of researchers and scientists from academic institutions, this program could derive its inputs from the efforts of volunteers such as local birdwatchers and school and college students. This will set the tone for generating long term data bases for breeding birds and also simultaneously taking a lead in initiating citizen science programs for the benefit of environment (Urfi 2004; Urfi et al. 2005; Greenwood 2007). Since the birds in question are fairly large sized and their nests easily approachable they are also easy to monitor and no special equipment is required to study them. A case in point is the Heronries Census of the British Trust of Ornithology which began in 1928 and is

today the longest-running breeding-season monitoring scheme in the world (British Trust for Ornithology (BTO) 2009).

The scientific advantages of initiating a long term monitoring program at the Delhi Zoo would be several. It will be useful in understanding population ecology issues, i.e., how various biotic and abiotic factors influence bird populations. In view of the recent concern about global climate change affecting the monsoon, it will help us understand better how yearly rainfall patterns affect Painted Stork nesting since these birds are monsoon dependant for breeding. Above all, this monitoring program would also helps us to keep tabs on urbanization and pollution and their possible impacts on birds.

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