Technical Report No. PR-226

# Assessing the population status of synanthropic bird species of India, including House Sparrow and House Crow, and their response to urbanization

**PRINCIPAL INVESTIGATORS**

Dr. Rajah Jayapal & Dr. S. Babu

**FIELD RESEARCH TEAM**

Priyanka Bansode, Shantanu Nagpure, Debanjana Basu, C.P. Ashwin, Nachiket Patil, Kiran Dalvi, S. Priyadarshini, Siddhesh Bhor, Pallavi Arora, Darshan Potdar, G Babu Rao, & Abhisikta Roy

**JUNE 2022**

Sálim Ali Centre for Ornithology and Natural History

(Institution under the Ministry of Environment, Forest & Climate Change, Government of India)

Anaikatty Post, Coimbatore- 641108, Tamil Nadu

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# TAKEAWAYS

Contrary to public perception, House Sparrow was found to occur in 80% of human-modified ecosystems, with an occupancy of 78-84% in rural/semi-urban areas and 68% in urban sites.

Occupancy of House Sparrows was positively related to extent of open green spaces in human settlements, but was found to be inversely correlated with PM2.5 level of air pollution.

We recommend further studies to investigate potential role of PM2.5-mediated oxidative stress in House Sparrows in limiting their numbers.

We also found that Common Mynas, in urban areas, seemed to be replacing House Sparrows, probably through competition for nesting space and predation.

The expanding urban population of Common Mynas (with 93% occupancy) raises serious concerns over their potential impacts on other co-existing urban avifauna.

Overall estimated occupancy of House Crow was found to be 77% in human-modified ecosystems, with 96% in urban areas and 72% in rural landscape.

Urbanization factors like human population density, night light intensity, and built-up area were found to positively contribute to the occupancy of House Crows.

Creation of open green spaces (as ‘mini-biodiversity parks’) in urban areas emerges as a key recommendation for sustaining the local populations of synanthropic birds, esp. House Sparrows.

**CONTENTS**

## SUMMARY

Synanthropic birds, living in close association with humans in human-modified environments are regarded as indicators of changes in urban ecosystems and farmlands. It is widely believed that there has been a sharp decline in their populations across the country in recent times, particularly of House Sparrow (*Passer domesticus*), and this has evoked considerable concern among the general public and conservationists. Though the decline has been attributed to a variety of causes including loss of nesting habitats, scarcity of insect and grain food in increasingly urbanized environments, pesticides, and vehicular pollution, it is the electromagnetic radiation from mobile and other telecommunication towers that remains the most popular hypothesis in mainstream media and society – despite inconclusive evidence.

In the absence of long-term bird monitoring programmes in India, there is a severe paucity of data on trends in bird populations in our urban and rural landscapes. In order to assess the current status of populations of synanthropic birds of India including House Sparrow and to study their responses to urbanization, the present study was conceived and undertaken in mainland India during 2018-21.

For the survey, the entire country was classified into 20 biogeographic provinces, which were, then, gridded into 2X2 km cells. A random-generation algorithm was applied to select at least 1% of the grids in each province as primary sampling units for field surveys of both bird population counts and quantification of land use parameters. Birds were counted from 3-5 point counts in each grid for 15 minutes each. This was accompanied by rapid assessment of habitat attributes in every point. We also derived urbanization and ecosystem parameters like NDVI-CV (representing open green spaces in human settlements), night light intensity, net sown area, Particulate Matter of size <2.5 µm pollution level (PM2.5), built-up area, human population density and road network density from remotely-sensed data. Questionnaire surveys were also conducted on past and present status of local populations of House Sparrow and other common birds. Single species-single season occupancy modelling was performed to estimate occupancy rate of birds after accounting for their detection probability, and to quantify response of birds to urbanization.

A total of 1,674 grids were surveyed covering 14 biogeographic provinces and 13 states; the latter included Kerala (84 grids), Tamil Nadu (219), Karnataka (227), Telangana (107), Maharashtra (328), Goa (7), Madhya Pradesh (207), Gujarat (98), Rajasthan (206), Delhi NCR (20), Odisha (41), Jharkhand (23), and West Bengal (107). Among these, 1,046 grids were located in rural landscape, 441 in semi-urban, and 187 in urban areas.

Contrary to public perception, House Sparrow was found to occur in 80% of human-modified ecosystems ($\Psi = 0.804 \pm SE\ 0.0273$); it occupied 78-84% grids in rural/semi-urban landscapes, and 68% in urban areas. In particular, central and western Indian states returned the highest occupancy of the species, while it was much less in south-western part of the country. Occupancy of House Sparrows was positively related to extent of open green spaces and net sown area, but was found to be inversely correlated with PM2.5. Since the levels of PM2.5 were not significantly different between rural and urban sites, we hypothesized that the negative correlation between House Sparrow occupancy and PM2.5 was not merely an urbanization effect, but could have

arisen owing to some untested mechanism. We recommend further studies to investigate potential role of PM2.5-mediated oxidative stress in sparrows leading to their premature mortality, as has been documented elsewhere. We also found that Common Mynas, in urban areas, seemed to be replacing House Sparrows, probably through competition for nesting space and predation. A majority of respondents (73%) in our questionnaire surveys claimed moderate to steep decline in local sparrow populations, while nearly 20% of rural and 13.5% of urban localities reported stable to moderate increase. Creation of open green spaces (as 'mini-biodiversity parks') in urban areas emerges as a key suggestion for sustaining the urban population of House Sparrows.

The overall estimated occupancy of House Crow (*Corvus splendens*) was 77% ($\Psi$ = 0.768 ± SE 0.0405) in human-modified ecosystems, with 96% in urban areas and 72% in rural landscape. Though its occupancy was found to be consistently similar across the states and biogeographic provinces, it was especially high (>90%) in Delhi and Kerala. Notably, House Crow was under-recorded in our surveys in Maharashtra, Madhya Pradesh, and Gujarat, though the estimated occupancy in the states was around 72%. As expected, urbanization factors like human population density, night light intensity, and built-up area were found to positively contribute to the occupancy of House Crows. Though we observed that the occupancy of House Crow was negatively correlated with that of Large-billed Crow, which is thought to increasingly colonize semiurban and urban ecosystems, the magnitude of relationship was too small to be any ecological significance. While 55% of respondent villages and urban localities in our questionnaire surveys claimed that the House Crows had since become scarcer in numbers, about 43% of them reported a stable to increasing population.

We conducted similar occupancy analyses for other three synanthropic species of birds as well, viz. Common Myna (*Acridotheres tristis*), Red-vented Bulbul (*Pycnonotus cafer*), and Large-billed Crow (*Corvus macrorhynchos*) and presented the findings in the report. The overall estimated occupancy of Common Myna was found to be 86% with highest occupancy in urban areas (93%); The expanding urban population of Common Mynas, which are known to be very adaptive, raises some serious concerns over their potential impacts on other co-existing urban avifauna. We recommend systematic studies to investigate and quantify the impacts of Common Mynas on other secondary-cavity nesters (like House Sparrows) in urban environs, where cavity-based nesting spaces are at a premium. While the estimated occupancy of Red-vented Bulbuls was about 84%, it was only 52% for Large-billed Crows – a species that is known to prefer well-wooded countryside and forested villages.

Findings of our survey have rightly highlighted the importance of open green spaces in human-dominated ecosystems from rural to urban gradients for the sustenance of synanthropic species of birds, particularly House Sparrow and Red-vented Bulbul. We have also made some specific recommendations for future studies to understand the environmental and physiological drivers of population size of these common birds in our increasingly urban landscapes.

**Appendix 1.** Model form of the data-sheet to collect data on bird counts and other survey-level covariates.

*Sálim Ali Centre for Ornithology and Natural History (SACON)*
*Coimbatore – 641108 (TN)*

*Population Survey of Synanthropic Birds of India*
*(incl. House Sparrow/House Crow)*

**Grid ID** :
**Biog. Prov.** :
**State/UT** :
**District** :

**Locality** :
**Site** :
**Date** :
**Observers** :

**Grid Centre Coordinates:** N
E

**Grid landscape type:**

O Rural O Semi-urban O Sub-urban O Urban O Metropolitan

**General definitions:**

| | |
|---|---|
| Metropolitan: | NCR of Delhi, Mumbai-Thane-Navi Mumbai, Kolkata-Howrah, Greater Chennai, Bengaluru, Hyderabad-Secunderabad, Ahmedabad, Surat, Pune-Pimpri, Jaipur, Lucknow, Kanpur, Nagpur, Visakhapatnam, and Indore. |
| Urban: | All the other big cities governed by Municipal Corporations. |
| Sub-urban: | Peripheral regions bordering the Metropolitan and Urban centres. |
| Semi-urban: | All the big towns usually governed by municipalities/townships/cantonments, and do not form part of Sub-urban landscape. |
| Rural: | All the small towns and villages along with surrounding countryside, dominated by agro-ecosystems and small-scale industries. |

**Point counts in the grid:**

Total number of point counts, covered in the grid:
No. of random points:
No. of points in human habitations:

**Observations/Notes:**

Grid ID: State/UT: Locality:

**POINT COUNT #**

**PCS Type:** O Random O Human Hab. **Observers:** **Date:**

**GPS Coordinates:** N E **Time:**

| SN | Bird species | Abund. | Group # | Dist. (m) | Notes |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
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| 14 | | | | | |
| 15 | | | | | |
| 16 | | | | | |
| 17 | | | | | |
| 18 | | | | | |
| 19 | | | | | |
| 20 | | | | | |

| **Land cover in 100m vicinity in %:** | **Building-roof type in %** (if built-up area is >5%): | **No. of telecom towers in 200m vicinity:** |
|---|---|---|
| O Built-up Area:<br>O Open Country (crop-fields, fallows, grasslands, grazing fields, & barren ground):<br>O Scrub jungle / Overgrown empty plot/patch:<br>O Open Woodland / Park / Grove / Plantation:<br>O Forest:<br>O Wetland: | O Concrete:<br>O Tile:<br>O Sheet:<br>O Thatch: | **Major industrial plants in 200m vicinity:**<br>O Absent O Present |

**Signs of livestock presence in 100m vicinity [mark them, only if easily visible]:**
O Dung/Pellets O Cattle grazing O Cowshed/Livestock enclosure O Free-ranging chickens O Nil

| | | | | |
|---|---|---|---|---|
| **Degree of civic sanitation / cleanliness in 100m vicinity** (as evident from accumulation of non-biodegradable garbage, debris, & waste water): | O Poor | O Fair | O Satisfactory | O Good |
| **Human activity (no. of footfalls) in 100m vicinity:** | O Nil | O Sparse | O Moderate | O High |
| **Motor vehicle movement in 100m vicinity:** | O Nil | O Sparse | O Moderate | O High |

**Appendix 2.** Model form of the semi-structured questionnaire survey conducted among local people on recent trends in population status of major synanthropic birds of India.

*Sálim Ali Centre for Ornithology and Natural History (SACON) Coimbatore – 641108 (TN)* | *Questionnaire Survey on Synanthropic Birds of India (incl. House Sparrow/House Crow)*

**Grid ID** : **Locality** :

**Biog. Prov.** : **Village/Town** :

**State/UT** : **Date** :

**District** : **Interviewer** :

**Habitation type:**

O Rural O Semi-urban O Sub-urban O Urban O Metropolitan

**Participatory Rapid Appraisal Questionnaire**:

[NOTE: One collective/common questionnaire is to be conducted per each grid intersecting village/town/suburb/city. In case you believe more than one questionnaire is necessary owing to some significant land use / socio-economic variations within a grid, please feel free to conduct more. You may opt to interact with a max. of 4-5 persons (either in group or separately) who are knowledgeable about their surroundings. Please do NOT read out the options given here, while interviewing. Let the respondents give their OWN replies/assessments and you may select the option closest to their reply. You may prod for more specific answers, if necessary. You may also arrive at a collective assessment after all the interactions and can fill in the questionnaire later.]

1. What is the current status of House Sparrow populations around the site, compared to the past?

   O Locally extinct? O Steep decline O Moderate decline O Stable
   O Steep increase O Moderate increase O Not known

2. If any local extinction or a marked decline/increase in House Sparrow populations is reported from the site, since when it has been/is being observed?

   O 0-5 years O 6-10 years O 11-20 years O Over 20 years O Not known

3. What, in your opinion, are the major causes of recent decline in House Sparrow populations around the site?

   O Scarcity of nesting space O Nesting failure O Scarcity of insect food
   O Scarcity of grains/seeds O Predation by cats O Predation by large birds
   O Competition from other birds O Pesticide use O Air pollution
   O Hunting/poaching O Mobile towers O Accidental death
   O Climate change O Others [Pl specify]

4. Does it concern you that populations of common birds, incl. House Sparrows, are declining in the country?

   O Yes, very much O Yes, it does
   O May be yes, but it is not a serious matter O Not at all

Grid ID: State/UT: Village/Town:

5. Could you tell us about the current status of other species of synanthropic birds around the site?

| | | | | |
|---|---|---|---|---|
| **House Crow** | O Decreasing | O Increasing | O Stable | O Locally extinct? |
| **Jungle Crow** | O Decreasing | O Increasing | O Stable | O Locally extinct? |
| **Common Myna** | O Decreasing | O Increasing | O Stable | O Locally extinct? |
| **Rock Pigeon** | O Decreasing | O Increasing | O Stable | O Locally extinct? |
| **Indian Peafowl** | O Decreasing | O Increasing | O Stable | O Locally extinct? |
| **Rose-ringed Parakeet** | O Decreasing | O Increasing | O Stable | O Locally extinct? |
| **Black Kite** | O Decreasing | O Increasing | O Stable | O Locally extinct? |
| **Baya Weaver** | O Decreasing | O Increasing | O Stable | O Locally extinct? |
| **Indian Roller** | O Decreasing | O Increasing | O Stable | O Locally extinct? |

Any other notable observations made by the respondents:

**Appendix 3.** List of the most abundant synanthropic bird species of India along with their abundance proportions.

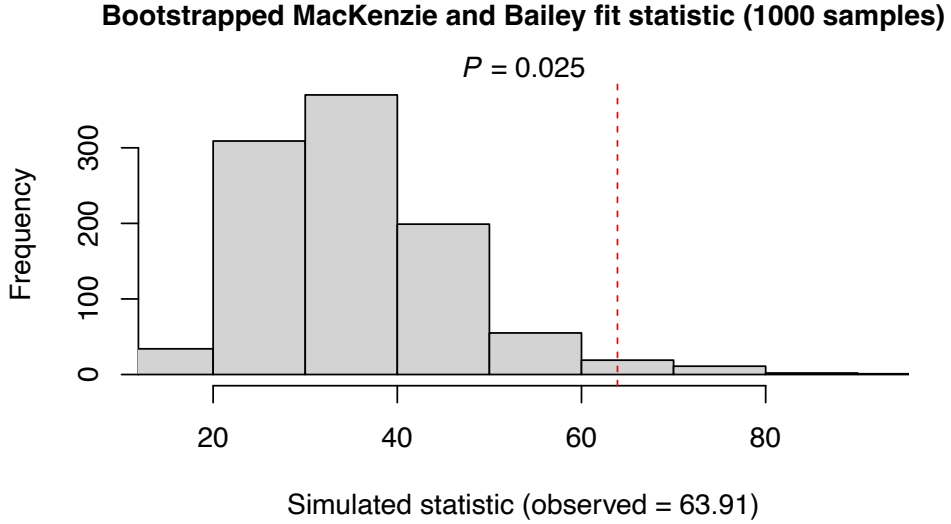
| SN | Bird Species | Abundance % (Proportion of total bird abundance) |
|---|---|---|
| 1 | House Crow | 20.72 |
| 2 | Common Myna | 17.68 |
| 3 | House Sparrow | 15.73 |
| 4 | Red-vented Bulbul | 12.06 |
| 5 | Rose-ringed Parakeet | 10.42 |
| 6 | Rock Pigeon | 6.45 |
| 7 | Eurasian Collared Dove | 4.13 |
| 8 | Laughing Dove | 3.58 |
| 9 | Black Drongo | 2.09 |
| 10 | Asian Pied Starling | 1.73 |
| 11 | Large-billed Crow | 1.49 |
| 12 | Spotted Dove | 1.00 |

**Appendix 4.** List of the five most abundant synanthropic bird species of all the states covered in the survey along with their abundance proportions.

| SN | Bird species | Abundance % |
|---|---|---|
| | **DELHI** | |
| 1 | Rock Pigeon | 26.55 |
| 2 | House Crow | 16.53 |
| 3 | Common Myna | 6.71 |
| 4 | Black Kite | 5.91 |
| 5 | Rose-ringed Parakeet | 3.51 |
| | **GUJARAT** | |
| 1 | Red-vented Bulbul | 10.03 |
| 2 | Rock Pigeon | 9.83 |
| 3 | House Sparrow | 7.24 |
| 4 | Purple Sunbird | 4.93 |
| 5 | Laughing Dove | 4.54 |
| | **GOA** | |
| 1 | House Crow | 23.31 |
| 2 | Red-whiskered Bulbul | 6.39 |
| 3 | Common Myna | 4.51 |
| 4 | Large-billed Crow | 4.14 |
| 5 | Rock Pigeon | 4.14 |
| | **JHARKHAND** | |
| 1 | Common Myna | 16.05 |
| 2 | House Crow | 11.3 |
| 3 | House Sparrow | 7.45 |
| 4 | Asian Pied Starling | 6.16 |
| 5 | Black Drongo | 5.52 |
| | **KARNATAKA** | |
| 1 | House Sparrow | 7.77 |
| 2 | House Crow | 6.62 |
| 3 | Common Myna | 6.52 |
| 4 | Rose-ringed Parakeet | 6.24 |
| 5 | Red-vented Bulbul | 4.59 |
| | **KERALA** | |
| 1 | House Crow | 22.67 |
| 2 | Large-billed Crow | 9.83 |
| 3 | Common Myna | 6.64 |
| 4 | Purple-rumped Sunbird | 5.84 |
| 5 | White-cheeked Barbet | 4.37 |
| | **MAHARASHTRA** | |
| 1 | Red-vented Bulbul | 9.28 |
| 2 | Common Myna | 5.95 |
| 3 | House Sparrow | 5.34 |
| 4 | House Crow | 4.58 |
| 5 | Laughing Dove | 3.63 |

| SN | Bird species | Abundance % |
|---|---|---|
| | **MADHYA PRADESH** | |
| 1 | Red-vented Bulbul | 7.24 |
| 2 | House Sparrow | 6.1 |
| 3 | Common Myna | 5.14 |
| 4 | Rose-ringed Parakeet | 4.7 |
| 5 | Laughing Dove | 4.19 |
| | **ODISHA** | |
| 1 | Common Myna | 12.63 |
| 2 | House Crow | 12.27 |
| 3 | Asian Pied Starling | 6.71 |
| 4 | Cattle Egret | 6.42 |
| 5 | Black Drongo | 5.56 |
| | **RAJASTHAN** | |
| 1 | Eurasian Collared Dove | 11.08 |
| 2 | Rock Pigeon | 10.47 |
| 3 | Rose-ringed Parakeet | 8.65 |
| 4 | House Sparrow | 8.31 |
| 5 | House Crow | 7.5 |
| | **TELANGANA** | |
| 1 | House Crow | 8.38 |
| 2 | House Sparrow | 6.93 |
| 3 | Red-vented Bulbul | 6.3 |
| 4 | Rose-ringed Parakeet | 5.33 |
| 5 | Common Myna | 5.26 |
| | **TAMIL NADU** | |
| 1 | Common Myna | 14.65 |
| 2 | House Crow | 13.52 |
| 3 | House Sparrow | 7.12 |
| 4 | Rose-ringed Parakeet | 5.28 |
| 5 | Black Drongo | 4.81 |
| | **WEST BENGAL** | |
| 1 | Common Myna | 14.14 |
| 2 | House Crow | 10.27 |
| 3 | Asian Pied Starling | 7.33 |
| 4 | Red-vented Bulbul | 6.5 |
| 5 | Spotted Dove | 6.32 |

**Appendix 5.** Statistical parameters of occupancy analysis: House Sparrow.

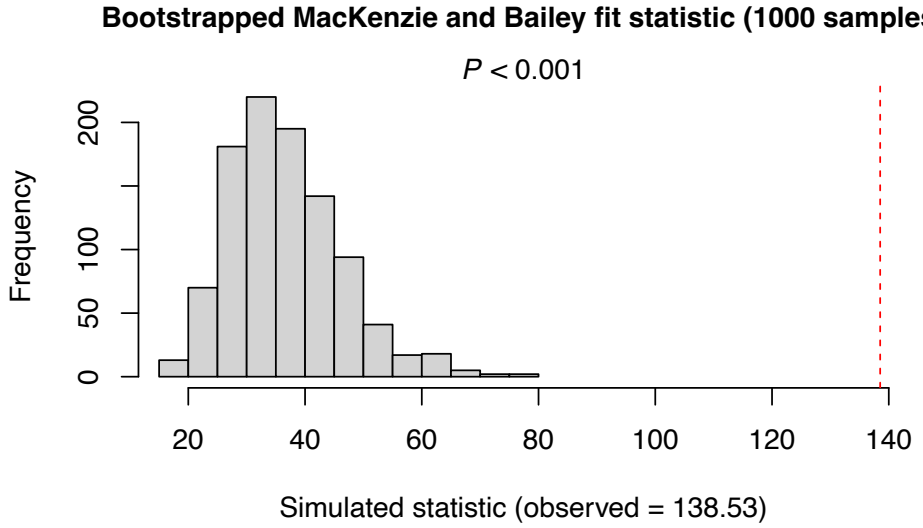



| Model No. | Model Covariates* | K | QAIC | ΔQAIC | QAICw | Log Likelihood |
|---|---|---|---|---|---|---|
| 1 | Ψ(ndvi+nsa+pm+pden), p(and+open) | 8 | 2951.3 | 0 | 0.158 | -2640 |
| 2 | Ψ(ndvi+nsa+pm+rden), p(and+open) | 8 | 2952.3 | 1.037 | 0.094 | -2640.9 |
| 3 | Ψ(bua+ndvi+nsa+pm), p(and+open) | 8 | 2952.5 | 1.171 | 0.088 | -2641 |
| 4 | Ψ(bua+ndvi+nsa+pm+pden), p(and+open) | 9 | 2953 | 1.645 | 0.069 | -2639.7 |
| 5 | Ψ(ndvi+nsa+pm+pden+rden), p(and+open) | 9 | 2953 | 1.707 | 0.067 | -2639.7 |
| 6 | Ψ(ndvi+nl+nsa+pm+pden), p(and+open) | 9 | 2953.1 | 1.786 | 0.064 | -2639.8 |
| 7 | Ψ(ndvi+nl+nsa+pm), p(and+open) | 8 | 2953.5 | 2.17 | 0.053 | -2641.9 |
| 8 | Ψ(bua+ndvi+nsa+pm+rden), p(and+open) | 9 | 2953.6 | 2.313 | 0.05 | -2640.3 |
| 9 | Ψ(ndvi+nsa+pm), p(and+open) | 7 | 2953.9 | 2.557 | 0.044 | -2644.1 |
| 10 | Ψ(ndvi+nl+nsa+pm+rden), p(and+open) | 9 | 2953.9 | 2.611 | 0.043 | -2640.5 |
| 11 | Ψ(bua+ndvi+nl+nsa+pm), p(and+open) | 9 | 2954.3 | 2.998 | 0.035 | -2640.9 |
| 12 | Ψ(bua+ndvi+nsa+pm+pden+rden), p(and+open) | 10 | 2954.8 | 3.505 | 0.027 | -2639.5 |
| 13 | Ψ(ndvi+nl+nsa+pm+pden+rden), p(and+open) | 10 | 2954.9 | 3.59 | 0.026 | -2639.6 |
| 14 | Ψ(ndvi+nl+nsa+pm+pden), p(and+open) | 10 | 2954.9 | 3.607 | 0.026 | -2639.6 |
| 15 | Ψ(ndvi+nsa), p(and+open) | 6 | 2955.2 | 3.9 | 0.022 | -2647.1 |
| 16 | Ψ(bua+ndvi+nl+nsa+pm+rpden), p(and+open) | 10 | 2955.6 | 4.253 | 0.019 | -2640.2 |
| 17 | Ψ(ndvi+nsa+rpden), p(and+open) | 7 | 2955.8 | 4.512 | 0.017 | -2645.8 |

* Site-level covariates: bua (built-up area), ndvi (NDVI-CV ~ open green spaces), nl (night light intensity), nsa (net sown area), pm (PM2.5 air pollutants), pden (human population density), and rden (road network density).
Survey-level covariates: and (ambient noise and disturbance) and open (habitat openness).

| Model No. | Ψ(bua) | Ψ(ndvi) | Ψ(nl) | Ψ(nsa) | Ψ(pm) | Ψ(pden) | Ψ(rden) | p(and) | p(open) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 1.652 | | 0.495 | -0.369 | 0.349 | | 0.313 | -0.935 |
| 2 | | 1.639 | | 0.506 | -0.37 | | 0.171 | 0.314 | -0.935 |
| 3 | 0.172 | 1.621 | | 0.472 | -0.36 | | | 0.314 | -0.936 |
| 4 | 0.073 | 1.655 | | 0.5 | -0.388 | 0.261 | | 0.313 | -0.936 |
| 5 | | 1.659 | | 0.511 | -0.388 | 0.257 | 0.07 | 0.314 | -0.935 |
| 6 | | 1.664 | 0.059 | 0.5 | -0.378 | 0.295 | | 0.312 | -0.936 |
| 7 | | 1.635 | 0.167 | 0.463 | -0.322 | | | 0.31 | -0.935 |
| 8 | 0.1 | 1.646 | | 0.503 | -0.392 | | 0.11 | 0.314 | -0.936 |
| 9 | | 1.568 | | 0.42 | -0.242 | | | 0.314 | -0.934 |
| 10 | | 1.656 | 0.081 | 0.507 | -0.381 | | 0.135 | 0.313 | -0.935 |
| 11 | 0.137 | 1.633 | 0.059 | 0.477 | -0.364 | | | 0.312 | -0.936 |
| 12 | 0.058 | 1.659 | | 0.509 | -0.397 | 0.213 | 0.051 | 0.314 | -0.936 |
| 13 | | 1.667 | 0.045 | 0.512 | -0.392 | 0.231 | 0.059 | 0.313 | -0.936 |
| 14 | 0.06 | 1.659 | 0.029 | 0.501 | -0.389 | 0.251 | | 0.313 | -0.936 |
| 15 | | 1.481 | | 0.386 | | | | 0.306 | -0.934 |
| 16 | 0.083 | 1.652 | 0.035 | 0.504 | -0.393 | | 0.105 | 0.314 | -0.936 |
| 17 | | 1.485 | | 0.408 | | 0.151 | | 0.305 | -0.935 |

**Appendix 6.** Statistical parameters of occupancy analysis: House Crow.

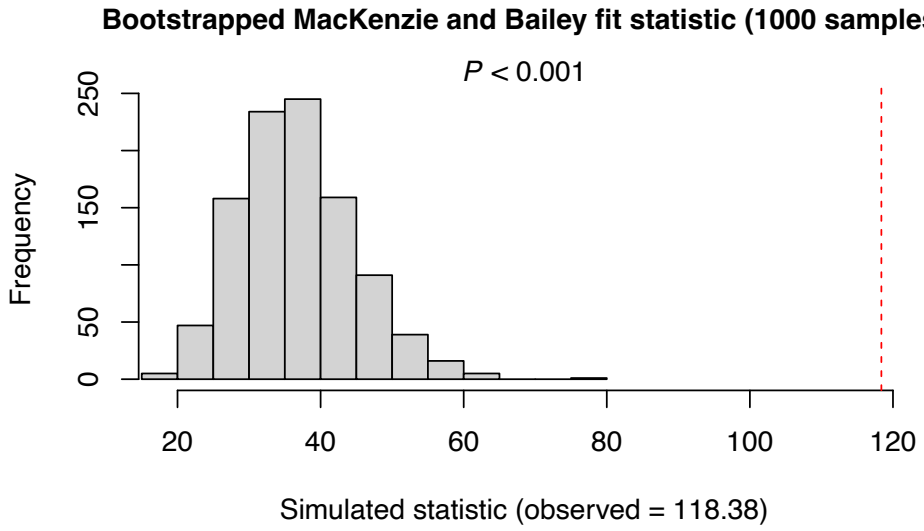



| Model No. | Model Covariates* | K | QAIC | ΔQAIC | QAICw | Log Likelihood |
|---|---|---|---|---|---|---|
| 1 | Ψ(bua+nl+pden), p(and+open) | 7 | 1717 | 0 | 0.072 | -3214.8 |
| 2 | Ψ(bua+nl+nsa+pden), p(and+open) | 8 | 1717.3 | 0.366 | 0.06 | -3211.8 |
| 3 | Ψ(nl+pden), p(and+open) | 6 | 1717.6 | 0.622 | 0.052 | -3219.8 |
| 4 | Ψ(nl+nsa+pden), p(and+open) | 7 | 1717.9 | 0.965 | 0.044 | -3216.7 |
| 5 | Ψ(bua+ndvi+nl+pden), p(and+open) | 8 | 1718.8 | 1.861 | 0.028 | -3214.6 |
| 6 | Ψ(bua+nl+pden), p(and+open) | 8 | 1718.9 | 1.875 | 0.028 | -3214.6 |
| 7 | Ψ(bua+nl), p(and+open) | 6 | 1718.9 | 1.894 | 0.028 | -3222.2 |
| 8 | Ψ(bua+nl+pm+pden), p(and+open) | 8 | 1718.9 | 1.896 | 0.028 | -3214.6 |
| 9 | Ψ(bua+pden), p(and+open) | 6 | 1719.1 | 2.084 | 0.025 | -3222.6 |
| 10 | Ψ(bua+nl+nsa+pden+rden), p(and+open) | 9 | 1719.3 | 2.311 | 0.023 | -3211.7 |
| 11 | Ψ(bua+nl+nsa+pm+pden), p(and+open) | 9 | 1719.3 | 2.334 | 0.022 | -3211.7 |
| 12 | Ψ(bua+ndvi+nl+nsa+pden), p(and+open) | 9 | 1719.3 | 2.359 | 0.022 | -3211.7 |
| 13 | Ψ(ndvi+nl+pden), p(and+open) | 7 | 1719.4 | 2.388 | 0.022 | -3219.4 |
| 14 | Ψ(bua+nl+nsa), p(and+open) | 7 | 1719.4 | 2.418 | 0.021 | -3219.4 |
| 15 | Ψ(nl+pm+pden), p(and+open) | 7 | 1719.5 | 2.498 | 0.021 | -3219.6 |
| … | … | … | … | … | … | … |
| 48 | Ψ(nl+nsa), p(and+open) | 6 | 1721.9 | 4.944 | 0.006 | -3228 |

* Site-level covariates: bua (built-up area), ndvi (NDVI-CV ~ open green spaces), nl (night light intensity), nsa (net sown area), pm (PM2.5 air pollutants), pden (human population density), and rden (road network density).
Survey-level covariates: and (ambient noise and disturbance) and open (habitat openness).

| Model No. | Ψ(bua) | Ψ(ndvi) | Ψ(nl) | Ψ(nsa) | Ψ(pm) | Ψ(pden) | Ψ(rden) | p(and) | p(open) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.113 | | 0.778 | | | 4.691 | | 0.191 | -0.475 |
| 2 | 2.183 | | 0.801 | 0.182 | | 4.781 | | 0.187 | -0.481 |
| 3 | | | 0.858 | | | 5.725 | | 0.191 | -0.479 |
| 4 | | | 0.879 | 0.182 | | 5.85 | | 0.187 | -0.485 |
| 5 | 2.096 | 0.071 | 0.82 | | | 5.01 | | 0.19 | -0.478 |
| 6 | 2.148 | | 0.837 | | | 4.815 | -0.18 | 0.191 | -0.475 |
| 7 | 3.015 | | 1.082 | | | | | 0.193 | -0.477 |
| 8 | 2.129 | | 0.803 | | 0.052 | 4.617 | | 0.19 | -0.476 |
| 9 | 2.526 | | | | | 6.327 | | 0.196 | -0.479 |
| 10 | 2.211 | | 0.839 | 0.179 | | 4.836 | -0.117 | 0.187 | -0.481 |
| 11 | 2.173 | | 0.787 | 0.193 | -0.031 | 4.833 | | 0.187 | -0.481 |
| 12 | 2.186 | -0.015 | 0.795 | 0.186 | | 4.711 | | 0.187 | -0.481 |
| 13 | | 0.095 | 0.912 | | | 6.169 | | 0.189 | -0.482 |
| 14 | 3.228 | | 1.12 | 0.175 | | | | 0.189 | -0.482 |
| 15 | | | 0.884 | | 0.057 | 5.652 | | 0.19 | -0.48 |
| … | … | … | … | … | … | … | … | … | … |
| 48 | | | 1.14 | 0.153 | | | | 0.2 | -0.496 |

**Appendix 7.** Statistical parameters of occupancy analysis: Common Myna.

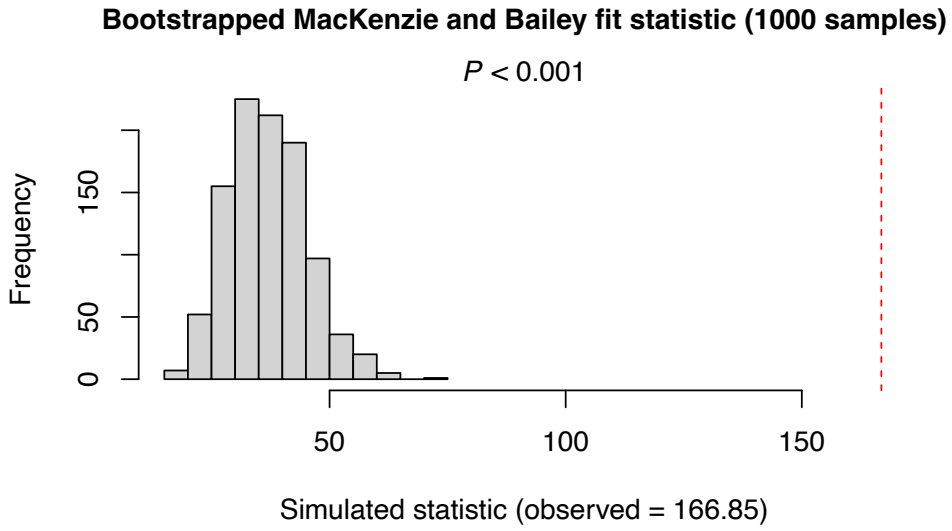



| Model No. | Model Covariates* | K | QAIC | ΔQAIC | QAICw | Log Likelihood |
|---|---|---|---|---|---|---|
| 1 | Ψ(pm+pden), p(and+open) | 6 | 2184.9 | 0 | 0.061 | -3495.2 |
| 2 | Ψ(bua+pm+pden+rden), p(and+open) | 8 | 2185.9 | 0.921 | 0.038 | -3490.3 |
| 3 | Ψ(nsa+pden), p(and+open) | 6 | 2186.1 | 1.184 | 0.034 | -3497.1 |
| 4 | Ψ(pm+pden), p(open) | 5 | 2186.4 | 1.45 | 0.029 | -3500.8 |
| 5 | Ψ(nsa+pm+pden+rden), p(and+open) | 8 | 2186.8 | 1.804 | 0.025 | -3491.7 |
| 6 | Ψ(pden), p(open) | 4 | 2187 | 2.026 | 0.022 | -3504.9 |
| 7 | Ψ(pm+rden), p(and+open) | 6 | 2187.3 | 2.347 | 0.019 | -3499 |
| 8 | Ψ(bua+pm+pden+rden), p(open) | 7 | 2187.5 | 2.539 | 0.017 | -3496.1 |
| 9 | Ψ(bua+nsa+pm+pden+rden), p(and+open) | 9 | 2187.5 | 2.578 | 0.017 | -3489.7 |
| 10 | Ψ(bua+ndvi+pm+pden+rden), p(and+open) | 9 | 2187.8 | 2.871 | 0.014 | -3490.2 |
| 11 | Ψ(rden), p(and+open) | 5 | 2187.8 | 2.895 | 0.014 | -3503.1 |
| 12 | Ψ(nsa+pden), p(open) | 5 | 2187.9 | 2.933 | 0.014 | -3503.2 |
| 13 | Ψ(pden+rden), p(open) | 5 | 2188 | 3.056 | 0.013 | -3503.4 |
| 14 | Ψ(nsa+pm+pden+rden), p(open) | 7 | 2188.2 | 3.226 | 0.012 | -3497.2 |
| 15 | Ψ(nsa+pm+pden), p(open) | 6 | 2188.2 | 3.241 | 0.012 | -3500.4 |
| … | … | … | … | … | … | … |
| 52 | Ψ(ndvi+pden+rden), p(open) | 6 | 2189.9 | 4.954 | 0.005 | -3503.2 |

* Site-level covariates: bua (built-up area), ndvi (NDVI-CV ~ open green spaces), nl (night light intensity), nsa (net sown area), pm (PM2.5 air pollutants), pden (human population density), and rden (road network density).
Survey-level covariates: and (ambient noise and disturbance) and open (habitat openness).

| Model No. | Ψ(bua) | Ψ(ndvi) | Ψ(nl) | Ψ(nsa) | Ψ(pm) | Ψ(pden) | Ψ(rden) | p(and) | p(open) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | 0.347 | 4.708 | | 0.106 | -0.162 |
| 2 | -0.575 | | | | 0.439 | 5.463 | 0.865 | 0.108 | -0.162 |
| 3 | | | | 0.164 | | 4.748 | | 0.111 | -0.162 |
| 4 | | | | | 0.385 | 5.014 | | | -0.198 |
| 5 | | | | 0.096 | 0.407 | 4.063 | 0.872 | 0.105 | -0.164 |
| 6 | | | | | | 5.075 | | | -0.193 |
| 7 | | | | | 0.388 | | 1.177 | 0.115 | -0.17 |
| 8 | -0.567 | | | | 0.462 | 5.615 | 0.861 | | -0.199 |
| 9 | -0.563 | | | 0.102 | 0.385 | 5.373 | 0.879 | 0.108 | -0.165 |
| 10 | -0.564 | -0.03 | | | 0.453 | 5.276 | 0.861 | 0.108 | -0.161 |
| 11 | | | | | | | 0.836 | 0.123 | -0.165 |
| 12 | | | | 0.166 | | 4.967 | | | -0.2 |
| 13 | | | | | | 4.57 | 0.532 | | -0.192 |
| 14 | | | | 0.09 | 0.449 | 4.348 | 0.891 | | -0.2 |
| 15 | | | | 0.08 | 0.332 | 4.976 | | | -0.201 |
| … | … | … | … | … | … | … | … | … | … |
| 52 | | 0.052 | | | | 4.828 | 0.547 | | -0.193 |

**Appendix 8.** Statistical parameters of occupancy analysis: Red-vented Bulbul.

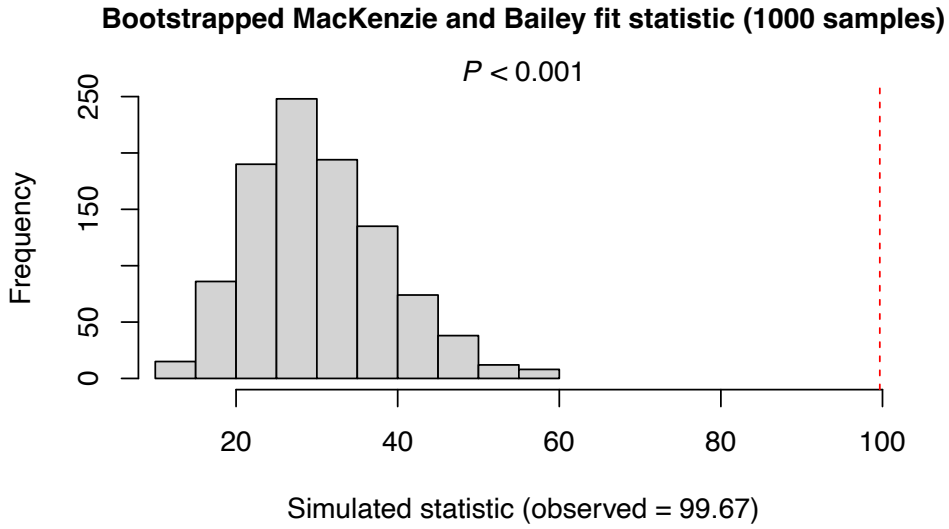



| Model No. | Model Covariates* | K | QAIC | ΔQAIC | QAICw | Log Likelihood |
|---|---|---|---|---|---|---|
| 1 | Ψ(ndvi), p(and+open) | 5 | 1534 | 0 | 0.032 | -3439.7 |
| 2 | Ψ(ndvi), p(and+open+time) | 6 | 1534.2 | 0.274 | 0.028 | -3435.8 |
| 3 | Ψ(ndvi+nsa), p(and+open) | 6 | 1534.5 | 0.556 | 0.024 | -3436.4 |
| 4 | Ψ(ndvi+rden), p(and+open) | 6 | 1534.7 | 0.745 | 0.022 | -3436.8 |
| 5 | Ψ(ndvi+nsa), p(and+open) | 7 | 1534.8 | 0.828 | 0.021 | -3432.5 |
| 6 | Ψ(ndvi+nl), p(and+open) | 6 | 1534.9 | 0.938 | 0.02 | -3437.3 |
| 7 | Ψ(ndvi+rden), p(and+open+time) | 7 | 1535 | 1.064 | 0.019 | -3433 |
| 8 | Ψ(ndvi+nl), p(and+open+time) | 7 | 1535.2 | 1.272 | 0.017 | -3433.5 |
| 9 | Ψ(bua+ndvi), p(and+open) | 6 | 1535.2 | 1.278 | 0.017 | -3438 |
| 10 | Ψ(bua+ndvi), p(and+open+time) | 7 | 1535.6 | 1.58 | 0.015 | -3434.2 |
| 11 | Ψ(ndvi+nsa+rden), p(and+open) | 7 | 1535.7 | 1.714 | 0.014 | -3434.5 |
| 12 | Ψ(ndvi+nl+nsa), p(and+open) | 7 | 1535.7 | 1.758 | 0.013 | -3434.6 |
| 13 | Ψ(ndvi), p(open) | 4 | 1535.7 | 1.767 | 0.013 | -3448.2 |
| 14 | Ψ(ndvi+pden), p(and+open) | 6 | 1535.8 | 1.851 | 0.013 | -3439.3 |
| 15 | Ψ(ndvi+pm), p(and+open) | 6 | 1536 | 1.98 | 0.012 | -3439.6 |
| … | … | … | … | … | … | … |
| 110 | Ψ(ndvi+pden+rden), p(open+time) | 7 | 1538.9 | 4.967 | 0.003 | -3441.8 |

* Site-level covariates: bua (built-up area), ndvi (NDVI-CV ~ open green spaces), nl (night light intensity), nsa (net sown area), pm (PM2.5 air pollutants), pden (human population density), and rden (road network density).
Survey-level covariates: and (ambient noise and disturbance), open (habitat openness), and time (time of sampling).

| Model No. | Ψ(bua) | Ψ(ndvi) | Ψ(nl) | Ψ(nsa) | Ψ(pm) | Ψ(pden) | Ψ(rden) | p(and) | p(open) | p(time) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 0.883 | | | | | | 0.136 | 0.3 | |
| 2 | | 0.917 | | | | | | 0.137 | 0.301 | -0.105 |
| 3 | | 0.769 | | 0.233 | | | | 0.135 | 0.293 | |
| 4 | | 0.858 | | | | | -0.14 | 0.14 | 0.298 | |
| 5 | | 0.801 | | 0.238 | | | | 0.136 | 0.294 | -0.105 |
| 6 | | 0.839 | -0.157 | | | | | 0.143 | 0.298 | |
| 7 | | 0.893 | | | | | -0.139 | 0.141 | 0.299 | -0.103 |
| 8 | | 0.873 | -0.155 | | | | | 0.144 | 0.299 | -0.103 |
| 9 | -0.113 | 0.865 | | | | | | 0.141 | 0.299 | |
| 10 | -0.112 | 0.899 | | | | | | 0.142 | 0.3 | -0.104 |
| 11 | | 0.763 | | 0.201 | | | -0.114 | 0.138 | 0.293 | |
| 12 | | 0.742 | -0.134 | 0.212 | | | | 0.141 | 0.293 | |
| 13 | | 0.914 | | | | | | | 0.251 | |
| 14 | | 0.88 | | | | -0.049 | | 0.137 | 0.299 | |
| 15 | | 0.893 | | | -0.031 | | | 0.138 | 0.3 | |
| … | … | … | … | … | … | … | … | … | … | … |
| 110 | | 0.925 | | | | 0.076 | -0.174 | | 0.248 | -0.099 |

**Appendix 9.** Statistical parameters of occupancy analysis: Large-billed Crow.




| Model No. | Model Covariates* | K | QAIC | ΔQAIC | QAICw | Log Likelihood |
|---|---|---|---|---|---|---|
| 1 | Ψ(ndvi+nl+pm), p(open+time) | 7 | 1551.7 | 0 | 0.068 | -2541.6 |
| 2 | Ψ(ndvi+nl+pm+rden), p(open+time) | 8 | 1552.3 | 0.537 | 0.052 | -2539.2 |
| 3 | Ψ(ndvi+nl+pm), p(open) | 6 | 1552.5 | 0.745 | 0.047 | -2546.2 |
| 4 | Ψ(bua+ndvi+nl+pm+rden), p(open+time) | 9 | 1552.8 | 1.086 | 0.04 | -2536.8 |
| 5 | Ψ(ndvi+nl+pm+rden), p(open) | 7 | 1553 | 1.304 | 0.036 | -2543.8 |
| 6 | Ψ(ndvi+nl+pm+pden), p(open+time) | 8 | 1553.3 | 1.544 | 0.032 | -2540.9 |
| 7 | Ψ(bua+ndvi+pm), p(open+time) | 7 | 1553.4 | 1.653 | 0.03 | -2544.4 |
| 8 | Ψ(bua+ndvi+nl+pm), p(open+time) | 8 | 1553.4 | 1.684 | 0.029 | -2541.1 |
| 9 | Ψ(bua+ndvi+nl+pm+pden), p(open+time) | 9 | 1553.4 | 1.7 | 0.029 | -2537.8 |
| 10 | Ψ(ndvi+nl+nsa+pm), p(open+time) | 8 | 1553.6 | 1.845 | 0.027 | -2541.4 |
| 11 | Ψ(bua+ndvi+nl+pm+rden), p(open) | 8 | 1553.6 | 1.914 | 0.026 | -2541.5 |
| 12 | Ψ(bua+ndvi+pm+rden), p(open+time) | 8 | 1553.9 | 2.165 | 0.023 | -2541.9 |
| 13 | Ψ(ndvi+nl+pm+pden), p(open) | 7 | 1554 | 2.268 | 0.022 | -2545.4 |
| 14 | Ψ(bua+ndvi+nl+pm), p(open) | 7 | 1554.2 | 2.453 | 0.02 | -2545.7 |
| 15 | Ψ(bua+ndvi+pm), p(open) | 6 | 1554.2 | 2.461 | 0.02 | -2549 |
| … | … | … | … | … | … | … |
| 45 | Ψ(ndvi+nsa+pm), p(open+time) | 7 | 1556.7 | 4.989 | 0.006 | -2549.9 |

* Site-level covariates: bua (built-up area), ndvi (NDVI-CV ~ open green spaces), nl (night light intensity), nsa (net sown area), pm (PM2.5 air pollutants), pden (human population density), and rden (road network density).
Survey-level covariates: open (habitat openness) and time (time of sampling).

| Model No. | Ψ(bua) | Ψ(ndvi) | Ψ(nl) | Ψ(nsa) | Ψ(pm) | Ψ(pden) | Ψ(rden) | p(open) | p(time) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | -0.447 | -0.26 | | -0.471 | | | -0.25 | -0.172 |
| 2 | | -0.436 | -0.35 | | -0.487 | | 0.172 | -0.251 | -0.173 |
| 3 | | -0.456 | -0.257 | | -0.46 | | | -0.252 | |
| 4 | -0.214 | -0.439 | -0.271 | | -0.477 | | 0.27 | -0.252 | -0.175 |
| 5 | | -0.444 | -0.345 | | -0.475 | | 0.168 | -0.253 | |
| 6 | | -0.443 | -0.354 | | -0.488 | 0.261 | | -0.245 | -0.171 |
| 7 | -0.224 | -0.406 | | | -0.477 | | | -0.246 | -0.175 |
| 8 | -0.089 | -0.45 | -0.209 | | -0.466 | | | -0.25 | -0.173 |
| 9 | -0.281 | -0.442 | -0.287 | | -0.491 | 0.565 | | -0.243 | -0.177 |
| 10 | | -0.43 | -0.267 | -0.052 | -0.456 | | | -0.249 | -0.17 |
| 11 | -0.208 | -0.447 | -0.269 | | -0.465 | | 0.262 | -0.254 | |
| 12 | -0.345 | -0.388 | | | -0.484 | | 0.207 | -0.247 | -0.176 |
| 13 | | -0.453 | -0.348 | | -0.475 | 0.249 | | -0.248 | |
| 14 | -0.085 | -0.459 | -0.208 | | -0.454 | | | -0.252 | |
| 15 | -0.219 | -0.415 | | | -0.465 | | | -0.249 | |
| … | … | … | … | … | … | … | … | … | … |
| 45 | | -0.346 | | -0.004 | -0.513 | | | -0.241 | -0.171 |

**Appendix 10.** Overall summary of observed (naïve) *versus* estimated occupancy and detection probability of major synanthropic bird species of India.

| SN | Bird Species | Total no. of sampling grids | No. of grids in which species was recorded | Naïve Occupancy (%) | Estimated Occupancy (%) | Estimated Detection Probability |
|---|---|---|---|---|---|---|
| 1 | Common Myna | 1674 | 1342 | 80.17 | 85.95 | 0.61 |
| 2 | House Crow | 1674 | 1154 | 68.94 | 76.81 | 0.56 |
| 3 | House Sparrow | 1674 | 996 | 59.49 | 80.43 | 0.38 |
| 4 | Large-billed Crow | 1674 | 706 | 42.17 | 51.77 | 0.42 |
| 5 | Red-vented Bulbul | 1674 | 1303 | 77.84 | 84.02 | 0.58 |

**Appendix 11.** A state-wise summary of observed (naïve) *versus* estimated occupancy of major synanthropic bird species of India.

| State | Total no. of sampling grids | No. of grids in which species was recorded | Naïve Occupancy (%) | Estimated Occupancy (%) | Abundance % (Proportion of total bird abundance) |
|---|---|---|---|---|---|
| **HOUSE SPARROW** | | | | | |
| Delhi | 20 | 10 | 50 | 66.58 | 1.9 |
| Goa | 7 | 0 | 0 | 59.29 | 0 |
| Gujarat | 98 | 72 | 73.47 | 86.34 | 7.24 |
| Jharkhand | 23 | 14 | 60.87 | 77.52 | 7.45 |
| Karnataka | 227 | 140 | 61.67 | 75.32 | 7.77 |
| Kerala | 84 | 13 | 15.48 | 34.61 | 1.58 |
| Madhya Pradesh | 207 | 134 | 64.73 | 93.24 | 6.1 |
| Maharashtra | 328 | 210 | 67.68 | 87 | 5.34 |
| Odisha | 41 | 7 | 19.51 | 73.51 | 2.53 |
| Rajasthan | 206 | 172 | 83.5 | 92.19 | 8.31 |
| Tamil Nadu | 219 | 114 | 52.51 | 71.93 | 7.12 |
| Telangana | 107 | 68 | 74.77 | 89.61 | 6.93 |
| West Bengal | 107 | 42 | 39.25 | 69.74 | 3.87 |
| **HOUSE CROW** | | | | | |
| Delhi | 20 | 20 | 100 | 95.11 | 16.53 |
| Goa | 7 | 7 | 100 | 88.96 | 23.31 |
| Gujarat | 98 | 51 | 52.04 | 86 | 4.14 |
| Jharkhand | 23 | 15 | 65.22 | 81.56 | 11.3 |
| Karnataka | 227 | 130 | 57.27 | 79.71 | 6.62 |
| Kerala | 84 | 77 | 91.67 | 79.1 | 22.67 |
| Madhya Pradesh | 207 | 120 | 57.97 | 78.91 | 3.33 |
| Maharashtra | 328 | 178 | 65.55 | 76.92 | 4.58 |
| Odisha | 41 | 31 | 75.61 | 76.04 | 12.27 |
| Rajasthan | 206 | 172 | 83.5 | 75.09 | 7.5 |
| Tamil Nadu | 219 | 198 | 90.41 | 74.83 | 13.52 |
| Telangana | 107 | 73 | 70.09 | 73.95 | 8.38 |
| West Bengal | 107 | 82 | 76.64 | 69.31 | 10.27 |
| **COMMON MYNA** | | | | | |
| Delhi | 20 | 15 | 75 | 96.86 | 6.71 |
| Goa | 7 | 3 | 42.86 | 85.7 | 4.51 |
| Gujarat | 98 | 48 | 48.98 | 83.75 | 3.38 |
| Jharkhand | 23 | 23 | 100 | 90.12 | 16.05 |
| Karnataka | 227 | 180 | 79.3 | 83.56 | 6.52 |
| Kerala | 84 | 68 | 84.52 | 89.53 | 6.64 |
| Madhya Pradesh | 207 | 168 | 81.64 | 86.2 | 5.14 |
| Maharashtra | 328 | 262 | 82.01 | 85.9 | 5.95 |
| Odisha | 41 | 37 | 90.24 | 86.57 | 12.63 |
| Rajasthan | 206 | 130 | 63.11 | 84.93 | 3.91 |
| Tamil Nadu | 219 | 214 | 97.72 | 84.97 | 14.65 |
| Telangana | 107 | 90 | 85.05 | 85.63 | 5.26 |
| West Bengal | 107 | 104 | 97.2 | 91.03 | 14.14 |

| State | Total no. of sampling grids | No. of grids in which species was recorded | Naïve Occupancy (%) | Estimated Occupancy (%) | Abundance % (Proportion of total bird abundance) |
|---|---|---|---|---|---|
| **LARGE-BILLED CROW** | | | | | |
| Delhi | 20 | 0 | 0 | 7.38 | 0 |
| Goa | 7 | 5 | 71.43 | 65.96 | 4.14 |
| Gujarat | 98 | 9 | 9.18 | 57.7 | 0.42 |
| Jharkhand | 23 | 2 | 8.7 | 35.57 | 0.39 |
| Karnataka | 227 | 144 | 63.44 | 63.44 | 4.37 |
| Kerala | 84 | 65 | 77.38 | 77.58 | 9.83 |
| Madhya Pradesh | 207 | 126 | 60.87 | 39.44 | 2.94 |
| Maharashtra | 328 | 169 | 64.63 | 47.37 | 3.46 |
| Odisha | 41 | 14 | 34.15 | 49.92 | 2.17 |
| Rajasthan | 206 | 3 | 1.46 | 41.47 | 0.07 |
| Tamil Nadu | 219 | 133 | 61.19 | 65.84 | 4.55 |
| Telangana | 107 | 12 | 11.21 | 50.46 | 0.33 |
| West Bengal | 107 | 24 | 22.43 | 42.59 | 0.88 |
| **RED-VENTED BULBUL** | | | | | |
| Delhi | 20 | 12 | 60 | 81.19 | 3.01 |
| Goa | 7 | 5 | 71.43 | 74.78 | 2.26 |
| Gujarat | 98 | 89 | 90.82 | 85.85 | 10.03 |
| Jharkhand | 23 | 13 | 56.52 | 86.98 | 4.36 |
| Karnataka | 227 | 170 | 74.89 | 80.49 | 4.59 |
| Kerala | 84 | 31 | 38.1 | 60.42 | 1.69 |
| Madhya Pradesh | 207 | 184 | 88.89 | 91.66 | 7.24 |
| Maharashtra | 328 | 311 | 92.99 | 87.49 | 9.28 |
| Odisha | 41 | 20 | 48.78 | 82.36 | 3.03 |
| Rajasthan | 206 | 160 | 77.67 | 90.53 | 4.87 |
| Tamil Nadu | 219 | 142 | 64.84 | 77.73 | 3.84 |
| Telangana | 107 | 89 | 83.18 | 87.29 | 6.3 |
| West Bengal | 107 | 77 | 71.96 | 81.09 | 6.5 |

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