Mysuru City Bird Atlas (2014–2016): A systematic study of birds across space and time

Shivaprakash A., Sheshgiri B. R., Suhel Quader & Mysore Nature Team

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Shivaprakash A, # 478, 3rd Cross, 8th Main, 'H' Block Ramakrishnanagar, Mysuru 570022, Karnataka, India. E-mail: adavanne@gmail.com [Corresponding Author]

Sheshgiri BR, 6, RMP Quarters, 926, 1st Main, Lakshmipuram, Mysore 570004, Karnataka, India. E-mail: sheshbagde@yahoo.co.in

Suhel Quader, Nature Conservation Foundation, 1311, 'Amritha', 12th Main, Vijayanagar 1st Stage, Mysuru 570017 & National Centre for Biological Sciences, GKVK Campus, Ballari Road, Bengaluru 560065, Karnataka, India. E-mail: suhelq@ncf-india.org

Mysore Nature Team—All participants: Abhijith APC, Abhishek MB, Amanulla Khan, Amathya Chandra AP, Anagha S, Ananya S, Archishmati SR, Arun Simha, Ashrita Anoop, Chandrashekar GS, Charumati SR, Dinesh KS, Girija T, Gouri Hoysala, Harsha NR, Janhavi Rajan, Joshika TK, Kaleemulla Sharieff, Kashyap R, Kiran Bagade, Krishnamurthy SR, Madhusudan MD, Maheshwari P, Manish Chandi, Michaelsen T, Mohankumar M, Murali DC, Narayan Sharma, Naveen Jois, Navya Ramesh, Pavan Ramachandra, Pavithra Sankaran, Prashanth, Raghunath R, Raviprakash, Sadananda KB (Late), Sahamath B, Sahana M, Sandeep Srivatsa, Sapthagirish MK, Shamkumari C, Shanmugam R, Sheshgiri BR, Shiv Kumar MN, Shivaprakash A, Shreeraksh Bhat, Shweta Bharati, Shylajesha S, Smitha Rao, Sneha Guptha, Sukrit S, Suresh VP, Swapna Shivakumar, Syed Ateeq, Syed Mudaseer, Syed Muzamil, Tanuja DH, Tushar, Vinay Nadig, Vishak KA, Yogendra HS

Author contributions: SA and SBR designed the work in consultation with SQ and others. SA and SBR coordinated the training and all fieldwork. SQ performed the data analysis. SA, SBR, and SQ wrote the paper. All participants listed above took part in fieldwork.

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The Mysuru City Bird Atlas is an ambitious volunteer project to map the birds of an entire city – the first systematic effort of its kind in India. Mysuru city was gridded into a set of square cells, and each cell was surveyed for birds in the winters and summers of 2014, 2015, and 2016. The goal of this effort was to assess the distribution and abundance of birds in Mysuru such that the accumulated information could be used to assess seasonal changes in avifauna, as well as to examine the relationship between birds and their habitat in an urban setting. Below, we present selected outcomes, including maps, as well as raw comparisons of abundance across the two seasons and the three years of the surveys. Some of the results recapture broadly understood phenomena, such as long-distance migration resulting in seasonal differences in bird communities and species richness. Other results are suggestive of previously undescribed patterns, such as seasonal local movements. Further learnings from the project include areas of improvement in Atlas design and the identification of more sophisticated approaches to data analysis. Taken as a whole, the information generated through the Mysuru City Bird Atlas can be used as a baseline against which long-term change in avifauna could be assessed.

Introduction

A biodiversity atlas is a collection of primary, spatially explicit, data on species occurrences (Dunn & Weston 2008), and through this, presents a detailed picture of distribution and abundance of biodiversity. There are over 400 completed bird atlases across the world (Gibbons *et al.* 2007). Because of their scale, almost all atlases rely heavily on volunteer effort, and such a project can only be feasible where sufficient numbers of skilled birdwatchers are willing to volunteer their time. In India, the first atlas effort covered the states of Delhi, and Haryana (Harvey *et al.* 2006), dividing up the region into grid cells and marking presence and abundance in each cell. More recently, a similar approach has been used to document the birds of Manipal town in Karnataka (Singal 2016). Both these pioneering efforts were based largely on opportunistically collected data.

The idea of preparing a systematic bird atlas came up during a discussion on bird atlases and monitoring at the second International Conference on Indian Ornithology, conducted by the Sálim Ali Centre for Ornithology and Natural History, at Coimbatore, in November 2013. Mysuru (formerly called Mysore) appeared a natural location to initiate the first systematic atlas of birds in India. By 'systematic atlas', we mean an atlas prepared on the basis of information collected through a common protocol, with uniform distribution of effort across the region of interest. For this to be feasible, a large number of skilled volunteers are needed, as is careful coordination among them.

Mysuru has a long history of detailed bird documentation as well as coordinated projects on birds. Information on waterbirds exists since 1986 through work initiated by Manu K., and Guruprasad P., and inspired by the Mysuru Zoo Youth Club. A large amount of information collected in this way is available in the Asian Waterbird Census reports, and with the Indian Bird Conservation Network of BNHS-India.

The Mysore Nature (www.mysorenature.org/) group has been regularly documenting birds in and around Mysuru through the monthly Mysore Birding Diary (http://www.mysorenature.org/mysore-birding-diary) since 2006, and the annual Winter Bird Monitoring Program since 2001. From 2014 onwards, Mysore Nature has also been a part of the Bird Count India (www.birdcount.in) partnership, which aims to document and monitor India's wild birds.

Despite all this work, much remains to be learned about the birds of Mysuru. For example, although birds of popular birding spots are well known, most locations in the city remain, understandably, unvisited by birders—so overall distribution, and spatial patterning remain unknown. Similarly, seasonal changes in distribution and abundance are inadequately known, since information is mostly available for the winter migratory season. The objectives of the Mysuru City Bird Atlas, therefore, were to survey the city in a systematic manner, so as to better understand the fine-scale distribution, abundance, and movement patterns of birds. A further objective was to set a baseline against which long-term changes (over years to decades) in these aspects can be assessed. The information generated could be used for these

purposes, as well as more detailed analyses (not attempted here)—such as understanding the fine-scale relationships between birds and their habitat. Here, we present an overview of the Atlas and the information it has generated.

Methods

The most important ingredient in a project such as this is the birdwatchers who contribute their time. Worldwide, a large number of nature enthusiasts play active roles in generating new information about ecology and biodiversity. Because birdwatching is a popular hobby, bird-monitoring projects have been particularly successful in drawing volunteers (Aravind 2013). Several Mysuru birdwatchers stepped forward to take part in the Atlas project. Most of them had already been part of a number of birdwatching trips and were skilled at identification. Across all birders who took part in the Atlas surveys, the average number of years of birding experience was 8.9 years, and 60% had been involved in previous bird surveys or censuses. Additional field-based birdwatching and training sessions were organized for relative newcomers, to increase their skill in visual and aural identification. Atlas surveys were led by experienced birders and were never carried out by novices. Two workshops were conducted at Kukkarahalli Lake in January and May 2014 to discuss the protocols to be followed. These training sessions also included instructions on how to upload the bird sightings to eBird (see below). Over the three years of the Atlas, 60 volunteer birders contributed their time, effort, and birdwatching skills to collect the information summarised here. Their names are listed under the Mysore Nature Team, above.

The protocol for data collection was designed to ensure equal effort across Mysuru city. The extent of the city (*c.*160 sq km) was divided into 33 cells (Fig. 1) of 2.2x2.2 km size (1.25°x1.25°), aligned to Survey of India toposheets. Each cell was further subdivided into four equal-sized sub-cells. There were, thus, a total of 132 sub-cells of size 1.1x1.1 km, an area that we considered reasonable for being covered in a single short visit. A single survey involved a team of one to four birders visiting a sub-cell for 30 min, between 0630 and 1000 h, and noting down the number of individuals of each species. Volunteers did not follow straight-line transects or other pre-defined routes; rather, they were asked to walk about, covering all available habitats in the sub-cell. Routes were not standardized across multiple surveys, nor was the actual coverage of a sub-cell assessed. Birds were not counted using a formal method, but volunteers were asked to try and avoid double counting. There was no explicit instruction to leave out birds flying over the sub-cells, and so some surveys include flyovers of species like Rose-ringed Parakeets *Psittacula krameri*, which can occasionally form large flocks.

Each sub-cell was surveyed in this way, once in February (winter), and once in June (summer/monsoon) in 2014, 2015, and 2016. Participants uploaded checklists (with counts of each species), for each sub-cell, to eBird (ebird.org), a global platform for recording bird sightings. The use of eBird made data collection more efficient by the use of a standardised taxonomy and nomenclature, digitizing data at source, and by removing the need to later combine data from multiple digital files. Data quality checks were conducted on the raw data downloaded from eBird. Survey lists were scrutinized to correct nomenclatural errors (e.g., reporting Great Tit for Cinereous Tit *Parus cinereus*, or Plaintive Cuckoo for Grey-bellied Cuckoo *Cacomantis passerinus*). In addition, all unusual and unlikely reports of species were also examined manually, and withheld if no supporting documentation was provided. In this way, records of 13 species were removed because of inadequate supporting documentation, including Common Golden-backed Woodpecker *Dinopium javanense*, Blue-bearded Bee-eater *Nyctyornis athertoni*, Painted Bush Quail *Perdicula erythrorhyncha*, and Black-lored Tit *Machlolophus xanthogenys*, none of which have documented records from Mysuru city or its immediate environs.

Progress was monitored using social media (https://www.facebook.com/groups/mysorenature/) as a notice board, where participants signed up to cover particular sub-cells, and posted the list URLs of their eBird observations for the sub-cell when completed. A master spreadsheet listed all sub-cell numbers, the names of those who had signed up to cover each sub-cell, and, as surveys were carried out, the list URLs for each sub-cell. Atlas coverage was complete in both years and seasons, except in February 2015, when 29 sub-cells were inadvertently left un-surveyed. Each year, data summaries were generated

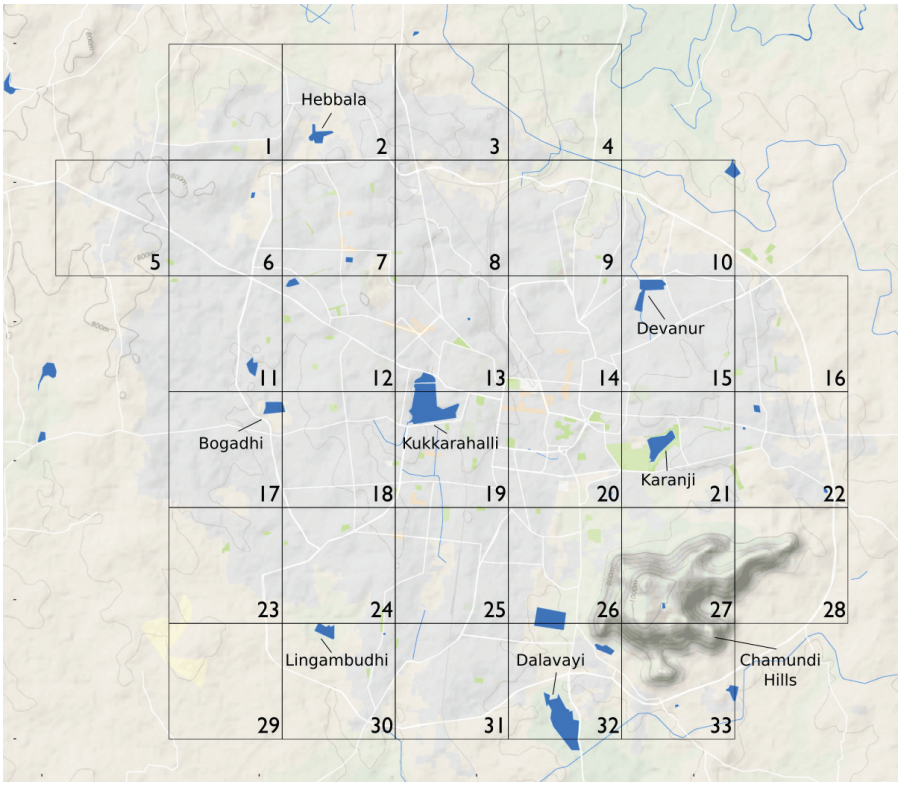

Fig. 1. The 33 grid cells surveyed in the Mysuru City Bird Atlas, with key locations indicated, including the lakes (keres) mentioned in the text. Map layer from Google Maps.

and uploaded to the Mysuru Atlas webpage (www.birdcount.in/events/mysore-bird-atlas): these included interactive maps (generated through the Tableau visualization platform) and tabular summaries.

To analyse the abundance of individual species, we have used 'frequency of reporting', which we have calculated as the proportion of sub-cells in which a species was observed. At the grid level, there are four sub-cells and so the frequency of reporting can be one of 5 values (0%, 25%, 50%, 75%, or 100%). When aggregating over grids to examine overall abundance, the denominator in these calculations is the total number of sub-cells surveyed.

All analyses and graphs presented below are based on the 'raw' frequencies of reporting. We discuss the limitations of this method, and possible future approaches, thereafter ('Lessons learnt'). All computations were carried out in the programming and statistical platform R (R Core Team 2017).

Results and discussion

Atlas participants adhered fairly closely to the standard protocol. The majority of sub-cells (93% of 763 sub-cell-repetitions across three years) were surveyed for exactly 30 min, and only 3% of sub-cells were surveyed for a duration outside the range of 30–40 min. Similarly, surveys in nearly all sub-cells (90%) were started within the prescribed time: between 0630 and 1000 h. Although participants were asked to count numbers of individuals of each species, rather than simply mark their presence, count information was absent from a small proportion of records (1.1% of 18,641 records). Counting presence-only records as single birds, 116,689 individual birds were counted in total. Overall, we believe that the information generated through the Atlas surveys can be compared across the city (different cells and sub-cells) as well as across seasons and years—although we do identify areas for improvement (see 'Lessons learnt', below).

Number of species across seasons and years

In all, 192 bird species were recorded across the three years of the Atlas. We should note that nocturnal species are less likely to appear in this tally than are diurnal, and extremely rare species are likely to be missing.

To assess the adequacy of sampling in each of the three years, we constructed species-effort curves (Fig. 2). In each season and each year, the total number of species found rises rapidly with survey effort (in this case sub-cells), and then the curves taper to become nearly flat, suggesting that we had detected a majority of, although not all, the species present by the end of the surveys.

Fig. 2 also shows a clear seasonal difference, with more species being found in February (winter) than in June (summer/monsoon), as expected from the known influx of winter migrants. On average, 33 additional species were seen in February than in June, giving rise to an overall difference of 50 species between the seasons (Table 1).

Table 1. Number of bird species recorded in each of the six iterations of the atlas surveys.

	February	June	Total
2014	154	120	168
2015	154	121	171
2016	162	122	172
Total	187	137	192

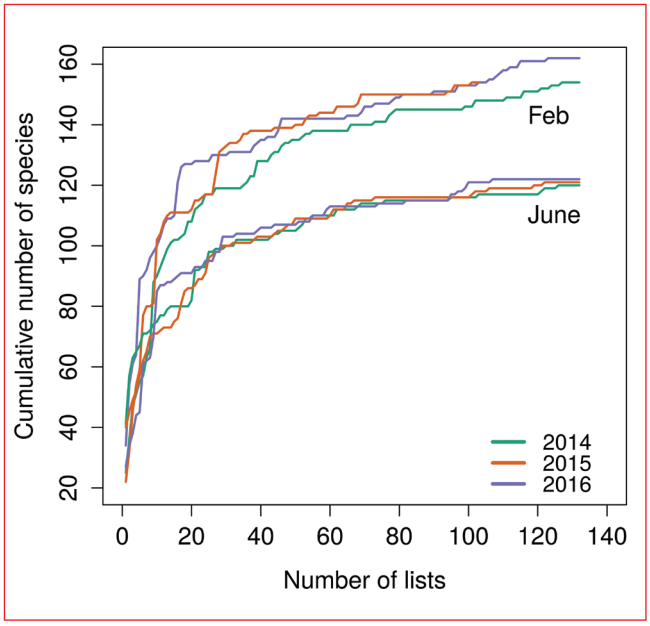

Fig. 2. Species-effort curves for each of the six iterations of the atlas surveys. Note the difference in final species numbers between the seasons, but the relative similarity across years within a season (especially in June).

Examining the overlap in species records within each season but across years (Fig. 3) reveals that 130 species were seen in all three years in February, and the equivalent number of June was 105, indicating that these are, roughly, the numbers of species that could be reliably expected each year in the respective seasons.

Species richness across Mysuru city

The Atlas protocol allows a grid-wise comparison of species numbers across Mysuru city since all grids are surveyed with equal effort (with only minor deviations). There was substantial variation in the number of species recorded per grid. Species numbers in February varied from fewer than 50 (grids 7, 13, and 14) to 100 or more (2, 10, and 30). In June, five grids yielded fewer than 50 species (12, 13, 14, 18, and 20); and the most species-rich grids (2, 10, and 30) were the same as those in February, plus two others (28 and 32), all of which yielded over 80 species. Reference to Fig. 4 indicates that the grids with the highest numbers of species were those with a combination of waterbodies, wooded areas, and open habitat; e.g., surrounding Hebbala (grid 2: 109 species in February; 93 species in June), Lingambudhi (grid 30: 103 species in February; 83 species in June), Dalavayi (grid 32; 99 species in February, 87 species in June), and Bogadhi Lakes (grid 17; 95 species in February, 74 species in June). This does not necessarily apply to all grids with lakes. For example, Karanji Lake (grid 21; 91 species in February, 64 species in June), and Devanur Lake (grid 15; 70 species in February, 55 species in June) held only a moderate number of species. Grid 28, covering the north-eastern spur of Chamundi Hill, contained a small seasonal waterbody, and accounted for an impressive 93 species in February and 88 species in June. At the other end of the scale, grids with the fewest species generally consisted of highly built-up areas with little open space.

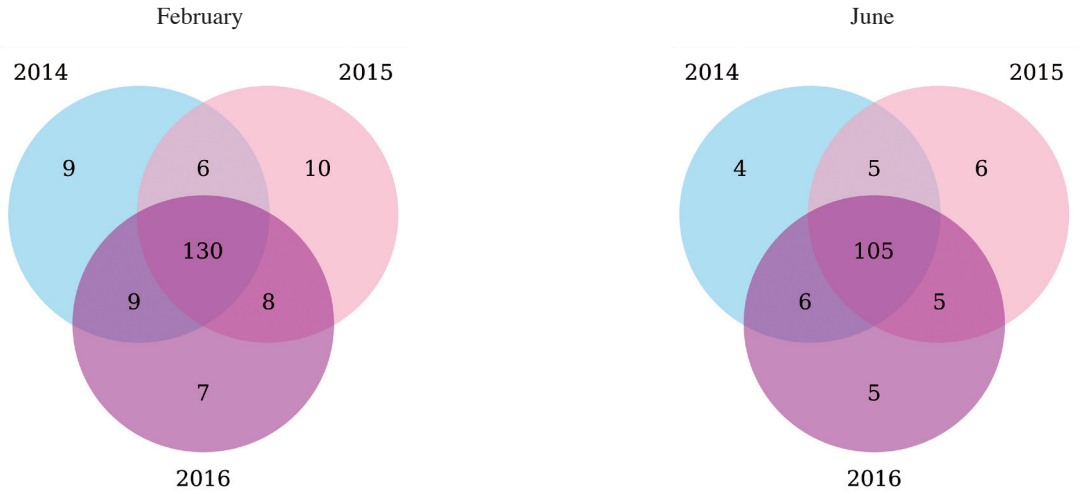

Fig. 3. Venn diagram of overlap in species recorded in the three years of the atlas, separately for February and June surveys. 70% of February species were recorded in all three years, with the equivalent number for June being 77%. No single year stands out in being particularly unusual (ie, showing more unique species than other years).

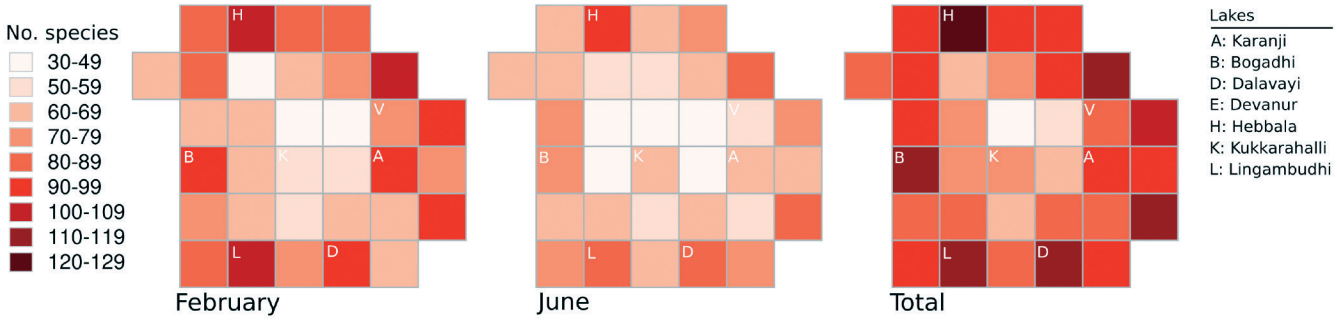

Fig. 4. Variation in species number across Mysuru city, by season. Comparing grids across seasons shows that, to a rough approximation, grids that have more species in February also tend to have more species in June (the correlation between the two months is 0.85). Broadly speaking, grids with more species are those that have wetlands within them. Grids containing each of seven major waterbodies are marked.

Seasonal abundance of individual species

The overall abundance of individual species (calculated as a frequency of reporting in sub-cells across years) reveals interesting seasonal and between-year patterns. A number of species show relatively consistent abundances between February and June and are resident in Mysuru city (Fig. 5). Other species have high abundances in February, which decline dramatically in June (Fig. 6). Some of these are true winter migrants (e.g., Barn Swallow *Hirundo rustica*, Blyth's Reed Warbler *Acrocephalus dumetorum*, and Rosy Starling *Pastor roseus*). But others (e.g., Black Drongo *Dicrurus macrocercus* and Purple Sunbird *Cinnyris asiaticus*) are not long-distance migrants and might, instead, be showing local or regional-scale movements in and out of Mysuru city. A final set of species show higher abundances in June than in February (Fig. 7). It is possible that some of the seasonal changes are not entirely due to the movement of birds, but, rather, due to seasonal differences in the behaviour of the birds, resulting in changing detectability (ability to find a bird when it is present). An obvious example comes from the Asian Koel *Eudynamys scolopaceus*, which is likely to remain relatively constant in abundance across the seasons, but is detected more frequently in June, when males sing much more often (and are therefore much more detectable) than in February. Similarly, the Black-headed Ibis *Threskiornis melanocephalus* may be more detectable in June, being more active during, and immediately after, their breeding season. Seasonal patterns for species without prominent song, or other changes in behaviour (e.g., Scaly-breasted Munia *Lonchura punctulata*), are likely to be more-or-less accurately reflected in the patterns shown here.

Note that for most species, the year-to-year variability in abundance within a season is relatively low (e.g., Black Kite *Milvus migrans*, Common Myna *Acridotheres tristis*, Barn Swallow, and Scaly-breasted Munia). Even when there is variation from one year to the next, it is typically not dramatic (Large-billed Crow *Corvus macrorhynchos* in June, and Rosy Starling, and Ashy Prinia *Prinia socialis* in February are exceptions). This gives us some confidence that, for many species, these estimates of abundance are robust and can therefore be compared across years and decades, e.g., during a subsequent repetition of the Atlas surveys.

Overall, which are the most common birds in Mysuru city? Again, we can answer this question using the frequency of reporting across sub-cells for each species. These are presented (separately for each season, and averaged across years) in Table 2.

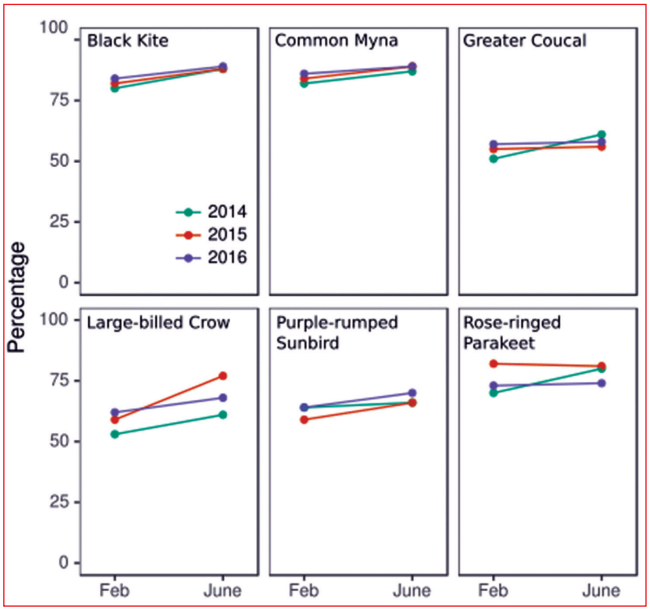

Fig. 5. Examples of species showing similar abundances (reporting frequency across sub-cells) between February and June.

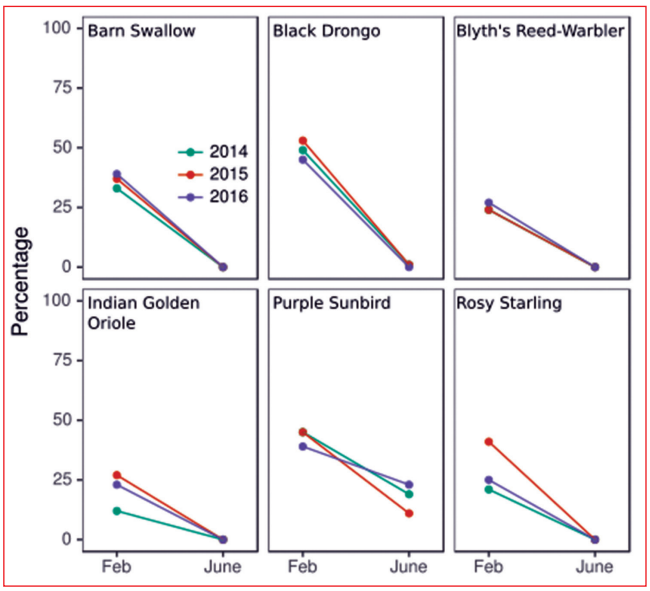

Fig. 6. Example of species showing seasonal change from high abundance (frequency of reporting) in winter, to low in summer/monsoon. Some of these are established long-distance migrants, but seasonality of 'residents' with local or regional movements can also be seen.

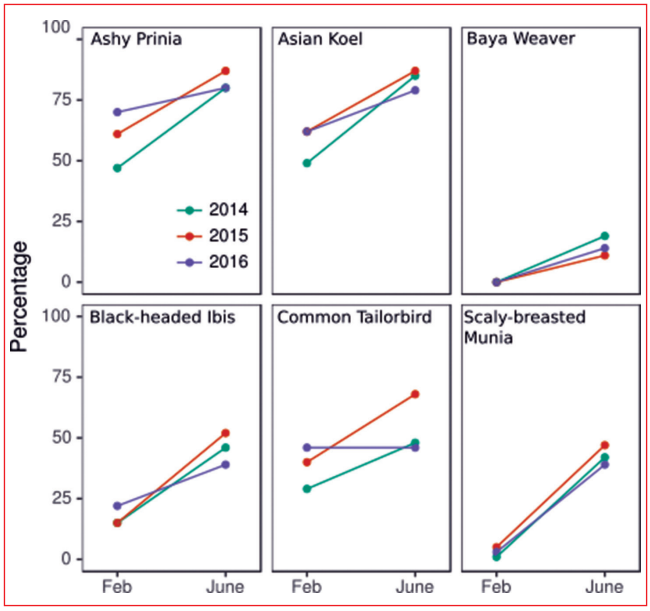

Fig. 7. Examples of species with greater abundances (frequency of reporting) in June, than in February. These are likely to contain some species that truly change in abundance with season, and others whose detectability (but not abundance) changes. See text for a discussion on this issue.

Table 2. The 20 most abundant species (in descending order), as measured by the percentage of sub-cells in which they were recorded, averaged across the three years of the survey. See the Appendix for a full list of species with abundances.

February, all years	June, all years
84% Common Myna	88% Common Myna
82% Black Kite	88% Black Kite
75% Rose-ringed Parakeet	84% Asian Koel
69% Feral Pigeon	82% Ashy Prinia
62% Purple-rumped Sunbird	78% Rose-ringed Parakeet
59% Brahminy Kite	74% Feral Pigeon
59% Ashy Prinia	69% Large-billed Crow
58% Large-billed Crow	67% Purple-rumped Sunbird
58% Asian Koel	62% Pale-billed Flowerpecker
57% House Crow	60% Red-whiskered Bulbul
55% Red-whiskered Bulbul	59% Spotted Dove
53% Spotted Dove	58% Jungle Myna
54% Greater Coucal	58% Greater Coucal
52% Red-vented Bulbul	57% House Crow
51% Jungle Myna	56% Brahminy Kite
51% Cattle Egret	54% Common Tailorbird
49% Black Drongo	53% Red-vented Bulbul
50% Pale-billed Flowerpecker	47% Cattle Egret
48% Pied Bushchat	46% Black-headed Ibis
43% Purple Sunbird	46% Pied Bushchat

The commonest among these are known commensals of humans, either living off garbage and waste, or taking readily to gardens and parks. It is interesting to note that, even in February, none of the top 20 commonest species are long-distance migrants.

Seasonal distribution of individual species

Apart from looking at the overall abundance of individual species and how this changes with the seasons, the Atlas surveys also allow an examination of the fine-scale distribution of different species across the extent of the city. A few such species are depicted and discussed here—maps of all species (including separate maps for each year of the survey) can be viewed at the Atlas' webpage (www.birdcount.in/mysore-bird-atlas/).

Certain birds can be roughly classified as obligatory commensals of humans, i.e., they are typically not found (or found only at very low density) away from human habitation. Of these, Black Kite, Feral Pigeon *Columba livia* (except around Chamundi Hill), and House Crow *Corvus splendens* are abundant and widespread across the city. House Sparrow *Passer domesticus*, by contrast, is only patchily distributed and is much less abundant (Figure 8). A few other species show interesting spatial patterns. For example, the Baya Weaver *Ploceus philippinus* is absent in February, but appears around the outskirts of the city in June,

presumably to breed (Figure 9). Some species pairs also show peculiar patterns. For example, while Spotted Dove *Streptopelia chinensis* is found across the city, Laughing Dove *S. senegalensis* appears only on the edges and outskirts. Similarly, while Red-whiskered Bulbul *Pycnonotus jocosus* is widespread, Red-vented Bulbul *P. cafer* is conspicuously absent from the centre of the city. A more thorough and systematic investigation of the spatial patterns in distribution of different species remains to be carried out.

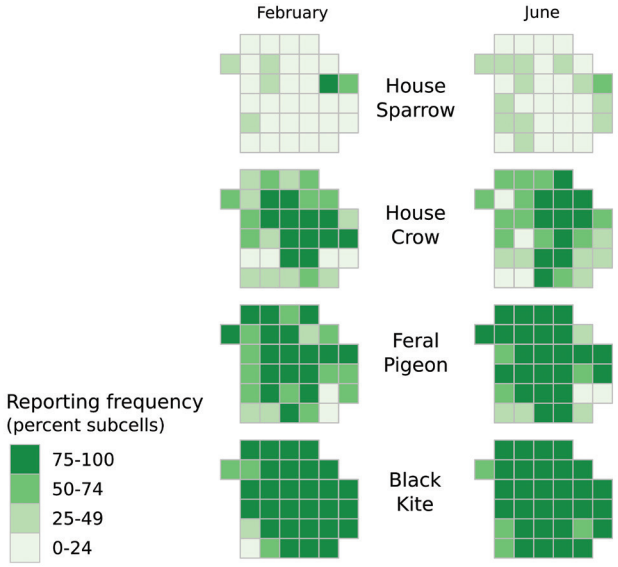

Fig. 8. Distribution of obligatory commensal species. The colours depict the frequency of lists in which a species was reported (i.e., the percent sub-cells containing that species, aggregated over the three years of the survey).

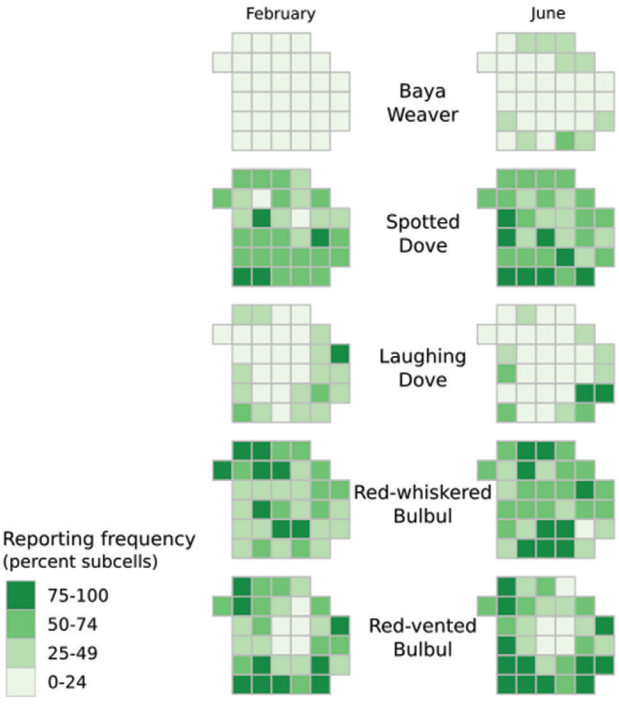

Fig.re 9. Distribution of selected species that show variation in spatial patterning across seasons or across space. The colours depict the frequency of lists in which a species was reported (ie, the percent sub-cells containing that species, aggregated over the three years of the survey).

Lessons learnt

The experience of organizing and conducting the Atlas surveys in Mysuru, over six seasons, has resulted in many lessons learnt. One set of lessons pertains to volunteer preparation and training. Participants of the Mysuru Atlas project were varied in their skill at identifying birds by sight and sound. We tried to minimize this issue by ensuring that team leaders were always of moderate-to-high experience and skill. In addition, formal training sessions would have ensured a minimum acceptable ability to identify and count birds (both visually and aurally) across all participants, not only team leaders. We also realized that some aspects of the protocol were either unspecified (e.g., to count flyovers separately) or, sometimes unclear (e.g., to *always* count individual birds and not just mark presence); better tools are needed to remind participants of what is expected, for example a physical list of key points that should be reviewed before starting a survey.

From the perspective of the design of atlas surveys, one important point that has emerged is the need to be able to assess the probability of detection of different species in different seasons. If the likelihood of detecting (by sight or sound) is different for different species (which it surely is), and if this changes with season (which is likely to be so, for at least some species) or habitat, then relying purely on the 'raw' frequencies of detection can be misleading. In such cases, survey designs that allow the estimation of detection probabilities to adjust the raw frequencies of detection are needed. Such designs are usually based on survey replicates in either space or time, with more replicates being better. The current design of the Mysuru City Bird Atlas reflects a compromise between the need to assess detection probabilities and the practicalities of a volunteer-dependent survey. It is possible to use the existing design to estimate probabilities of detection, since each grid cell has four spatial replicates in each season in each year. Such an analysis is beyond the scope of the present article, but we invite anyone interested to use the data (available at https://doi.org/10.5061/dryad.8k3d81r) to carry out more sophisticated analyses.

Conclusions and future directions

We draw several conclusions from conducting the first systematic bird atlas in India. Most importantly, with a combination of enthusiasm and careful organization, it is clearly possible for a community of birdwatchers to generate scientifically valuable information even when the project requires that city centers and bus stands (not typical birdwatchers' haunts) be surveyed! The data gathered during the Atlas work can now be used in a variety of valuable ways. From the perspective of a basic understanding of bird ecology, the Atlas gives an insight into the details of seasonality and distribution at a very fine scale. For example, the analysis presented here reveals previously unsuspected features of spatial patterning and seasonal variation in even common species. From a conservation point of view, in a world of rapid urbanization, we need to understand how cities change over time and how these changes influence bird species composition and abundance. How do decisions about urban growth and zoning by residents, developers, planners, and elected representatives affect birds? Data acquired by remote sensing or other methods remotely-sensed, or otherwise, can be used to assess different kinds of habitats (e.g., parks, waterbodies, *etc.*) across the city, and how they

change over time—information that is freely available online. The Mysuru Atlas allows these questions to be answered by providing information on the bird side of the equation, both in itself and in creating a baseline to measure future changes. The answers should inform attempts to design urban living spaces that allow birds and other wildlife to coexist with humans.

Acknowledgements

In a citizen science project such as this, a very large number of people must be thanked for freely volunteering their time. The names of all birdwatchers who took part in the atlas surveys are listed on the first page of this article. Sandeep Kumar Jayasankar helped create the Tableau visualizations on the Mysuru City Bird Atlas website in 2014, and these were updated and modified subsequently by Abinand Reddy in 2015 and 2016. Mousumi Ghosh did some preliminary analysis of the bird data taken together with landcover information. M. D. Madhusudan helped create the map (Fig. 1) from Google's mapping tools.

The late Sri Sadananda K. B. was a leading light for many amateur and expert naturalists in the Mysuru region. He was the inspiration behind many collective efforts to document birds and other aspects of nature in and around Mysuru. The Mysuru City Bird Atlas is conducted in his memory and is dedicated to him, with gratitude and thanks.

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Appendix: List of all bird species, with abundances in each year and season. Separate information is presented on the frequency of reporting (percent of lists in which the species occurred), and the count of each species, averaged over only those lists in which the species occurred. In other words, the average count represents the number of individuals one can expect to find, when the species is present.

	Frequency (percent of lists)								Average count (when present)							
	2014		2015		2016		Average		2014		2015		2016		Average	
Species name	Feb	June	Feb	June	Feb	June	Feb	June	Feb	June	Feb	June	Feb	June	Feb	June
Lesser Whistling Duck *Dendrocygna javanica*	2	2	0	1	2	5	1	3	50.7	5		2	18	18	34.4	8.3
Cotton Teal *Nettapus coromandelianus*	0	1	0	0	1	0	0	0		3			3		3	3
Indian Spot-billed Duck *Anas poecilorhyncha*	5	21	7	19	8	11	7	17	18.1	5.4	15.4	5.4	9.1	14.6	14.2	8.5
Northern Shoveler *Spatula clypeata*	2	0	1	0	2	0	2	0	46		500		39		195	
Northern Pintail *Anas acuta*	2	0	1	0	2	0	2	0	5		4		10		6.3	
Common Teal *Anas crecca*	1	0	0	0	0	0	0	0	3						3	
Indian Peafowl *Pavo cristatus*	3	12	12	15	7	13	7	13	2	1.8	2.5	1.8	3.3	1.9	2.6	1.8
Jungle Bush Quail *Perdicula asiatica*	0	0	1	2	1	3	1	2			4	1.7	3	3.8	3.5	2.8
Grey Francolin *Francolinus pondicerianus*	27	23	50	21	36	23	38	22	2.6	1.2	2.1	2.1	1.8	1.8	2.2	1.7
Little Grebe *Tachybaptus ruficollis*	5	8	5	10	5	9	5	9	11.8	18.1	9.6	5	6	11.3	9.1	11.5
Asian Openbill *Anastomus oscitans*	2	8	4	4	1	2	2	5	1.5	3.5	1	2	1	8.5	1.2	4.7
Painted Stork *Mycteria leucocephala*	8	4	7	3	11	8	9	5	3.7	10.6	3.6	4.8	3.2	4.3	3.5	6.6
Little Cormorant *Microcarbo niger*	6	21	17	26	15	5	13	17	1.9	3.3	6.9	2.4	4.3	5.4	4.4	3.7
Great Cormorant *Phalacrocorax carbo*	6	5	7	10	8	5	7	7	4.1	6.5	3.6	9	4	7.3	3.9	7.6
Indian Cormorant *Phalacrocorax fuscicollis*	2	3	7	13	3	2	4	6	2	3.5	4.9	6.5	3.5	6	3.5	5.3
Oriental Darter *Anhinga melanogaster*	2	10	1	7	2	7	2	8	2	1.9	6	1.6	2	1.2	3.3	1.6
Spot-billed Pelican *Pelecanus philippensis*	7	2	6	8	8	5	7	5	11.2	7.7	3.7	4.3	3.3	8.3	6.1	6.8
Yellow Bittern *Ixobrychus sinensis*	0	1	0	1	1	2	0	1		2		2	1	1	1	1.7
Grey Heron *Ardea cinerea*	14	5	17	8	10	5	14	6	1.9	2.7	1.4	2	2.3	3.9	1.9	2.9
Purple Heron *Ardea purpurea*	3	4	6	4	7	5	5	4	1.2	1.6	1	1.4	1.8	2.2	1.3	1.7
Great Egret *Ardea alba*	2	2	7	5	2	0	4	2	3.3	2	5.3	1.2	1.3		3.3	1.6
Intermediate Egret *Ardea intermedia*	5	8	2	8	3	7	3	8	2.8	3.1	4.5	2.8	1.2	1.8	2.8	2.6
Little Egret *Egretta garzetta*	10	14	14	18	18	20	14	17	4.9	9.8	13.6	4.2	6	4	8.2	6
Cattle Egret *Bubulcus ibis*	54	55	46	46	52	39	51	47	9.6	6.8	9.3	3.5	6.2	8.4	8.4	6.2
Indian Pond Heron *Ardeola grayii*	36	37	37	48	42	39	38	41	6	4.6	12.6	3	5.1	3.9	7.9	3.8
Striated Heron *Butorides striata*	1	0	0	0	0	0	0	0	1						1	
Black-crowned Night Heron *Nycticorax nycticorax*	2	2	5	4	3	2	3	3	2.3	2.3	2.8	4.2	2.8	5	2.6	3.8
Glossy Ibis *Plegadis falcinellus*	5	0	2	0	4	1	4	0	18.9		1.5		2.6	3	7.7	3
Indian Black Ibis *Pseudibis papillosa*	29	31	14	26	22	20	22	26	2.8	2.4	2.3	1.6	2.3	2.5	2.5	2.2
Black-winged Kite *Elanus caeruleus*	1	1	4	1	0	2	2	1	1	1	1	1		1	1	1
Oriental Honey Buzzard *Pernis ptilorhynchus*	2	1	4	0	2	1	3	1	1.7	2	1.2		1.3	1	1.4	1.5
Crested Serpent Eagle *Spilornis cheela*	0	1	0	0	1	1	0	1		1			1	1	1	1
Short-toed Snake Eagle *Circaetus gallicus*	0	0	0	0	2	0	1	0					1		1	
Indian Spotted Eagle *Clanga hastata*	2	2	0	1	1	0	1	1	1	1		1	2		1.5	1
Booted Eagle *Hieraaetus pennatus*	1	0	0	0	1	0	1	0	1				1		1	
Tawny Eagle *Aquila rapax*	0	2	3	1	0	2	1	2		1	1	1		1	1	1
Bonelli's Eagle *Aquila fasciata*	0	1	0	1	1	2	0	1		1		1	1	3.5	1	1.8
Western Marsh Harrier *Circus aeruginosus*	1	0	5	0	3	0	3	0	1		1.4		1		1.1	
Shikra *Accipiter badius*	22	23	25	17	25	23	24	21	1.4	1.5	1.2	1.3	1.2	1.3	1.3	1.4

	Frequency (percent of lists)								Average count (when present)							
	2014		2015		2016		Average		2014		2015		2016		Average	
Species name	Feb	June	Feb	June	Feb	June	Feb	June	Feb	June	Feb	June	Feb	June	Feb	June
Black Kite *Milvus migrans*	80	88	82	88	84	89	82	88	5.9	6.1	5.3	4.6	6.5	5	5.9	5.2
Brahminy Kite *Haliastur indus*	51	59	65	54	61	55	59	56	3.6	2.9	3.7	2.6	2.3	2.8	3.2	2.8
White-breasted Waterhen *Amaurornis phoenicurus*	8	9	8	13	15	20	10	14	1.4	1.9	2.3	1.9	1.8	2	1.8	1.9
Ruddy-breasted Crake *Zapornia fusca*	0	0	0	0	1	1	0	0					1	1	1	1
Common Coot *Fulica atra*	4	4	5	8	5	7	5	6	11.8	28.6	20	7.8	11.5	18.1	14.4	18.2
Indian Thick-knee *Burhinus indicus*	1	1	0	1	1	2	1	1	3	2		4	2	1.5	2.5	2.5
Black-winged Stilt *Himantopus himantopus*	4	1	4	0	2	0	3	0	13.2	3	10.2		6.7		10	3
Yellow-wattled Lapwing *Vanellus malabaricus*	3	6	2	4	7	9	4	6	3	4	10.5	5.4	4.3	3.8	5.9	4.4
Red-wattled Lapwing *Vanellus indicus*	20	36	45	38	29	42	31	39	2.6	4	2.7	2.4	3.4	2.8	2.9	3.1
Little Ringed Plover *Charadrius dubius*	1	0	2	0	1	0	1	0	6		1.5		2		3.2	
Pheasant-tailed Jacana *Hydrophasianus chirurgus*	0	2	0	0	0	2	0	1		1.7				1		1.4
Bronze-winged Jacana *Metopidius indicus*	3	3	2	4	3	4	3	4	6.2	1.8	3.5	2.2	2	2.2	3.9	2.1
Little Stint *Calidris minuta*	1	0	0	0	0	0	0	0	31						31	
Common Sandpiper *Actitis hypoleucos*	6	0	6	0	5	0	6	0	2.5		2.3		2.6		2.5	
Green Sandpiper *Tringa ochropus*	7	0	7	0	6	0	7	0	2.8		2.7		1.5		2.3	
Common Greenshank *Tringa nebularia*	2	0	1	0	1	0	1	0	1		7		1		3	
Marsh Sandpiper *Tringa stagnatilis*	1	0	1	0	0	0	1	0	18		4				11	
Wood Sandpiper *Tringa glareola*	8	0	7	0	8	0	8	0	6.5		11		2.6		6.7	
Barred Buttonquail *Turnix suscitator*	2	0	1	0	0	1	1	0	1.7		2			3	1.8	3
Whiskered Tern *Chlidonias hybrida*	0	0	2	0	1	0	1	0			11.5		3		7.2	
River Tern Sterna aurantia	0	0	3	1	1	1	1	1			3.7	8	4	1	3.8	4.5
Feral Pigeon *Columba livia*	58	73	78	75	72	73	69	74	16.1	18.5	19.9	14.4	13.4	20.7	16.5	17.9
Eurasian Collared Dove *Streptopelia decaocto*	27	20	20	17	17	20	21	19	3.4	3.4	2.3	2.8	2.2	2.6	2.6	2.9
Spotted Dove *Streptopelia chinensis*	45	62	61	64	52	52	53	59	2.4	2.8	2.8	2.4	2.1	2.4	2.4	2.5
Yellow-legged Green Pigeon *Treron phoenicopterus*	2	0	0	0	0	0	1	0	3						3	
Greater Coucal *Centropus sinensis*	51	61	55	56	57	58	54	58	2.2	1.9	1.8	1.9	1.7	1.6	1.9	1.8
Blue-faced Malkoha *Phaenicophaeus viridirostris*	4	2	5	3	2	2	4	2	1	1.3	1.4	1.5	1.5	1	1.3	1.3
Pied Cuckoo *Clamator jacobinus*	1	8	1	8	1	7	1	8	1	1.9		1.2	2	1.2	1.5	1.4
Asian Koel *Eudynamys scolopaceus*	49	85	62	87	62	79	58	84	3.2	3	1.9	2.8	1.9	2.3	2.3	2.7
Grey-bellied Cuckoo *Cacomantis passerinus*	1	5	0	5	0	1	0	4	1	1.2		1.3		1	1	1.2
Indian Eagle Owl *Bubo bengalensis*	0	1	0	1	0	0	0	1		1		1				1
Spotted Owlet *Athene brama*	2	3	4	5	7	6	4	5	1.7	2.5	1.5	3.8	2.1	2	1.8	2.8
Mottled Wood Owl *Strix ocellate*	0	0	1	0	0	0	0	0			4				4	
Indian Nightjar *Caprimulgus asiaticus*	0	1	0	1	0	0	0	1		3		3				3
Indian House Swift *Apus affinis*	2	12	10	8	2	14	5	11	9	5.1	11	5.4	12	4.4	10.7	5
Common Hoopoe *Upupa epops*	13	8	14	6	12	9	13	8	1.6	1.5	1.4	1.2	2	1.6	1.7	1.4
Indian Grey Hornbill *Ocyceros birostris*	28	34	39	37	30	36	32	36	2.4	3.1	3	2.2	2.3	2.6	2.6	2.6
Common Kingfisher *Alcedo atthis*	2	3	4	2	3	3	3	3	1.3	1.2	1.2	1	1.5	1.8	1.3	1.3
Stork-billed Kingfisher *Pelargopsis capensis*	0	0	0	0	2	0	1	0					1		1	
White-throated Kingfisher *Halcyon smyrnensis*	29	40	40	50	44	45	38	45	1.6	2	1.6	1.8	1.6	1.9	1.6	1.9
Pied Kingfisher *Ceryle rudis*	0	0	1	1	1	2	1	1			2	1	1	1.5	1.5	1.2
Green Bee-eater *Merops orientalis*	44	33	40	29	42	39	42	34	4.7	6.1	6.2	4.2	4.4	3.2	5.1	4.5
Blue-tailed Bee-eater *Merops philippinus*	23	4	18	0	20	1	20	2	7.6	2.4	8.5		4.4	2	6.8	2.2
Indian Roller *Coracias benghalensis*	6	10	13	5	8	6	9	7	1.9	1.8	1.1	1.3	1.6	1.1	1.5	1.4
Coppersmith Barbet *Psilopogon haemacephalus*	36	31	41	27	37	38	38	32	2	2	1.6	2.7	1.4	1.8	1.7	2.2
Lesser Golden-backed Woodpecker *Dinopium benghalense*	3	11	7	4	7	6	6	7	1.2	1.4	1.7	1.2	1.1	1.6	1.3	1.4
Common Kestrel *Falco tinnunculus*	4	0	7	0	2	0	4	0	1.2		1.1		1		1.1	
Peregrine Falcon *Falco peregrinus*	0	0	1	1	0	0	0	0			1	1			1	1
Rose-ringed Parakeet *Psittacula krameri*	70	80	82	81	73	74	75	78	87.3	34	41.2	36.3	13.2	23	47.2	31.1
Plum-headed Parakeet *Psittacula cyanocephala*	0	1	0	2	1	2	0	2		1		1.5	1	1	1	1.2
Indian Pitta *Pitta brachyura*	0	0	1	0	0	0	0	0			1				1	
Common Woodshrike *Tephrodornis pondicerianus*	2	0	0	3	2	0	1	1	2.7			2.5	1.7		2.2	2.5
Common Iora *Aegithina tiphia*	15	27	34	23	21	28	23	26	2.5	1.9	1.5	2.6	1.6	1.7	1.9	2.1
Small Minivet *Pericrocotus cinnamomeus*	10	17	20	18	16	11	15	15	4.4	2.7	3.6	3.6	3.6	2.8	3.9	3
Black-headed Cuckooshrike *Lalage melanoptera*	0	0	4	1	2	0	2	0			1.3	1	1.7		1.5	1
Brown Shrike *Lanius cristatus*	13	0	10	0	10	0	11	0	1.2		1.1		1		1.1	
Bay-backed Shrike *Lanius vittatus*	3	0	5	2	1	0	3	1	1.2		1	1	1		1.1	1
Long-tailed Shrike *Lanius schach*	4	7	11	8	11	8	9	8	1.8	1.3	1.4	1.9	1.8	1.6	1.7	1.6
Indian Golden Oriole *Oriolus kundoo*	12	0	27	0	23	0	21	0	1.4		2.1		1.5		1.7	
Black-naped Oriole *Oriolus chinensis*	0	0	0	0	2	0	1	0					1.3		1.3	
Black-hooded Oriole *Oriolus xanthornus*	1	0	0	0	1	0	1	0	1				1		1	
Black Drongo *Dicrurus macrocercus*	49	1	53	1	45	0	49	1	2.9	1	2.6	1	2.1		2.5	1
White-spotted Fantail *Rhipidura albogularis*	7	6	9	14	13	11	10	10	3.3	2.8	2.4	1.9	1.7	1.5	2.5	2.1
Black-naped Monarch *Hypothymis azurea*	0	0	1	0	0	0	0	0			1				1	
Indian Paradise-flycatcher *Terpsiphone paradisi*	2	0	4	0	3	0	3	0	1.7		1		1.5		1.4	
Rufous Treepie *Dendrocitta vagabunda*	1	0	0	1	0	0	0	0	1			5			1	5
Large-billed Crow *Corvus macrorhynchos*	53	61	59	77	62	68	58	69	13.3	4.8	8.2	4.7	5	4.5	8.8	4.7
Rufous-tailed Lark *Ammomanes phoenicura*	1	0	1	0	2	0	1	0	2		2		1.5		1.8	
Ashy-crowned Sparrow Lark *Eremopterix griseus*	2	3	6	2	5	4	4	3	2.7	1.5	5.3	1	2.1	2.6	3.4	1.7
Singing Bushlark *Mirafra cantillans*	1	0	1	0	0	2	1	1	2		2			1	2	1
Jerdon's Bushlark *Mirafra affinis*	17	20	14	18	14	11	15	16	2.6	2.5	2.2	3.1	2.1	2.3	2.3	2.6

	Frequency (percent of lists)								Average count (when present)							
	2014		2015		2016		Average		2014		2015		2016		Average	
Species name	Feb	June	Feb	June	Feb	June	Feb	June	Feb	June	Feb	June	Feb	June	Feb	June
Indian Bushlark *Mirafra erythroptera*	2	5	4	5	5	10	4	7	3.3	1.6	1.2	1.3	2.2	1.9	2.2	1.6
Oriental Skylark *Alauda gulgula*	1	4	10	1	0	1	4	2	1	2.8	2.8	1		2	1.9	1.9
Dusky Crag Martin *Ptyonoprogne concolor*	1	2	0	0	0	1	0	1	10	3.5				3	10	3.2
Barn Swallow *Hirundo rustica*	33	0	37	0	39	0	36	0	24.3		33.9		15.3		24.5	
Wire-tailed Swallow *Hirundo smithii*	3	5	5	7	9	3	6	5	2	2	2.4	2.6	2.6	3.5	2.3	2.7
Red-rumped Swallow *Cecropis daurica*	16	33	20	27	30	30	22	30	10.9	3.7	14.6	4	14.1	4.3	13.2	4
Streak-throated Swallow *Petrochelidon fluvicola*	1	0	3	0	2	1	2	0	8		27.3		2	1	12.4	1
Cinereous Tit *Parus cinereus*	20	36	28	30	33	32	27	33	2.7	2.5	2.6	2.6	2.3	2	2.5	2.4
Red-vented Bulbul *Pycnonotus cafer*	49	48	56	55	50	56	52	53	5.8	3.5	3.6	3.7	3.4	4.4	4.3	3.9
Red-whiskered Bulbul *Pycnonotus jocosus*	40	47	63	64	61	68	55	60	3.3	3.2	3.6	2.8	3.2	2.8	3.4	2.9
White-browed Bulbul *Pycnonotus luteolus*	21	18	29	24	20	26	23	23	4.6	2.9	3.7	3	3	2.2	3.8	2.7
Green Leaf Warbler *Phylloscopus nitidus*	0	0	0	0	2	0	1	0					1.5		1.5	
Greenish Leaf Warbler *Phylloscopus trochiloides*	2	0	3	0	8	0	4	0	1		1		1.3		1.1	
Booted Warbler *Iduna caligata*	32	0	40	0	30	0	34	0	3.2		5.4		2		3.5	
Sykes's Warbler *Iduna rama*	15	0	2	0	20	0	12	0	2		1		1.2		1.4	
Paddyfield Warbler *Acrocephalus Agricola*	5	0	2	0	2	0	3	0	1		1.5		1		1.2	
Blyth's Reed Warbler *Acrocephalus dumetorum*	24	0	24	0	27	0	25	0	1.8		2.3		1.7		1.9	
Clamorous Reed Warbler *Acrocephalus stentoreus*	3	0	5	0	5	0	4	0	1.8		2		2		1.9	
Zitting Cisticola *Cisticola juncidis*	0	3	1	2	2	5	1	3		4.8	2	1.3	2	1.7	2	2.6
Common Tailorbird *Orthotomus sutorius*	29	48	40	68	46	46	38	54	1.8	2.2	2.6	2	2	1.7	2.1	2
Grey-breasted Prinia *Prinia hodgsonii*	0	2	1	0	0	0	0	1		1.5	1				1	1.5
Jungle Prinia *Prinia sylvatica*	2	10	0	5	1	5	1	7	1	2.1		3.4	1	1.3	1	2.3
Ashy Prinia *Prinia socialis*	47	80	61	87	70	80	59	82	2.4	5.2	3.3	4.3	2.2	3.2	2.6	4.2
Lesser Whitethroat *Sylvia curruca*	0	0	1	0	0	0	0	0			1				1	
Yellow-eyed Babbler *Chrysomma sinense*	2	0	0	3	5	2	2	2	3			2.8	4.7	4	3.8	3.4
Oriental White-eye *Zosterops palpebrosus*	0	0	0	2	0	0	0	1				2.5				2.5
Tawny-bellied Babbler *Dumetia hyperythra*	1	2	1	2	1	2	1	2	3	2	4	1.7	3	2.5	3.3	2.1
Large Grey Babbler *Argya malcolmi*	6	4	4	3	4	2	5	3	8.7	4.6	8.2	4.2	6	6	7.6	4.9
Yellow-billed Babbler *Turdoides affinis*	27	25	33	26	24	24	28	25	9.5	5.3	6.6	5.9	6.8	5.2	7.6	5.5
Asian Brown Flycatcher *Muscicapa dauurica*	4	0	1	0	4	0	3	0	1		1		1		1	
Indian Robin *Saxicoloides fulicatus*	33	35	40	45	40	52	38	44	3.3	3.8	2.4	3.4	2.3	3	2.7	3.4
Oriental Magpie Robin *Copsychus saularis*	22	31	32	38	35	37	30	35	2	2.4	2.1	1.5	2.1	1.7	2.1	1.9
Tickell's Blue Flycatcher *Cyornis tickelliae*	3	7	14	7	6	7	8	7	1.2	1.8	1.1	1.2	1.9	1.3	1.4	1.4
Verditer Flycatcher *Eumyias thalassinus*	0	0	0	0	1	0	0	0					1		1	
Indian Blue Robin *Larvivora brunnea*	0	0	1	0	0	0	0	0			1				1	
Bluethroat *Luscinia svecica*	0	0	0	0	1	0	0	0					1		1	
Red-breasted Flycatcher *Ficedula parva*	0	0	0	0	1	0	0	0					1		1	
Blue-capped Rock Thrush *Monticola cinclorhyncha*	2	0	1	0	1	0	1	0	1.5		1		1		1.2	
Blue Rock Thrush *Monticola solitarius*	1	0	1	0	0	0	1	0	1		1				1	
Siberian Stonechat *Saxicola maurus*	0	0	1	0	0	0	0	0			1				1	
Pied Bushchat *Saxicola caprata*	44	47	50	43	49	48	48	46	3.4	3.6	3	3.1	2.9	2.9	3.1	3.2
Rosy Starling *Pastor roseus*	21	0	41	0	25	0	29	0	87.5		47.3		40.9		58.6	
Brahminy Starling *Sturnia pagodarum*	4	6	6	5	3	7	4	6	3	2.1	3.2	2.4	6.2	2.4	4.1	2.3
Chestnut-tailed Starling *Sturnia malabarica*	6	0	8	0	4	0	6	0	14.5		33.9		20.2		22.9	
Common Myna *Acridotheres tristis*	82	87	84	89	86	89	84	88	18.9	13.7	15.1	8.9	8	10.6	14	11.1
Jungle Myna *Acridotheres fuscus*	42	58	60	60	52	56	51	58	11.2	7.2	12.5	6.2	7.7	6.9	10.5	6.8
Jerdon's Leafbird *Chloropsis jerdoni*	3	2	2	1	2	2	2	2	1.8	1.5	1	2	1.5	2	1.4	1.8
Pale-billed Flowerpecker *Dicaeum erythrorhynchos*	50	64	48	67	52	56	50	62	3.1	3.7	3.5	3	2.5	2.4	3	3
Purple-rumped Sunbird *Leptocoma zeylonica*	64	66	59	66	64	70	62	67	4.1	3.4	4.7	3	3.4	2.5	4.1	3
Purple Sunbird *Cinnyris asiaticus*	45	19	45	11	39	23	43	18	2.7	1.8	3.7	1.5	1.9	1.4	2.8	1.6
Western Yellow Wagtail *Motacilla flava*	7	0	11	0	14	0	11	0	9.2		15		8.3		10.8	
Grey Wagtail *Motacilla cinerea*	3	0	7	0	11	0	7	0	1.2		2		3.1		2.1	
White Wagtail *Motacilla alba*	1	0	6	0	7	0	5	0	1		3.2		4.8		3	
White-browed Wagtail *Motacilla maderaspatensis*	11	11	17	11	17	13	15	12	2.5	2	2.2	1.9	1.7	2.4	2.1	2.1
Paddyfield Pipit *Anthus rufulus*	5	1	1	5	2	3	3	3	2.3	1	1	1.8	3	2.5	2.1	1.8
Tree Pipit *Anthus trivialis*	0	0	1	0	1	0	1	0			11		1		6	
House Sparrow *Passer domesticus*	10	20	17	21	17	16	15	19	37.2	25.7	16.4	7	5.7	7.4	19.8	13.4
Streaked Weaver *Ploceus manyar*	0	2	1	3	0	2	0	2		10.5	6	3.8		18.5	6	10.9
Baya Weaver *Ploceus philippinus*	0	19	0	11	0	14	0	15		15.5		14.1		13.7		14.4
Red Munia *Amandava amandava*	1	1	2	0	2	4	2	2	8	2	3.5		14	4.2	8.5	3.1
Indian Silverbill *Euodice malabarica*	8	12	10	17	14	22	11	17	5.5	4.8	6.6	4.8	8.3	6.9	6.8	5.5
White-rumped Munia *Lonchura striata*	0	1	2	2	2	3	1	2		4	5.5	4.3	6.3	2.2	5.9	3.5
Scaly-breasted Munia *Lonchura punctulata*	1	42	5	47	3	39	3	43	7	7.7	7.8	4.3	4.5	5.4	6.4	5.8
Tricoloured Munia *Lonchura malacca*	2	8	0	10	2	11	1	10	6	5.8		3.8	3	6.5	4.5	5.4