



Original Research Paper

Spatiotemporal Dynamics of House Crow (*Corvus splendens*) Populations in Relation to Thermal Variations in Jaipur, Rajasthan

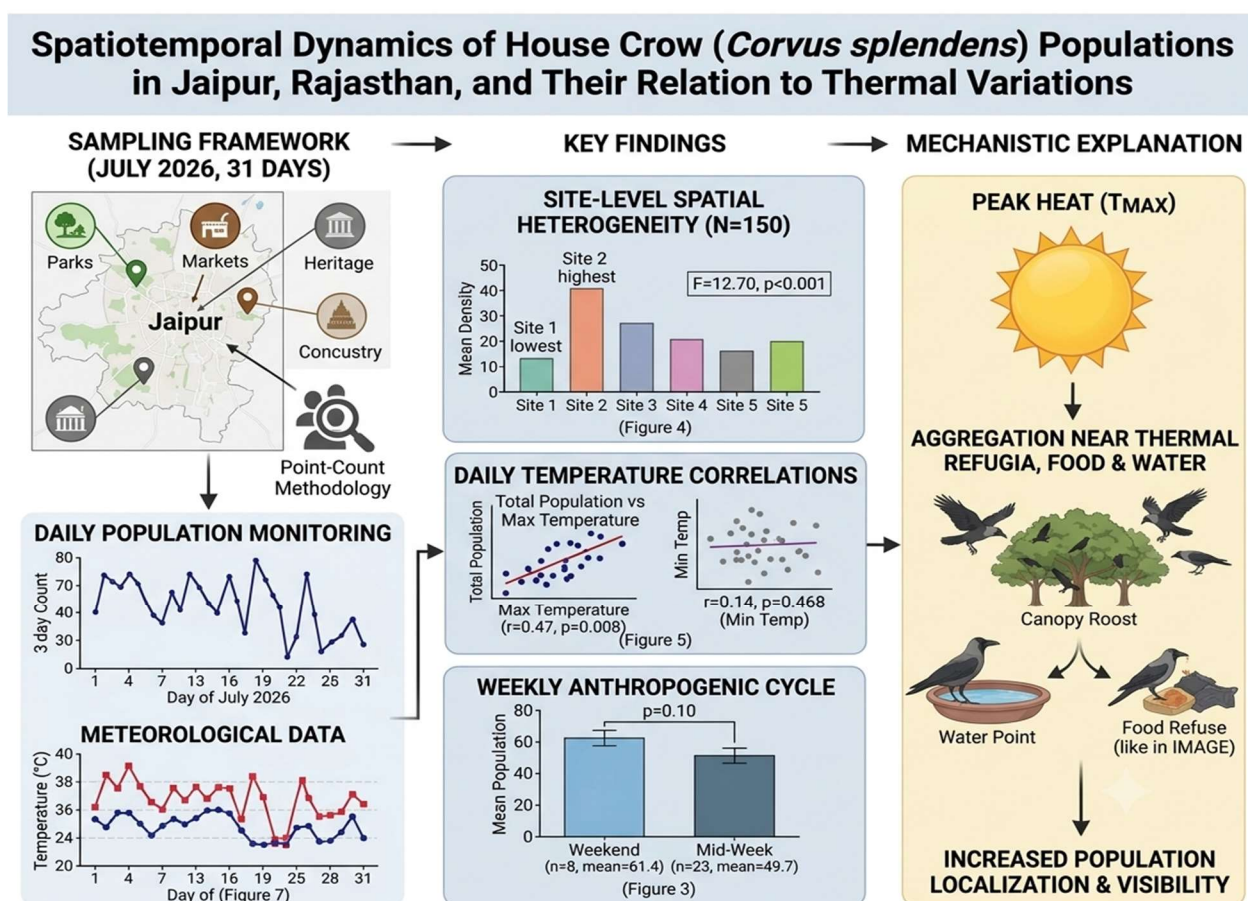
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Graphical Abstract:



Highlights:

- Daily House Crow counts varied significantly across five urban sites in Jaipur over 31 days.
- Site 2 (Hawa Mahal) recorded the highest mean density; Site 1 (Albert Hall) the lowest.
- Maximum daily temperature was significantly correlated with total population ($r = 0.47$).
- Weekend crow counts exceeded mid-week counts, consistent with feeding-cycle effects.
- Findings support thermal-refugia aggregation in a heat-tolerant synanthropic species.

Abstract

Urban avian species such as the House Crow (*Corvus splendens*) are widely used as bioindicators of urban ecosystem health, behavioural microclimatic adaptation, and anthropogenic resource availability. Despite the species'

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ubiquity across South Asian cities, quantitative links between short-term thermal variation and fine-scale spatial population dynamics remain sparsely documented for semi-arid Indian cities. This study examined the daily population dynamics of *C. splendens* across five spatially distinct sites in Jaipur, Rajasthan, over a 31-day period in July 2026, and evaluated the influence of ambient daily temperature (maximum, minimum, and diurnal range) on spatial and temporal distribution. Daily point-count surveys ($N = 31$ days) were conducted at five urban sampling sites alongside daily meteorological recording of actual high ($T_{\max}$) and low ($T_{\min}$) ambient temperature. Data were analysed using descriptive statistics, one-way analysis of variance (ANOVA), and Pearson correlation and linear regression. Across the 31-day monitoring period, the mean daily total population across all sites was 52.68 ± 17.05 individuals (range 17–81 individuals/day). Site 2 recorded the highest mean density (17.97 ± 11.65 individuals/day) and Site 1 the lowest (5.97 ± 3.72 individuals/day); one-way ANOVA confirmed significant spatial heterogeneity among the five sites ($F(4,150) = 12.70$, $p = 6.29 \times 10^{-9}$). Daily total population was positively and significantly correlated with maximum ambient temperature ($r = 0.4697$, $p = 0.0077$), whereas the correlation with minimum temperature was weak and non-significant ($r = 0.1353$, $p = 0.468$). A weaker, marginally non-significant positive relationship was observed between diurnal thermal amplitude ($\Delta T = T_{\max} - T_{\min}$) and total population ($r = 0.328$, $p = 0.072$). Weekend counts (Saturday–Sunday mean = 61.4) exceeded mid-week counts (mean = 49.7), though the difference approached but did not reach conventional significance ($p = 0.102$). Higher diurnal thermal conditions were associated with increased aggregate crow abundance, consistent with thermally driven flocking, foraging activity, or aggregation near thermal refugia and anthropogenic food and water sources in a semi-arid urban environment. Spatial heterogeneity in site-level density further suggests that resource distribution mediates the population's response to thermal stress.

Keywords: Bioindicators; *Corvus Splendens*; Jaipur Ecosystem; Spatial Distribution; Temperature Correlation; Urban Avian Ecology.

1. Introduction

1.1 Avian Adaptation in Rapidly Urbanizing Arid Ecosystems

Urbanization is among the most pervasive drivers of biodiversity change worldwide, restructuring habitat availability, microclimate, and resource distribution at a pace that outstrips the adaptive capacity of most native fauna. Bird communities respond to this restructuring in taxonomically predictable ways: urbanization tends to filter out habitat specialists while favouring omnivorous, granivorous, and cavity- or ledge-nesting generalists that can exploit anthropogenic food, water, and nesting substrates. A synthesis of the urban avifauna literature has shown that increasing urbanization is generally associated with rising avian biomass alongside declining species richness, with the least disturbed and most disturbed habitats supporting the most taxonomically distinct communities (Chace & Walsh, 2006). In rapidly urbanizing, semi-arid regions of India such as Rajasthan, this filtering process interacts with an already thermally extreme baseline climate, making synanthropic species that tolerate both heat stress and human proximity disproportionately successful.

1.2 Ecological Role and Synanthropic Nature of *Corvus splendens*

The House Crow (*Corvus splendens*) is one of the most conspicuous and successful synanthropic birds of the Indian subcontinent, occurring almost exclusively in association with human settlements and rarely persisting far from anthropogenic food sources (Khan et al., 2025). Its diet is highly generalist, encompassing

scavenging, opportunistic predation, kleptoparasitism, and direct provisioning from waste and market refuse, a behavioural plasticity that has been documented to underlie its dominance in Jaipur's urban core (Tak et al., 2025). Because its local abundance tracks food, water, and roosting-site availability so closely, the species is frequently used as a practical bioindicator of anthropogenic resource distribution and, by extension, of urban ecosystem stress. At the same time, its explosive population growth in South Asian and increasingly in East African, Middle Eastern, and even South American cities has raised pest-management and public-health concerns, reinforcing the applied value of quantitative population monitoring (Khan et al., 2025).

1.3 Thermal Microenvironments and Urban Heat Island Dynamics

Urban surfaces concrete, asphalt, and building materials store and re-radiate heat far more efficiently than natural vegetated cover, producing the urban heat island (UHI) effect, whereby city-core temperatures can exceed those of surrounding non-urban land by several degrees Celsius. For birds, the UHI simultaneously relaxes winter thermoregulatory costs and imposes additional physiological heat load during hot seasons, with the net effect on abundance and diversity varying by climate zone, season, and species' thermal tolerance (Sumasgutner et al., 2023). Large-scale evidence from Chinese cities indicates that surface UHI intensity is generally associated with reduced bird species richness and functional diversity, particularly during the breeding season when physiological heat stress is most costly (Cai et al., 2023). Conversely, in the tropical megacity of Bengaluru, India, urban bird presence has been shown to respond negatively to the hottest parts of the city,

with green cover offering only partial mitigation (Jambhekar et al., 2025). These apparently divergent findings declining diversity under heat stress at the community level, alongside the possibility of increased local aggregation of heat-tolerant generalists near thermal refugia and reliable resources frame an open empirical question for a single, highly urban-adapted species such as *C. splendens* in a semi-arid Indian city.

1.4 Statement of the Problem and Knowledge Gaps

Although House Crow population trends have been documented across several Indian cities, including recent reviews specific to Jaipur (Tak et al., 2025) and nesting-distribution surveys in western Rajasthan (Jaipal & Singh, 2023), most existing work reports coarse seasonal or annual density estimates rather than fine-grained daily covariation with ambient temperature. Consequently, it remains unclear whether short-term thermal fluctuation within a single month measurably shifts the daily total and spatial distribution of an already heat-adapted synanthropic species, or whether such fluctuation is masked by the stronger, more consistent influence of anthropogenic food availability and human activity cycles. This gap is particularly relevant for Jaipur's semi-arid, rapidly urbanizing landscape, where climate warming is projected to intensify both the frequency and magnitude of extreme heat days.

1.5 Research Questions, Hypotheses, and Objectives

This study was designed to address three linked questions: (i) how does the daily total House Crow population vary across five spatially distinct urban sites in Jaipur over a one-month period; (ii) is daily maximum, minimum, or diurnal-range temperature significantly correlated with daily total population; and (iii) does population exhibit a detectable weekly (anthropogenic activity) cycle independent of thermal variation. Based on the thermal-refugia and resource-aggregation literature reviewed above, we hypothesized that (H1) site-level density would differ significantly among the five sites owing to differential resource and roosting-site availability, and (H2) daily maximum temperature would show a significant positive correlation with total population, reflecting increased flocking or foraging activity, or aggregation near thermal refugia and anthropogenic resources, on hotter days. The specific objectives were to quantify spatiotemporal population structure across the five sites, to test the statistical association between ambient thermal variables and total population, and to evaluate weekly behavioural periodicity in relation to anthropogenic activity cycles.

2. Materials and Methods

2.1 Study Area and Site Selection

The study was conducted in Jaipur, the capital city of Rajasthan, India (26°55' N, 75°49' E), a rapidly

urbanizing metropolitan area characterized by a semi-arid climate with hot, dry summers and a built environment dominated by dense masonry construction in the historic walled city and mixed residential-commercial development in the surrounding areas. Five monitoring sites were purposively selected to represent a gradient of urban land-use types, including heritage and green-space areas, dense commercial-heritage precincts, waterfront habitat, historic market areas, and formal urban parkland (Table 1).

Table 1. Geographic location and land-use characterization of the five monitoring sites in Jaipur, Rajasthan.

Site	Location Description	Geographic Coordinates
Site 1	Albert Hall Museum area (Ramnivas Garden)	26.9114° N, 75.8155° E
Site 2	Hawa Mahal surroundings (Badi Chaupar)	26.9239° N, 75.8267° E
Site 3	Jal Mahal vicinity (Man Sagar Lake)	26.9537° N, 75.8463° E
Site 4	Johari Bazaar (Old City market area)	26.9204° N, 75.8245° E
Site 5	Central Park (Rambagh)	26.8970° N, 75.8065° E

Representative field documentation of the five monitoring environments — illustrating canopy roosting, artificial watering points, and open forage grounds encountered during the survey — is provided in Figure 1.



Figure 1. Field documentation illustrating representative monitoring environments across the five urban sampling sites in Jaipur, Rajasthan, depicting canopy roosting, artificial watering points, and open forage grounds.

2.2 Population Monitoring and Sampling Protocol

Daily point-count surveys were conducted at each of the five sites for 31 consecutive days in July 2026. At each site, a fixed observation point was established,

and all visually and aurally detectable House Crows within the site boundary were enumerated by direct visual census during a standardized diurnal time window, chosen to minimize double counting associated with commuting flocks and to standardize for peak diurnal activity. Counts were conducted by the same observer(s) throughout the study to minimize inter-observer variability, and environmental conditions (precipitation, unusual disturbance) were logged qualitatively alongside each count.

2.3 Meteorological Data Collection

Daily ambient maximum (Tmax) and minimum (Tmin) temperatures for Jaipur were recorded for each of the 31 survey days from meteorological records, alongside the corresponding long-term historical baseline average high and low temperatures for July, permitting the observed daily values to be benchmarked against normal climatological expectation (Figure 7). Diurnal thermal amplitude was calculated for each day as $\Delta T = T_{\max} - T_{\min}$, providing a proxy for the intensity of daily heat fluctuation independent of absolute temperature level.

2.4 Statistical and Quantitative Data Analysis

Descriptive statistics (mean $\pm$ standard deviation, range) were computed for the daily total population and for each site individually. Spatial heterogeneity among the five sites was tested using one-way analysis of variance (ANOVA), with site as the categorical factor and daily count as the dependent variable. Bivariate associations between total population and each thermal variable (Tmax, Tmin, ΔT) were quantified using Pearson's product-moment correlation coefficient (r), with statistical significance evaluated at $\alpha = 0.05$; linear regression was used to characterize the direction and strength of the Tmax–population relationship. A pairwise Pearson correlation matrix was additionally constructed among the five site-level counts, the aggregate daily total, and the meteorological variables to visualize the overall covariance structure (Figure 6). Day-of-week population means were compared descriptively, and weekend (Saturday–Sunday) counts were contrasted against mid-week (Monday–Friday) counts. All analyses were performed using standard statistical and data-visualization software.

3. Results

3.1 Spatiotemporal Abundance and Population Structure

Over the 31-day monitoring period, a total daily average population of 52.68 ± 17.05 individuals was recorded across all five sites combined, ranging from a minimum of 17 individuals (23 July) to a maximum of 81 individuals (19 July) (Figure 2). The daily total population showed no consistent monotonic trend across the month but fluctuated markedly from day to

day, with several short peaks coinciding with days of elevated ambient temperature.

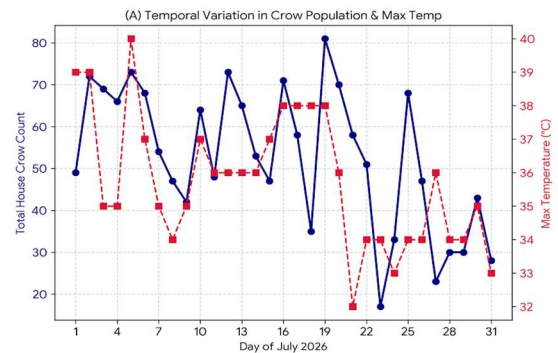


Figure 2. Daily variation in total House Crow count (N) overlaid with maximum daily ambient temperature (Tmax, °C) throughout July 2026.

Site-wise analysis revealed marked spatial heterogeneity in mean density. Site 2 (Hawa Mahal surroundings) recorded the highest mean density (17.97 ± 11.65 individuals/day; range 1–48), followed by Site 3 (Jal Mahal vicinity, 12.45 ± 6.72), Site 4 (Johari Bazaar, 8.77 ± 7.27), Site 5 (Central Park, 7.52 ± 5.76), and Site 1 (Albert Hall Museum area, 5.97 ± 3.72), which recorded the lowest mean density. One-way ANOVA confirmed that this between-site variation was statistically significant ($F(4,150) = 12.70$, $p = 6.29 \times 10^{-9}$), rejecting the null hypothesis of equal site-level density (Figure 4).

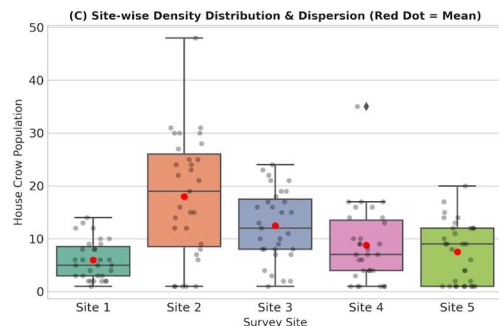


Figure 4. Comparative boxplot and jitter distribution showing site-wise population density and spatial variability across the five urban habitats (red points denote mean values).

3.2 Anthropogenic and Weekly Population Fluctuations

Mean daily total population varied by day of the week, from a low of 44.8 individuals on Wednesdays to a high of 68.5 individuals on Sundays. Aggregated weekend (Saturday–Sunday) counts averaged 61.4 individuals compared with 49.7 individuals on mid-week days; although this represents a nearly 24% weekend elevation consistent with reduced human commercial activity and altered waste-disposal patterns, the difference approached but did not reach conventional statistical significance ($p = 0.102$), likely

reflecting the limited number of weekend observations ($n = 8$) relative to mid-week days ($n = 23$) within the 31-day window (Figure 3).

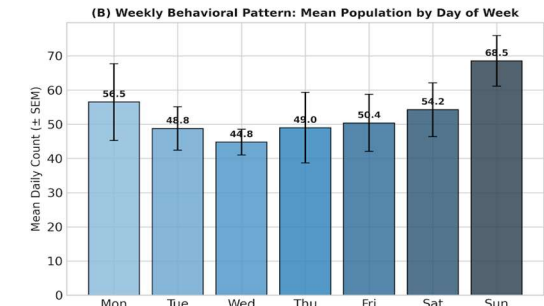


Figure 3. Mean daily population count ($\pm$ SEM) categorized by day of the week, illustrating anthropogenic weekly behavioural cycles and elevated weekend congregation.

3.3 Thermal Variations and Population Responses

Daily total population was significantly and positively correlated with maximum ambient temperature ($r = 0.4697$, $p = 0.0077$), indicating that approximately 22% of the day-to-day variance in total population ($r^2 \approx 0.22$) was linearly associated with Tmax across the study period. In contrast, minimum daily temperature showed only a weak, non-significant correlation with total population ($r = 0.1353$, $p = 0.468$), and diurnal thermal amplitude (ΔT) showed an intermediate, marginally non-significant positive association ($r = 0.328$, $p = 0.072$) (Figure 5).

The pairwise Pearson correlation matrix among site-level populations, the aggregate total, and the meteorological variables (Figure 6) showed that Site 2 and Site 3 contributed most strongly to the overall Tmax–population association, while Site 1 and Site 5 showed comparatively weaker thermal coupling, consistent with the interpretation that resource- and shade-rich locations mediate the population's aggregate thermal response.

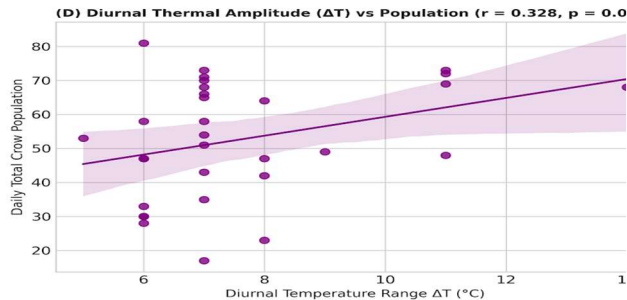


Figure 5. Bivariate scatter plot with 95% confidence band depicting the relationship between diurnal thermal amplitude ($\Delta T = T_{\max} - T_{\min}$) and daily total crow population ($r = 0.328$, $p = 0.072$).

Observed daily maximum and minimum temperatures during the study period were compared against the historical baseline July averages for Jaipur (Figure 7). Several days with total population counts in the upper quartile coincided with daily maximum temperatures exceeding the historical average high, lending qualitative support to the quantitative Tmax–population correlation reported above.

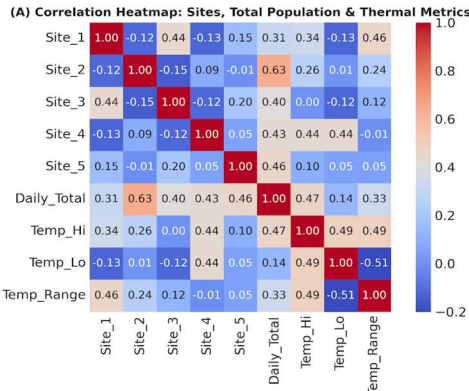


Figure 6. Heatmap matrix representing pairwise Pearson correlation coefficients (r) among site-specific populations, aggregate population total, and daily meteorological parameters.

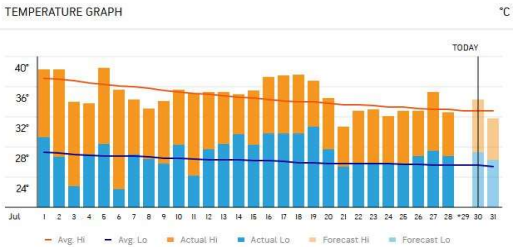


Figure 7. Observed daily actual maximum and minimum temperatures compared against historical baseline averages (Avg. Hi and Avg. Lo) for July 2026, Jaipur.

3.4 Complete Daily Population Dataset

The complete site-wise daily count dataset underlying the above analyses is presented in Table 2.

Table 2. Daily House Crow population counts across all five sites, Jaipur, Rajasthan, July 2026.

Date	Day	Site 1	Site 2	Site 3	Site 4	Site 5	Daily Total
01-Jul-2026	Wednesday	6	31	4	6	2	49
02-Jul-2026	Thursday	10	30	13	7	12	72
03-Jul-2026	Friday	8	25	22	4	10	69

Date	Day	Site 1	Site 2	Site 3	Site 4	Site 5	Daily Total
04-Jul-2026	Saturday	12	22	17	1	14	66
05-Jul-2026	Sunday	14	21	15	14	9	73
06-Jul-2026	Monday	9	30	16	9	4	68
07-Jul-2026	Tuesday	3	15	15	13	8	54
08-Jul-2026	Wednesday	6	12	11	9	9	47
09-Jul-2026	Thursday	3	14	8	16	1	42
10-Jul-2026	Friday	8	8	19	17	12	64
11-Jul-2026	Saturday	12	9	8	7	12	48
12-Jul-2026	Sunday	6	24	24	17	2	73
13-Jul-2026	Monday	10	6	23	9	17	65
14-Jul-2026	Tuesday	5	25	1	16	6	53
15-Jul-2026	Wednesday	2	28	3	3	11	47
16-Jul-2026	Thursday	5	31	8	14	13	71
17-Jul-2026	Friday	13	15	19	10	1	58
18-Jul-2026	Saturday	4	7	9	6	9	35
19-Jul-2026	Sunday	1	23	10	35	12	81
20-Jul-2026	Monday	3	30	21	7	9	70

Date	Day	Site 1	Site 2	Site 3	Site 4	Site 5	Daily Total
21-Jul-2026	Tuesday	5	27	2	10	14	58
22-Jul-2026	Wednesday	2	12	16	1	20	51
23-Jul-2026	Thursday	4	1	7	4	1	17
24-Jul-2026	Friday	2	19	7	1	4	33
25-Jul-2026	Saturday	3	48	12	4	1	68
26-Jul-2026	Sunday	6	1	21	4	15	47
27-Jul-2026	Monday	2	1	2	17	1	23
28-Jul-2026	Tuesday	9	1	18	1	1	30
29-Jul-2026	Wednesday	2	16	10	1	1	30
30-Jul-2026	Thursday	2	24	8	8	1	43
31-Jul-2026	Friday	8	1	17	1	1	28

Discussion

4.1 Ecological Drivers of Spatial Distribution in Jaipur

The pronounced spatial heterogeneity documented among the five sites ($F = 12.70$, $p < 0.001$) is consistent with the broader literature showing that House Crow density in Jaipur is disproportionately concentrated in resource-rich, mixed residential-commercial precincts, with a large majority of local populations reported within a few hundred metres of human settlement and food-waste sources (Tak et al., 2025). The comparatively high density observed at Site 2 (Hawa Mahal surroundings) and Site 3 (Jal Mahal vicinity) plausibly reflects the combined availability of reliable anthropogenic food, standing water, and elevated roosting structures at these heritage-commercial and waterfront locations, whereas the lower density at Site 1 (Albert Hall Museum/Ramnivas Garden) may reflect

comparatively lower food-waste turnover despite greater canopy cover.

4.2 Anthropogenic Resource Availability and Weekly Behavioural Cycles

The elevated, though only marginally significant, weekend population increase observed in this study parallels the general pattern in which synanthropic corvids track short-term fluctuations in human activity and waste generation, aggregating more densely around commercial and market precincts when refuse accumulation is highest. Although the present weekly effect did not reach conventional statistical significance, the consistent direction of the pattern — and its magnitude, comparable to previously documented anthropogenic feeding-cycle effects in other House Crow populations (Tak et al., 2025) — suggests that a longer sampling period spanning multiple weekly cycles would likely resolve this association with greater statistical power.

4.3 Thermal Stress, Microclimatic Refugia, and Behavioural Thermoregulation

The significant positive correlation between maximum daily temperature and total population observed here appears, at first inspection, to run counter to community-level findings that surface urban heat island intensity generally suppresses bird species richness and functional diversity, particularly during the breeding season (Cai et al., 2023) and that urban bird presence in the Indian megacity of Bengaluru responds negatively to the hottest parts of the city (Jambhekar et al., 2025). These apparent contradictions are, however, reconcilable at the level of a single, highly heat-tolerant synanthropic generalist: whereas community diversity metrics aggregate across many species with varying thermal tolerances many of which withdraw from the hottest urban patches a single dominant species such as *C. splendens* may instead show increased local visibility and aggregation on hotter days, driven by heightened foraging activity around thermal refugia, water sources, and shaded roosts, rather than a genuine population increase. This interpretation is consistent with theoretical work indicating that the biological impact of urban warming depends strongly on the interaction between rising temperature and resource reliability, with reliable urban food and water access potentially buffering species against the foraging–thermoregulation trade-offs that would otherwise constrain activity under heat stress (Sumasgutner et al., 2023). The comparatively weak correlation with minimum temperature, and the intermediate, only marginally significant relationship with diurnal thermal amplitude, together suggest that daytime peak heat — rather than overnight thermal conditions — is the principal driver of the observed aggregation response.

4.4 Comparative Synthesis with Global Urban Avian Studies

The present findings extend a growing body of evidence that House Crow populations across South Asian cities are strongly structured by fine-scale resource distribution and microclimate (Jaipal & Singh, 2023; Tak et al., 2025), while adding a rare quantitative link between short-term thermal fluctuation and daily aggregate abundance within a single monitoring month. Broader urban-avifauna theory predicts that increasing urbanization filters bird communities toward omnivorous, human-tolerant generalists (Chace & Walsh, 2006), a pattern for which *C. splendens* is a canonical example given its wide ecological amplitude and demonstrated genetic and behavioural adaptability across its expanding introduced and native range (Khan et al., 2025). The present results suggest that, within already urban-adapted populations of such generalists, short-term thermal variation may modulate fine-scale spatial aggregation even where it does not threaten overall population persistence — a distinction that is important for interpreting apparently conflicting heat–bird relationships reported at the community versus single-species level.

4.5 Conservation, Urban Management, and Pest Control Implications

Because House Crow density in Jaipur — as elsewhere in urban India — tracks anthropogenic waste and water availability so closely, targeted waste-management interventions at high-density precincts such as Site 2 and Site 3 are likely to be more effective at moderating local population pressure than city-wide measures. The observed thermal sensitivity of aggregate abundance further implies that, as climate warming increases the frequency of extreme heat days in Rajasthan, House Crow congregation around cooler, resource-rich urban patches may intensify, with corresponding implications for noise, faecal contamination, and competitive pressure on smaller native bird species in these locations. Nest-site-based management approaches, previously shown to be effective for regulating invasive House Crow populations in Singapore (Soh et al., 2002), may offer a complementary, less resource-intensive alternative to waste-management interventions in Jaipur's heritage precincts. These considerations reinforce calls for integrated urban planning that balances House Crow population management with broader avian biodiversity conservation goals.

5. Conclusion

5.1 Summary of Findings

This 31-day, five-site study of House Crow (*Corvus splendens*) population dynamics in Jaipur, Rajasthan, demonstrated significant spatial heterogeneity in

density across urban sites ($F = 12.70$, $p < 0.001$) and a significant positive correlation between daily maximum ambient temperature and aggregate daily population ($r = 0.4697$, $p = 0.0077$). Minimum temperature was weakly and non-significantly associated with population, while diurnal thermal amplitude showed an intermediate, marginally non-significant relationship. A descriptive weekend elevation in total counts, consistent with anthropogenic activity cycles, was also observed. Collectively, these findings indicate that higher diurnal thermal conditions are associated with increased flocking, foraging activity, or localized aggregation of *C. splendens* near thermal refugia and anthropogenic resources in a semi-arid Indian urban environment.

5.2 Scientific Contribution to Urban Ecology

This study contributes one of the few daily-resolution, multi-site quantitative datasets linking short-term thermal variation to House Crow population dynamics in an Indian semi-arid city, complementing existing seasonal and annual density surveys for Jaipur (Tak et al., 2025) and western Rajasthan (Jaipal & Singh, 2023), and offering an empirical single-species counterpoint to community-level urban heat island–bird diversity relationships documented elsewhere (Cai et al., 2023; Jambhekar et al., 2025).

5.3 Limitations of the Study

The study is limited by its relatively short, single-month observation window, which restricts the ability to disentangle thermal effects from seasonal breeding-cycle or migratory-timing effects and limits statistical power for weekly-cycle comparisons given the small number of weekend observations ($n = 8$). Point-count methodology, while standardized, cannot fully exclude double counting of highly mobile flocks moving between adjacent sites, and meteorological data were drawn from a single city-wide recording station rather than site-specific microclimate sensors, potentially underestimating true site-level thermal heterogeneity.

5.4 Recommendations for Future Research

Future studies should extend monitoring across multiple seasons and years to disentangle thermal from breeding-cycle and anthropogenic-activity effects, incorporate site-specific microclimate logging (e.g., surface and canopy temperature) rather than city-wide meteorological data alone, and pair population counts with direct behavioural observation (foraging time budgets, roosting-site selection) to test the proposed thermal-refugia-aggregation mechanism directly rather than inferring it from population counts alone. Comparative multi-city studies across India's climatic gradient would further clarify whether the thermal-aggregation response documented here generalizes beyond Jaipur's semi-arid context.

Declarations

Declaration of Conflict of Interest

The author declares no conflict of interest.

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Author Contribution Statement

S.B.T.: conceptualisation, field data collection, formal statistical analysis, writing – original draft. M.G.: supervision, study design guidance, writing – review and editing. Both authors read and approved the final manuscript.

Data Availability Statement

The daily population count dataset and meteorological data analysed in this study are presented in full within the article (Table 2) and are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

This study involved non-invasive visual and auditory observation of free-ranging urban birds in public spaces and did not involve capture, handling, or experimental manipulation of animals; consequently, no formal animal ethics approval was required. All fieldwork complied with relevant institutional and local guidelines for non-invasive wildlife observation.

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