Counting birds in India: Methodologies and trends

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Counting is central to ecological studies and conservation research in ornithology. This article examines the present status of counting birds for various purposes in India. Though there is general awareness about proper counting techniques, as evidenced by the variety of methods employed by field biologists, reliability estimates are not available for most studies. Counts that employ large sets of volunteers, such as the Asian Waterfowl Census have not developed rigorousness, and bird-counts in community studies have ignored to perform standardization exercises such as developing species incidence curves. Studies on single species, though important, have mostly focused on species with high conservation value, but are expanding to include other species as well. Some recommendations for future work are provided.

Keywords: Asian Waterfowl Census, bird-count, Indian birds, line-transect, reliability.

BIRDS are ideal bio-indicators and useful models for studying a variety of environmental problems[1]. As increasingly more attention is now being given to conservation monitoring and ecological studies, the methods employed in field ornithology warrant a closer examination. Developing scientifically sound census programmes is essential in describing long-term trends in bird populations, highlighting species declines and unravelling the underlying causes. While in the developed world there has been extensive research on the standardization of bird-count techniques[2–4], in the Indian context, however, it turns out that most writings are fairly general in nature[5–8], leading one to suspect that scant attention has been paid to this subject. In this article we provide a preliminary review of studies that have involved counting birds. Our approach here is to take an overview of bird-count programmes in India and thereby stimulate greater interest among scientists and environmental managers.

The basic objectives with which bird-count exercises have been undertaken in India are a logical starting point for our discussion. For endangered birds, the question 'how many individuals survive?' is crucial. Usually, an apprehension first surfaces that a particular species is declining and this leads to conservation action, the first exercise in which is to determine the numbers of that species in the wild. Population estimation exercises have been undertaken for a variety of endangered birds such as the Siberian Crane (*Grus leucogeranus*)[9], Sarus Crane (*Grus antigone*)[10], The Indian Bustard (*Ardeotis nigriceps*)[11], Lesser Florican (*Sypheotides indica*)[12], Bengal Florican (*Houbaropsis bengalensis*)[13], White-winged Duck (*Cairina scutulata*)[14], Narcondam Hornbill (*Aceros narcondami*)[15], Black-necked Crane (*Grus nigricollis*)[16], Edible-nest Swiftlet (*Collocalia fuciphaga*)[17], vultures[18], etc. Being the first of their kind, some of these studies have not employed rigorous field methods. Another reason for undertaking counting exercises is when community ecology questions are being addressed. In a well-cited work[19], the question asked was, what is the difference in bird diversity between less disturbed evergreen forest (with dense canopy) and moderately disturbed semi-evergreen forest (with more patchy canopy), in the Uttara Kannada district of Karnataka? The method of line transect to estimate abundances of different species of birds was used, and diversity and richness indices calculated. Other studies with similar objectives have since been undertaken in various other parts of the country, as discussed later.

The Asian Waterfowl Census

A characteristic feature of the growth of field ornithology in India (as also in other parts of the world) has been the involvement of large number of amateur naturalists, who volunteer in conservation monitoring events and are instrumental in generating population data across large geographical scales[8]. Over the last decade, one of the most significant, large-scale bird-count programmes is the Asian Waterfowl Census (AWC)[8]. The scheme was initiated by the International Waterfowl and Wetlands Research Bureau (IWRB), UK in 1987, but is now being coordinated by Wetlands International (formerly Asian Wetlands Bureau) and the Bombay Natural History Society (BNHS). Its basic objectives are: (i) To obtain information on an annual basis of waterbird populations at wetlands in the Asian region during the non-breeding period of most species (January), as a basis for evaluation of sites and monitoring of populations, (ii) to monitor on an annual basis, the status and conditions of Asian wetlands, and (iii) to encourage a greater

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popular interest in waterbirds, and thereby promote their conservation.

Among the many spin-offs of the AWC, one has been the focused attention on the status of flagship species, such as the Black-necked Stork (*Ephippiorhynchus asiaticus*)[20], pelicans[21], etc. Also, valuable information has been obtained on sex and age-related differences in migration of waterfowl species[22], which is of considerable relevance for testing theories of differential migration[23]. Taking a cue from the success of the AWC, many governmental and non-governmental agencies have started water-bird-count programmes in their own states[24]. However, as some studies have demonstrated, in the case of many species the population data generated from AWC counts have limited reliability[25]. For instance, these figures present an underestimate of the regional population because the same species (such as the Black-necked Stork) is likely to occur at non-wetland sites as well, from where counting effort is totally missing[25].

Comparable to the AWC, other large-scale bird-count programmes on terrestrial habitats have not been undertaken in India, although the BNHS did initiate the 'Salim Ali Bird-count' to census the common Indian birds, along the lines of the 'Common Birds Census' of the British Trust for Ornithology. However, at smaller spatial scales, state-level programmes have been initiated to census birds, notably in Gujarat where an attempt was made to create a database of birds at the level of the smallest administrative unit (taluka) by the Gujarat Ecological Education and Research Foundation[26,27].

An overview of bird-count studies in India

Most bird-count methods fall into the categories of 'total counts' and 'sampling estimates' (Figure 1). The AWC as well as many of the preliminary population size-assessment studies of endangered birds, discussed earlier, fall into the former category. In the latter category are to be included many of the density/abundance estimation studies as well as indices derived from calls and sight encounters per unit effort (time taken or distance covered). An outline of population count studies on various groups of birds that have been undertaken in India in the last few decades is given below. This summary is not exhaustive.

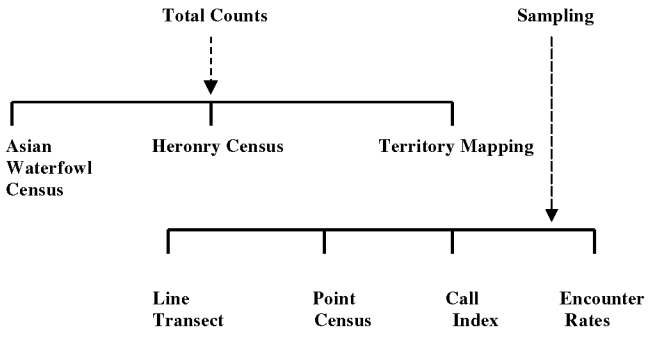

Figure 1. Schematic representation of different types of bird census methods discussed in the text.

Galliform birds

The group includes the conservationally important pheasants, partridges, quails and megapodes. Since many pheasants are endemic to the Himalayas, where the chief difficulties encountered in the field are poor visibility conditions and uneven terrain, count programmes have generally employed indirect methods such as call indices or encounter rates (based on calls/sightings)[28–33]. For Francolins, territory mapping as well as line transect methods (based on calls/sightings) have been used[7,32,33]. It is encouraging to note that many of these studies have taken full account of seasonal variations in call rates while interpreting results.

Wetland birds

India has a vast coastline which is an important habitat for resident and migratory waders (shorebirds). Generally, studies of coastal birds[34–36] have used the total count method, i.e. count all the birds from a defined area of the coast from a vantage point. In those cases where counts have focused on large, single-species flocks, block count methods have been attempted[8,37]. Much attention has also been focused on the waterfowl inhabiting inland wetlands[38–48] and the flagship species therein. A classical study to census the flagship species Sarus Crane was done by Gole[10], in which a sampling method (variant of the line transect method) was used. Along with volunteer birdwatchers, the investigator travelled in a motor vehicle in the Sarus homeland and counted Sarus seen on either side of the road. At the end of the study some 20,000 km^2 of land had been surveyed and the total number of Sarus in India was estimated somewhere close to 12,000 (in 1989). Other studies on Sarus have attempted comparisons between their day roost counts and night roost counts[48].

Heronry birds

Herons, storks, cormorants, ibises and related birds have also received considerable attention in wetland bird-counts. Heronries are a concentrated breeding effort in time and space[49] and due to this reason they are conservationally significant. One of the chief factors that has to be taken into account while counting heronry birds is the fluctuations in the number of adult birds during the course of a day. As seen in Figure 2, the total population of birds at a heronry varies considerably at different hours of the day, signifying local foraging or nest material collection flights. Therefore, the count time has to be kept constant if any meaningful trends are to be derived from a long-term heronry census at a particular site. Many of the studies on Indian heronries

Table 1. Sample of studies on bird communities in India with details of counting methods used

Habitat	Region of study	Methods employed	Method details and comments	Reference
Inland wetlands	Keoladeo Ghana National Park, Rajasthan	Total count	Waterfowl counted fortnightly at fixed times (half an hour after sunrise to 1100 and 1500 h to half an hour prior to sunset) from vantage points, walking along untarred roads and dykes. Local movements not taken into account.	47
	Okhla Barrage Bird Sanctuary, Delhi	Total count	Waterfowl counted at sporadic intervals and times of the day in blocks accessible from tarred road. Reliability low.	40
Coastal wetlands	Pichavaram Mangroves, Tamil Nadu	Total count	Waterfowl counted at regular intervals at a constant time of the day (0600–1000 h). Reliability low.	34
	Pichavaram Mangroves, Tamil Nadu	Total count	Waterbird density estimated by direct count. Reliability of counts not reported.	36
	Byet Dwarka Island, Gujarat	Total count	Wader count in February. No reliability estimates provided.	35
Forests and woodlands	Nanda Devi National Park, Uttranchal	Encounter rate and call index	Birds counted as and when encountered. No reliability estimate.	28
	Anamalai Hills, Western Ghats Tamil Nadu	Transect	Fixed width transects approx 100 m. Transect length not standardized. Counts done at constant time of day and due consideration made for varying weather conditions. However, when inclement weather conditions preceeded a morning census, work was done in the evening. No reliability estimates.	61
	Dampa Tiger Reserve, Mizoram	Variable width line transect	Birds counted at constant time of the day (0.5–3 h after sunrise), while walking at a slow, uniform pace to complete each transect in 50 min. Detections placed in perpendicular distance classes away from the transect. No reliability estimates mentioned.	71
	Silent Valley, Kerala	Variable width line transect	Constant time of the day (30 min after sunrise in all months) and weather. No justification for length of transect and no reliability estimates.	64
	Kalakad–Mundanthurai Tiger Reserve, Tamil Nadu	Line transect, point count and territory spot mapping	Comparative study of different sampling methods. Reliability tested by comparing results using different methods.	62

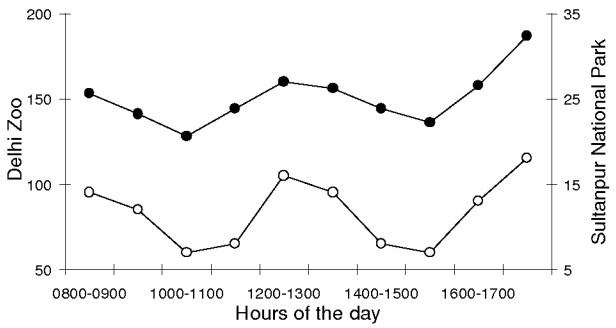

Figure 2. Roost counts of Painted Stork (*Mycteria leucocephala*) at different times of the day at the Delhi Zoo ( ) and Sultanpur National Park ( ). Counts were made by a telescope from vantage points close to the heronries during October 2004. Note considerable fluctuations in the number of birds counted at different times of the day due to their movements to and from the nesting site for the purpose of collecting food and nesting material. (Source: A. J. Urfi, A. Kalam and T. Meganathan, unpublished obs.).

report both total population size (roost count) as well as number of nests[50–57]. A recent study has evaluated nest density as a census parameter in place of nest count[58].

Terrestrial birds and other studies

Bird-count programmes have been undertaken in a number of terrestrial habitats[59–72], and virtually all types of habitats – natural and man-made have been covered.

We took a sample of studies published in standard, peer-reviewed journals and some relevant research reports and divided them into two categories: studies dealing with bird communities and those on single species. The results are detailed in Tables 1 and 2, and the following broad patterns emerge from this analysis. Much of the studies counted birds to derive local patterns of community structure or studied specific taxa to derive cause–effect relationships with habitat variables, with a conservation focus. Fewer studies are available on single species over larger geographical scales, and were mostly carried out with an intent to determine local abundance patterns. Clearly, while Indian workers are aware of standard bird-count methodologies, the studies reported generally suffer from two major drawbacks. First, in the case of community studies, many of them fail to mention whether a species–incidence curve was first established in order to ascertain the quantum of

Table 2. Sample of studies on single species in India with details of counting methods used

Species	Region of study	Method employed	Comments	Reference
Painted Francolin *Francolinus pictus*	Jamnagar, Gujarat	Call count	Calling males counted in a circle around the observer. By taking the radius of the circle as the maximum distance over which the francolin can be heard (300 m), a density of calling males (assuming monogamy) was calculated. Reliability was tested by making visual counts/flushing birds in the area.	32
Satyr Tragopan *Tragopan satyra*	Singhalila National Park, West Bengal	Call count	Population was estimated by call counts using standard methodology. Information on reliability not presented.	31
Red Junglefowl *Gallus gallus* Grey Peacock Pheasant *Polyplectron bicalcaratum* and Black Kalij Pheasant *Lophura leucomelanos lathami*	Pakhui Wildlife Sanctuary, and Doimara and Papum Reserve Forest, Arunachal Pradesh	Call count, encounter rate	Ten trails, adding to a total of 187.12 km, were walked in five habitats, each being replicated 6–10 times during a day. Population estimates based on both calls and sightings. However, no information on reliability provided.	30
Blyth's Tragopan *Tragopan blythii*	Blue Mountain National Park, Mizoram	Call count	Population estimated through the call count method. Reliability information not presented.	29
Narcondam Hornbill *Aceros narcondami*	Narcondam Island, Andaman	Total count	Count of all hornbills as and when seen, but no reliability estimates provided.	15
Malabar Grey Hornbill *Ocyceros griseus*	Kalakad–Mundanthurai Tiger Reserve, Tamil Nadu	Line transect	Hornbills counted using point counts and line transect methods. Reliability tested. Density estimated by using point count methods was much higher than that obtained from the transect method.	59
Indian Bustard *Ardeotis nigriceps*	Throughout India	Total count (based on direct field sighting and interviews)	No tests of reliability.	11
Siberian Crane *Grus leucogeranus*	Keoladeo National Park, Rajasthan	Total count	Reliability likely to be very high since the species is conspicuous and the park is the only known wintering habitat of this species in the region.	9
Sarus Crane *Grus antigone*	Several states in India	Modified line transect	Minimum and maximum populations estimated based on habitat associations using assumptions of line transect theory. Reliability not possible to determine.	10
	Keoladeo Ghana National Park, Rajasthan	Total count	Data presented as breeding pair/km^2 of park. Reliability not presented, but likely to be high since breeding pairs and nests within park are conspicuous.	39
	Several states in India	Encounter rate	Data compared between transects in areas with different land use. High reliability but not useful to determine population estimates.	25
	Kheda, Gujarat	Road transect/ roost count	Basic tests for reliability attempted making some comparisons.	48
Black Kite *Milvus migrans govinda*	Pune, Maharashtra	Roost count	Total number of birds arriving at the roost counted. Likely to be accurate.	69
Western Reef Egret *Egretta gularis*	Gogha and New Port, Gujarat	Heronry count/ roost count	Population was estimated during the breeding and non-breeding season by directly counting of the birds at the heronry. Reliability of data likely to be moderately high, since most birds at the heronry were counted.	57
Cattle Egret *Bubulcus ibis* and Little Egret *Egretta garzetta*	Amroha, Uttar Pradesh	Heronry count	Population was assessed by nest counts. Reliability of data likely to be high, although both in this and the above study, confounding factors such as leaves blocking the view, etc. are likely to lead to an underestimate.	58
Flamingos *Phoenicopterus* spp.	Gulf of Kachchh, Gulf of Khambhat and other coastal sites and inland wetlands of Anand, Kheda and Rajkot, Gujarat	Total count	Reliability estimates not calculated and unknown. Method easy to replicate, but with little utility for estimating population or monitoring local abundance of focal species.	37

(contd...)

Table 2. (*contd...*)

Species	Region of study	Method employed	Comments	Reference
Painted Stork *Mycteria leucocephala*	Anantapur, Andhra Pradesh	Total count	Population was estimated by directly counting of birds at the heronry. Reliability information not presented. No mention made of time of the day.	55
	National Zoological Park, Delhi	Heronry count	Population was estimated by directly counting the birds at the heronry. Reliability likely to be high, since all the birds were present at roost count.	53
Asian Openbill *Anastomus oscitans*	Raiganj Sanctuary, West Bengal	Heronry count	Population was estimated by directly counting birds at the heronry. Reliability not presented, but is likely to be high since all the nesting birds were counted.	54
Greater Adjutant *Leptoptilos dubius*	Brahmaputra Valley, Assam	Heronry count	Population was estimated by directly counting the birds at the heronry. Reliability likely to be high since birds were counted at different times of the day.	50
White-bellied Shortwing *Brachypteryx major*	Rajamalai, Kerala and Cairnhill Reserve Forest, Tamil Nadu	Encounter rate	Population was assessed by calculating the encounter rates (sighting per km). No reliability of method presented.	63

sampling effort required. Secondly, few studies have attempted to compare different bird-count methods, in a rigorous manner with respect to relative accuracy, bias, precision and convenience of application in the field. A notable study[62] in this regard attempts to compare various census techniques for birds in tropical rainforests of Western Ghats. Its main objectives were to compare (i) density estimates from variable-width line transects, variable-width point counts and territory-mapping, and (ii) simple fixed-width line transect and fixed-radius point count estimates with corresponding variable-width estimates. Abundances for a number of bird species, estimated by variable-width line transect and variable-radius point count were plotted against the values obtained by territory mapping, which is assumed to be the most accurate descriptor of abundance of territorial song birds in the nesting season. The results show an overestimate in abundances, which is minimized if the two most abundant species in the study, Crimson-backed Sunbird (*Nectarinia minima*) and Oriental White-eye (*Zosterops palpebrosus*) are removed from the analysis. The author elaborates upon various factors such as consistent biases in underestimating distances, presence of non-territorial 'floaters 'and non-breeding young that are not counted in territory mapping and/or the influence of the most abundance species, that may have caused this discrepancy and discusses the usefulness of these exercises in developing simple and convenient field census programmes that can be readily used by volunteers and professionals alike.

Conclusion and recommendations

A dominant trend of bird-count exercises undertaken in India has been a focus on endangered birds, wetland birds, heronries and birds found in conservationally significant terrestrial habitats. Adherence to methodological assumptions has been lax in many cases. In many waterbird-counts, guesses or unjustified extrapolations have been made and in many large-scale transect studies, the nature of the function between detectability and distance of sighting away from the transect has been ignored. This can often result in inaccurate density estimates. Most studies have failed to test the reliability of count estimates by comparative studies. 'Encounter rates' have been a popular method for large birds. While the emphasis on endangered birds and high-value habitats is understandable, and also justified on account of their conservation significance, census of the common birds has generally been ignored. A standardization of census techniques using common birds would yield useful information in understanding biases inherent in sampling bird populations in the Indian context, and it could also be possible to experiment with a number of different techniques. One laments that more comprehensive methods like territory mapping have not been tried out in different parts of the country, given that there are so many Indian birds which are highly territorial and demonstrative. In community studies involving bird-counts, the absence of serious attempts to standardize 'efforts' by developing species–incidence curves is a serious drawback. Indeed, such an exercise would be valuable for bird atlasing projects that would be undertaken in future.

While national level bird-count programmes like the AWC have enjoyed enormous popularity among professional and amateur birdwatchers, similar programmes have not taken-off in India for terrestrial habitats. For this, a number of factors could be responsible: (i) Size of the country and inaccessibility of many parts due to bad transport or roads. (ii) In spite of the popular interest in conservation and bird-watching, scientific ornithology has not been taken up in many academic institutions. In those institutions where field ornithology research is undertaken, there is often little synergy between field-workers and theoretically minded colleagues, who could help in analysis of data and designing statistically sound data-recording protocols.

(iii) Non-availability of detailed site maps and other basic equipment and the nature of the terrain, especially in the Himalayas. Although the involvement of amateurs has been impressive in many bird-count projects, it is also necessary to develop a cadre of committed and scientifically disciplined volunteers to collect good quality data on bird populations. Well-known governmental and non-governmental organizations have a greater role to play in training and educating amateur birdwatchers.

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