Status and distribution of breeding cattle egret and little egret in Amroha using density method

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We report the status and distribution of nesting egrets in Amroha using a density method, which is robust, cost-effective and useful in all field situations. We estimated a mean of 0.016 nests/m^3 of canopy volume ± 0.008 95% CI for cattle egrets and 0.024 nests/m^3 of canopy volume ± 0.01 95% CI for little egrets. Colony size averaged 171 nests ± 89 95% CI. We report a human-induced hatching failure of 1782 and 1613 eggs of cattle egrets and little egrets respectively, and poaching of 1274 nestlings of egrets (cattle egret = 688; little egret = 586). Correlation analysis indicated that occasional disturbance/threat does not impact nest densities, but intense and constant ones may even result in desertion of colonies.

ONE of the major priorities in conserving animals is monitoring changes in their populations to find prescriptions for their long-term survival[1–4]. One of the most simple and commonly used methods for recording and monitoring ardeids is counting their nests or enumerating the total in the roosts[5,6]. However, in countries with a large number of ardeids distributed over vast geographical areas, total count of birds is not possible due to larger requirement of manpower, time and money. So nest count is the only feasible method for population monitoring. Further, in relatively inaccessible study areas of the world (e.g. Himalaya), where difficult field conditions are compounded by dense vegetation, steep terrain and difficult topography, nest census is the only suitable method for counting ardeids, and therefore their monitoring using nest count method has been widely used by several workers[7–12] across the world.

Most of previous workers[7–9] have monitored ardeids by counting their nests or breeding pairs (colony size) at a given time in an area and compared the nests of an area over a time interval. However, comparison of areas using colony size may suffer from a serious drawback, specifically when two or more sites contain identical number of nests. Such a situation, when grossly deficient in other environmental data, often poses difficulties for drawing site-specific management plans in a region. For example, the local wildlife management body can afford protection to only two heronries in a region as a result of money, manpower, time and other constraints. And with such grossly deficient data, it is impractical to choose the best ones from management point of view until converted into densities. Therefore, some workers[11,13] have used nest density/unit geographical area for monitoring the population of ardeids. In certain situations, however, calculating nest density/unit geographical area suffers from two main drawbacks. (a) it may be impractical to count all nests within an area, if nesting colonies are located in inaccessible areas (e.g. vast tracts of Andaman and Nicobar Islands, and Himalaya), unless costly means (e.g. aerial surveys) are used; and (b) in areas where nests are dispersed over large discontinuous tracts (e.g. most of Southeast Asia), it is difficult to delineate areas to calculate nest densities until sophisticated technologies such as remote-sensing and Geographical Information System (GIS) are used. However, both these approaches are costly and are still not accessible to all. Therefore, Telfair[13] has used a combination of six methods (ground measurement via remote sensing to aerial flight-line surveys) to estimate nesting densities of egrets within heronries.

Although ardeids widely breed throughout India[14], the noticeable absence of heronries in the Indo-Gangetic Plains is surprising[15]. Unfortunately, our knowledge of distribution and status of nesting ardeids in India is incomplete, although they are among the most common breeding birds in the region.

We, therefore, surveyed nesting colonies of cattle egrets and little egrets that were hitherto unknown in parts of the Indo-Gangetic Plains, with the aim to develop a nest density method, which is robust, cost-effective and useful in all situations, for determining the status of breeding egrets across different nesting colonies. Both studied species are among the most common of the four species of egrets that

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breed in the region, i.e. cattle egret (*Bubulcus ibis*), great egret (*Ardea alba*), intermediate egret (*E. intermedia*) and little egret (*E. garzetta*).

Study area

The study area[16] is located 131 km northeast of Delhi between 28°26′–29°26′N long. and 78°04′ and 78°39′E lat. and falls under Biogeographic Zone 7A of India[17]. The Ganges with its tributaries (Ban, Gagan, Yagad, Bagad, Kurula, Sotra and Krishna) forms a complex wetland system in the region[16].

Methods

We defined nesting colonies according to Gochfeld[18]. Most nesting colonies of egrets in the study area were more than 1 km apart. Nesting colonies that were within 500 m radius were considered as discrete colonies, when man-made landuse changes obscured the activity of one colony from another.

Although egrets initiated clutches by late May, counts were made in mid-June towards the end of incubation. Nest census of egrets was conducted following the Tally method[19] between 15 June and 30 August 2001. We studied 42 nesting colonies (aggregations of > five nests). Empty nests and those with contents were distinguished. An active nest was one that contained an egg or nestling in it.

At each nesting colony, trees used for nesting were identified to species and measured for canopy diameter and canopy height in order to calculate canopy volume of nesting trees. The canopy shape of each nesting tree was also recorded. In addition, the distance of each nesting tree from the nearest wetland was also measured.

Quantitative information was collected on potential disturbances to nesting egrets, specifically number of nestlings and/or adults poached and number of eggs collected and/or number of nests destroyed by locals were collected by interviewing locals, who in the opinion of their fellow villagers, were involved in such activities following Sethi and Hilaluddin[20]. We also collected qualitative information on disturbances at each colony and classified them as predation (by domestic cats and snakes), lopping of nesting tree, destruction of nests as a result of wind/storm, and drum-beating and/or lighting firecrackers. While data on predation and nest destruction due to storm were gathered by interviewing owners of the nesting trees, direct observations were made on lopping, drum beating and/or lighting firecrackers.

Data analysis

We excluded empty nests from our analysis because we were not certain about the identity of nest-builders. We also discarded nests that were in two particular trees, because we were unable to measure their canopy diameter and height due to heavy waterlogging around them. In addition, we also excluded nests in two trees from analysis, because each tree had less than five nests.

Canopy spread was computed following Muller-Dombois and Ellenberg[21], whereas canopy volume of nesting trees was calculated using standard algebraic equations following Singhal *et al.*[22]. Number of nests/m^3 of canopy volume of each nesting egret species was calculated for each nesting.

Quantitative information gathered on the number of nests destroyed by local villagers for each nesting tree was pooled together for the entire study area to estimate the overall human-induced hatching failure and/or mortality of nestling egrets. Our calculations are based on the assumption that each of the destroyed nest had an egg or nestling in it and all the fallen eggs and/or nestlings, failed and/or died. We further calculated human-induced hatching failure and/or nestling mortality for both species by assuming that destroyed nests were in similar proportion to our reported census ratio of cattle egret (CE): little egret (LE) = 54: 46% in Amroha. We considered mean clutch sizes of each egret species (CE = 3.03; LE = 3.22 eggs/nest) in our calculations following Hilaluddin *et al.*[23] for the region.

Similarly, quantitative data collected on the number of bag(s) containing nestlings poached from each nesting colony were pooled for the entire study area. The number of nestlings poached was computed at mean weight of nestling (normal weight ranging between 100 and 200 g) and normal capacity of each jute bag to carry 40 to 50 kg weight based on information provided by the local villagers.

The qualitative information collected on each category of disturbance for each nesting tree was quantified by assigning 1 to each ‘yes’ and 0 to each ‘no’. Information analysed thus was pooled for each nesting colony in order to investigate the impact of disturbance/predation on nest density of egrets. The impact of disturbance/predation on nest density was examined using Spearman’s rank correlation.

Results

We calculated a mean of 0.016 nests/m^3 of canopy volume ± 0.008 95% CI for the cattle egret and a mean of 0.024 nests/m^3 of canopy volume ± 0.01 95% CI for the little egret. Total estimated breeding population was 7059 adult pairs (CE = 3812; LE = 3247) in 160 trees belonging to 20 species (*Azadirachta indica*, *Acacia nilotica*, *Albizia lebbek*, *Averrhoe carambola*, *Bombax ceiba*, *Delonix regia*, *Dalbergia sissoo*, *Eucalyptus species*, *Ficus benjamina*, *F. benghalensis*, *F. glomerata*, *F. religosa*, *Mangifera indica*, *Manlkara hexandraroxburgi*, *Melia azadirach*, *Mimusops elengi*, *Pithecellobium dulce*, *Syzygium cumini*, *Tamarindus indica* and *Ziziphus mauritiana*). Overall colony size ranged from 5 to 882 nests and averaged 171 nests ± 89 95% CI, whereas overall nest density ranged from 0.007 to 0.104 nests/m^3 of canopy volume (Table 1).

We found a total of 164 dead nestlings (CE = 112; LE = 52) as a result of human persecution. The villagers admitted to destroying 1089 egret nests during the nesting season of 2001, suggesting a human-induced hatching failure and/or mortality of at least 1782 cattle egrets and 1613 little egrets, provided that the destroyed nests were in similar proportion to our reported census figure for nesting egrets (CE: LE = 54: 56%) in Amroha. On similar assumptions, we report poaching of 1274 nestlings 1274 (CE = 688, LE = 586) from our study area.

Overall nest density of colonies showed non-significant correlations (Spearman's rank correlation) with factors, namely nest destruction by humans ($r_s = -0.14$, n.s., $N = 42$), egg collections ($r_s = -0.01$, n.s., $N = 42$), predation ($r_s = 0.04$, n.s., $N = 42$), tree lopping ($r_s = 0.08$, n.s., $N = 42$), nest destruction due to storms ($r_s = 0.02$, n.s., $N = 42$), poaching of nestling ($r_s = -0.23$, n.s., $N = 42$), poaching of adults ($r_s = -0.04$, n.s., $N = 42$) and drum-beating and/or lighting of firecrackers ($r_s = -0.01$, n.s., $N = 42$). Data disturbances (Table 2) suggest that roughly half of the nesting colonies and a quarter of nesting trees were prone to nest destructions by human, whereas 38% of nesting colonies and 15% of nesting trees were subjected to egg-collection. Similarly, 30% each of nesting colonies had incidences of nestling and adult poaching, whereas 15 and 13.7% of nesting trees experienced incidences of poaching of nestling and adult respectively. Five per cent nesting trees were prone to moderate to heavy lopping (>20% canopy lopped) at 7.1% nesting colonies.

Table 1. Density (nests/m^3 canopy volume) and colony size of nesting egrets in Amroha

Site	Cattle egret	Little egret	Overall	Colony size
Afzalpur	0.005	0.019	0.024	80
Akbarpur Patti	0.010	0.002	0.012	57
Bar Wala Gora	0.027	0.004	0.031	419
Bhoora	0.016	0.019	0.035	325
Burhena	0.010	0.014	0.024	228
Chowdherpur	0.0	0.021	0.021	57
Chupka	0.0	0.031	0.031	5
Daryapur	0.010	0.007	0.017	82
Dhanora	0.002	0.005	0.007	24
Ekzabad	0.025	0.0	0.025	168
Hafizpur	0.005	0.007	0.012	44
Hisampur	0.0	0.008	0.008	5
Jamuna Khas	0.007	0.019	0.026	82
Kalampur	0.003	0.007	0.01	48
Kalberi Milak	0.0	0.024	0.024	186
Kamalpur Khalsa	0.0	0.059	0.059	41
Kankar Sarai	0.014	0.019	0.033	410
Kanpura	0.052	0.037	0.089	306
Kazikhera	0.0	0.013	0.013	16
Keshopur	0.069	0.0	0.069	82
Khayya Shekhpura	0.013	0.025	0.038	476
Leelee Khedi Dhakia	0.085	0.013	0.098	148
Lodhipur Banjara	0.009	0.034	0.043	101
Manjhola	0.011	0.036	0.047	68
Mansoorpur	0.014	0.009	0.023	814
Mohanpur Junab	0.0	0.103	0.103	97
Mohanpur Somali	0.0	0.021	0.021	58
Moonda Imma	0.0	0.025	0.025	20
Nabbu Shah's Shrine	0.029	0.0	0.029	86
Nagalia	0.034	0.0	0.034	40
Nanhera	0.017	0.042	0.059	254
Old Slaughter House	0.025	0.009	0.034	102
Pachokra	0.0	0.007	0.007	44
Paigambarpur	0.0	0.021	0.021	36
Puranpur	0.021	0.083	0.104	10
Railway Station	0.045	0.026	0.071	882
Ramtalab	0.024	0.009	0.032	459
S.F. Plantation near Basudev Temple	0.0	0.092	0.092	153
Shekh Chah Mosque	0.039	0.021	0.06	396
Shyampur	0.016	0.032	0.048	224
Sonpura	0.032	0.005	0.037	42
Umbarpur	0.007	0.06	0.067	18

Discussion

Nest densities of cattle egrets and little egrets calculated by us are not directly comparable with those of the two species produced elsewhere[11,13], because we used another nest density method. However, colony sizes are directly comparable with others[7–9,12,15]. With a few exceptions, nests in heronries were generally arranged in multi-layers up to 2 m in depth. Thus, we used 3D density because of apparent multi-layered arrangement of nests in 3D rather than 2D in space. Our density method is based on nest concentration in relation to available resources (nest placement space), which is crucial for establishing nesting colonies in an area. The number of nests that a plant could hold is a function of crown radius[13] and canopy height, which ultimately determines canopy volume. Like other density methods, the suggested density method also represents concentration of objects in relation to per unit area.

The suggested density method is based on the number of nests/unit volume of tree canopy rather than the number of nests/unit geographical area of the land mass. Consequently, in this method one does not have to delineate geographical area of the land mass, which is often inaccurately calculated in the countries where sophisticated technologies are not accessible to the majority. Further, the suggested method is cheaper when compared to the use of

Table 2. Threat/disturbance to heronries in Amroha

Threat/disturbance	Number of sites	Number of trees
Tree lopping	3	8
Tree felling	2	2
Egg collection	16	24
Poaching of nestlings	13	24
Poaching of adults	13	22
Nest destruction by humans	21	41
Nest destruction due to storm	5	6
Drum beating/lighting firecrackers	2	4
Predation	7	8

sophisticated means like aerial survey, aerial photographs, imageries and GIS, because measuring canopy variable of a tree takes less than 2 min by two persons and therefore less labour-intensive than estimating the area of a colony. Even if a map of the colony is available, our method will be less labour-intensive and error-deficient to calculate area of the colony from the map using a planimeter or by dividing the map into grids and estimating its area.

The most significant application of our density method is its capability of producing equally good results (compared with other density estimates) in monitoring trends of nesting ardeid populations, if used over years in the previously surveyed areas. For example, in a hypothetical situation, the suggested density method will show significant change in a colony with a population crash, if few remaining birds nest on one or a few trees: say, from 100 birds on 20 trees in a colony in a particular year, each tree having 10 m^3 canopy volume and supporting five birds. Therefore, density for each tree works out to be 0.5 m^3 of canopy volume. The mean of the density in the colony remained 0.5 m^3 of canopy. The population shows drastic decline over a year: say, to just 10 birds on two trees (five birds on each tree). In such circumstances, mean of density in the colony (0.5 + 0.5 + 0 + 0 + 0/5) works out to be 0.2 m^3 of canopy volume.

Further, high or low nest density of ardeids in a particular tree or a site may also indicate preference and under use for that particular tree or site, which may not be reflected with the absolute numbers. For example, colony size of Jamuna Khas, Keshopur and Daryapur villages are identical to each other in terms of number of nests, as are those of Kamalpur Khalsa and Sonpura villages besides others (Table 1); but these sites show different values for densities.

However, we could not avoid marginal bias in density estimation due to difficulties in calculating the volume of tree canopies in a few situations. Tree canopies were assumed to be perfect cones/cylinders/half spheroids depending on their shapes. The canopy breaks at certain portions and/or one or two shoots leading outside the canopy structure resulted in slightly over- or underestimation of the canopy volume and accordingly impacted nest density estimates. However, such marginal biases prevailed uniformly across survey sites and therefore density values across sites allowed viable comparisons among them.

Further, observer's bias of underestimating breeding pairs (also made by most of the previous workers) could not be avoided because our surveys were opportunistic and consequently, we were unable to control the timing of visits to the breeding grounds. Observers in the early breeding season may not even recognize breeding egrets until they see them in breeding plumage and/or courtship displays. Later, when nests are constructed, it is easier to find breeding pairs. However, if searches are not made prior to the nest-construction stage, pairs that failed to breed at an early stage and as a result moved away from colonies are missed, leading to an underestimation of breeding populations.

Despite these shortcomings, the suggested method is an appropriate way of calculating the density in an area. This method can be easily applied in difficult field conditions where roost counts are practically impossible due to time, manpower and money constraints. Further, for species like cattle egret and little egret with their numerous numbers and widespread distribution in vast geographical areas across the world, this method is best suited as it involves little expertise, time, manpower and money. There is little disturbance to the birds while counting their nests.

Cattle egret and little egret often form nesting colonies that may contain up to several thousand breeding pairs[5]. They form small and medium sized nesting colonies throughout their breeding ranges in India[15] and few heronries are large[14]. Although small heronries were not uncommon (33%) in Amroha, large and medium sized nesting colonies (>50 nests) were abundant (66%).

Our correlation analysis suggests that although egrets are quite tolerant to disturbances and may form breeding colonies even in disturbed areas, their nest densities are influenced by disturbances. While continued intense disturbance forces birds to desert nesting sites, occasional disturbances often result in relocating and re-assembling nesting colonies[15], leading to unnecessary energy expenditure in mobility and search. The landowners often lop nesting trees prior to onset of the breeding season with the misbelief that breeding egrets convert the nesting trees to 'bare poles' with their excreta. In addition, offensive smell arising out of heronries due to defecation by adults and newly fledged young, and rotting food scraps fallen from the nests also provoke landowners to lop nesting trees.

The most significant source of mortality of nestlings in Amroha was human persecution. Traditional communities, specifically, Banjara, Gidia and Phasia often raid heronries for nestlings and adults for self-consumption as well as illegal trade. Incidences of poaching were relatively higher in the Kelsa–Umri–Nowgavan belt, specifically in traditional heronries of Burhena, Ekzabad, Hafizpur and Kalampur villages. However, the practice of egg-collection, nest destruction and tree lopping was comparatively higher in the Joya–Didoli belt.

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MEETINGS/SYMPOSIA/SEMINARS

National Seminar on Natural Resources, Health Care and Natural Hazards

Date: 2–3 June 2005
Place: Visakhapatnam

Topics include: Conservation of natural resources, biodiversity and animal welfare; Marine pollution, problems and solutions; Urban ecology, environmental health, management plans and natural hazards, etc.

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Intensive Course on Heterogeneous Catalysis and Kinetics

Date: 15–25 June 2005
Place: Varanasi

Topics include: Catalyst classification and preparation; Catalyst characterization; Advanced and nano-structured materials; Kinetics of catalytic reactions; Activation, deactivation and poisoning of catalysts, etc.

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Third All India Summer Research Training Programme on Molecular Techniques

Date: 16–30 May 2005
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Topics include: Genome technology; Plant molecular biotechniques; Bio-separation; Bioinformatics; Aquatic nanotechnology; Virus cultivation, etc.

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