

Landscape characteristics of house crow aggregation and their implications for urban landscape planning

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ARTICLE INFO	ABSTRACT
<i>Article history:</i> Received March 23, 2026 Received in revised form April 24, 2026 Accepted August 12, 2026 Available online September 01, 2026 <i>Keywords:</i> Crow population control Spatial environment Sustainable landscape design Tree species selection Urban landscape planning *Corresponding author: Nooriati Taib School of Housing, Building and Planning, Universiti Sains Malaysia Email: nooriati@usm.my ORCID: https://orcid.org/0000-0001-7788-958X	<i>House Crows (<i>Corvus splendens</i>) are highly adaptable urban birds whose overpopulation has become a major ecological and social problem in Malaysian cities. This study investigated the tree species composition, tree morphology, architectural and spatial features, as well as the abundance and behavior of house crows at Paramit Factory, Penang. Results showed that the long-term aggregation of house crows was strongly influenced by the presence and the abundance of specific preferred tree species (<i>Eucalyptus camaldulensis</i> and <i>Syzygium grande</i>). In addition, safe and stable spatial environments played an important role in supporting crow aggregation. It is recommended that urban landscape design reduces the planting of tree species preferred by house crows, selects less suitable species, and enhances spatial openness and architectural details to decrease environmental stability. These landscape management strategies offer a sustainable approach to managing house crow populations while preserving the ecological functions of urban green spaces.</i>

Introduction

The overpopulation of the House Crow (*Corvus splendens*) in Malaysian cities has become a critical ecological and social issue (Mohd-Taib, Mohd-Saleh, and Ismail 2022). As omnivorous scavengers, house crows do provide certain ecological services by helping to clean up urban waste (Wilson, Sarim, and Rahman 2015; Anjum et al. 2021). However, their large numbers also lead to numerous negative impacts, including attacks on native animals and humans, scattering refuse, and threatening biodiversity (Alias and Hashim 2016; Johan et al. 2022). Furthermore, their droppings can potentially transmit

pathogens, raising public health concerns (Fraser et al. 2015). Although various control measures have been implemented, their effectiveness has often been limited (Mohd-Taib, Mohd-Saleh, and Ismail 2022).

House crows demonstrate strong adaptability to urban landscapes (Benmazouz et al. 2021), yet their distribution is still governed by specific biological needs and habitat preferences (Soh et al. 2002; Kumar and Ojha 2022). Research indicates that their overpopulation is closely linked to urban landscape features that provide ideal conditions for nesting and foraging (Dutta and Raut 2013). Specifically, tall trees (Awais et al. 2015; Kaur and Khera 2020), densely populated residential and commercial areas (Lim

and Sodhi 2009), open spaces (Soh et al. 2002), and man-made structures like streetlights (Dutta and Raut 2013) are key factors attracting them. From a landscape restoration perspective, it is feasible to regulate species populations by modifying habitat characteristics (Fischer and Lindenmayer 2007). Therefore, a deep understanding of the landscape drivers behind house crow habitat selection is essential for developing sustainable management strategies.

This study focused on the Paramit factory area in Penang, known for its large house crow population, to investigate their habitat landscape characteristics in a tropical urban environment. Specifically, this research investigated tree species and morphology, and spatial environmental features and house crow abundance and behavior. The objective was to identify the key landscape factors that attract house crow congregations and, based on these findings, propose potential landscape planning strategies to reduce the suitability of these spaces for the birds. The findings are expected to not only reveal the habitat selection mechanisms of urban house crows but also provide practical references for ecologically-oriented urban green space planning and crow population management.

Methods

Study area

This study was conducted at the Paramit Factory in Simpang Ampat, Seberang Perai, Penang, Malaysia. The Paramit Factory was designed with the concept of an "eco-factory within a forest," aiming to create a work environment that harmonizes with nature. The main landscape greenery space includes the parking areas, rooftop gardens, and inner courtyards. However, the factory has been heavily invaded by house crows, which have formed dense populations in this area.

Data collection

This study investigated the landscape environment and house crow activity at the

Paramit Factory from March 6 to March 22, 2024. The study area was divided into four sites: the ground-level parking lot greenery, ground-level courtyard, first-floor rooftop garden, and second-floor rooftop garden.

Data collection consisted of three parts. First, all trees within the study area were surveyed to record their species, quantity, and spatial distribution location. Tree identification was based on the species list provided by the factory, supplemented with the plant identification app PictureThis and direct field observation. Photographic records were taken as supporting evidence. Second, prominent architectural and space features were documented. Third, House crow populations were surveyed on March 11, 2024, with three rounds of observations conducted between 9:00 a.m. and 4:00 p.m. During each survey, systematic visual counts were performed at four sites from a sufficient distance to minimize disturbance, recording both the number of crows and their behavioral activities (foraging, perching, flying). The average number of crows across the three counts was calculated to represent the relative abundance at each site.

Results and discussion

Tree species and abundance

Table 1 presents the types and quantities of trees in study site. Across the entire Paramit Factory, a total of 23 tree species and 209 individual trees were recorded. The most abundant species was *Syzygium grande* (60 individuals), followed by *Cinnamomum iners* (32), *Eucalyptus camaldulensis* (23).

The parking lot contained 13 species and 117 individuals, accounting for over half of the total tree population (117/209). The ground-level courtyard was the most diverse, with 18 species and 51 individuals. The first-floor rooftop garden included 4 species and 21 individuals, while the second-floor had 5 species and 20 individuals. Overall, the study area exhibited high tree abundance and species diversity.

Table 1. Tree species abundance across different sites of the Paramit factory

Tree Species	Car park	Courtyard	1st floor	2nd floor
<i>Caesalpinia ferrea</i>	1	2	7	4
<i>Cassia fistula</i>	1	–	–	–
<i>Cinnamomum iners</i>	22	10	–	–
<i>Eucalyptus camaldulensis</i>	22	1	–	–

Tree Species	Car park	Courtyard	1st floor	2nd floor
Filicium decipiens	10	3	–	–
Hopea odorata	7	4	1	–
Jacaranda mimosifolia	4	1	–	–
Lagerstroemia speciosa	6	1	–	–
Millettia pinnata	1	–	5	5
Swietenia macrophylla	1	3	–	–
Syzygium grande	40	5	8	7
Averrhoa carambola	1	–	–	–
Mangifera indica	1	–	–	1
Caesalpinia pulcherrima	–	1	–	–
Calophyllum inophyllum	–	1	–	–
Dracaena draco	–	1	–	–
Ficus benjamina	–	5	–	–
Garcinia subelliptica	–	4	–	–
Melaleuca cajuputi	–	5	–	–
Mimusops elengi	–	2	–	–
Schizolobium parahyba	–	1	–	–
Terminalia neotaliala	–	1	–	–
Magnolia champaca	–	–	–	3

Architectural and spatial characteristics

The Paramit factory incorporates several distinctive architectural components. Slender columns and a 15-meter-high brise soleil louver structure (figure 1) are key architectural elements of the area, giving the area a unique identity. The

aluminum louvers are angled at 37°, allowing morning sunlight to penetrate into the gardens and courtyards while blocking the harsher midday and afternoon sun, thereby reducing heat accumulation on the office roof and improving local microclimatic conditions.



Figure 1. Slim Columns and Brise Soleil Louver Structure (left)

Figure 2. Cantilevered Concrete Conference Room(right)

In addition, there is a distinctive architectural feature a conference room cantilevered 10 meters from the second floor (figure 2), extending above the parking area, it serves as a visual highlight of the space.

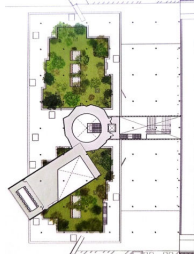
All four green spaces are closely integrated with the building, forming semi-enclosed environments with diverse forms but a unified structure. The parking lot is arranged in a nearly rectangular shape, the ground courtyards are divided into two independent areas, north and south, the roof garden on the first floor extends in a long strip, while the roof garden on the second floor is divided into two centralized areas, north and south (see table 2 Plan view). Although the spatial forms are different, they all possess the dual characteristics of building enclosure and the continuous upper-layer louvre shading system.

Among them, half of the parking lot area, the two courtyards, and the entire area of the two roof gardens are all covered by the louvre shading structure (see table 2 On-site photo). In terms of vegetation, table 2 shows that all four spaces feature diverse plant configurations. The parking lot combines shrubs, trees, and grasses in clustered layers. The courtyard contains a variety of large trees and palms, while the rooftop garden hosts multiple plant communities.

Overall, although the four surveyed sites differ in their landscape and space patterns, the combined effect of the building structure, the louver shading devices, and the dense plants effectively reduces external air disturbances and regulates light and heat temperature, providing a relatively stable and safe surrounding environment for each green space.

Table 2. The overall spatial characteristics of the four locations

Site	Plan view	On-site photo	
(a) Car park (Including Lobby)			
			
(c) 1st floor roof garden			

Site	Plan view	On-site photo
(d) 2nd floor roof garden		

Abundance and activity of house crows

During the investigation, a total of 80 house crows were recorded. Their main behavior was resting. The crows showed a clear preference for certain tree species for resting: *Eucalyptus camaldulensis* (see [figure 3](#)) and *Syzygium grande* (see [figure 4](#)) were frequently utilized tree

species, while *Cinnamomum iners*, although widely planted, was rarely utilized by the crows. No crows were observed resting on low shrubs. Additionally, the large amount of feces accumulated under the *Eucalyptus camaldulensis* trees confirmed that this area was frequently used as a nocturnal resting place.

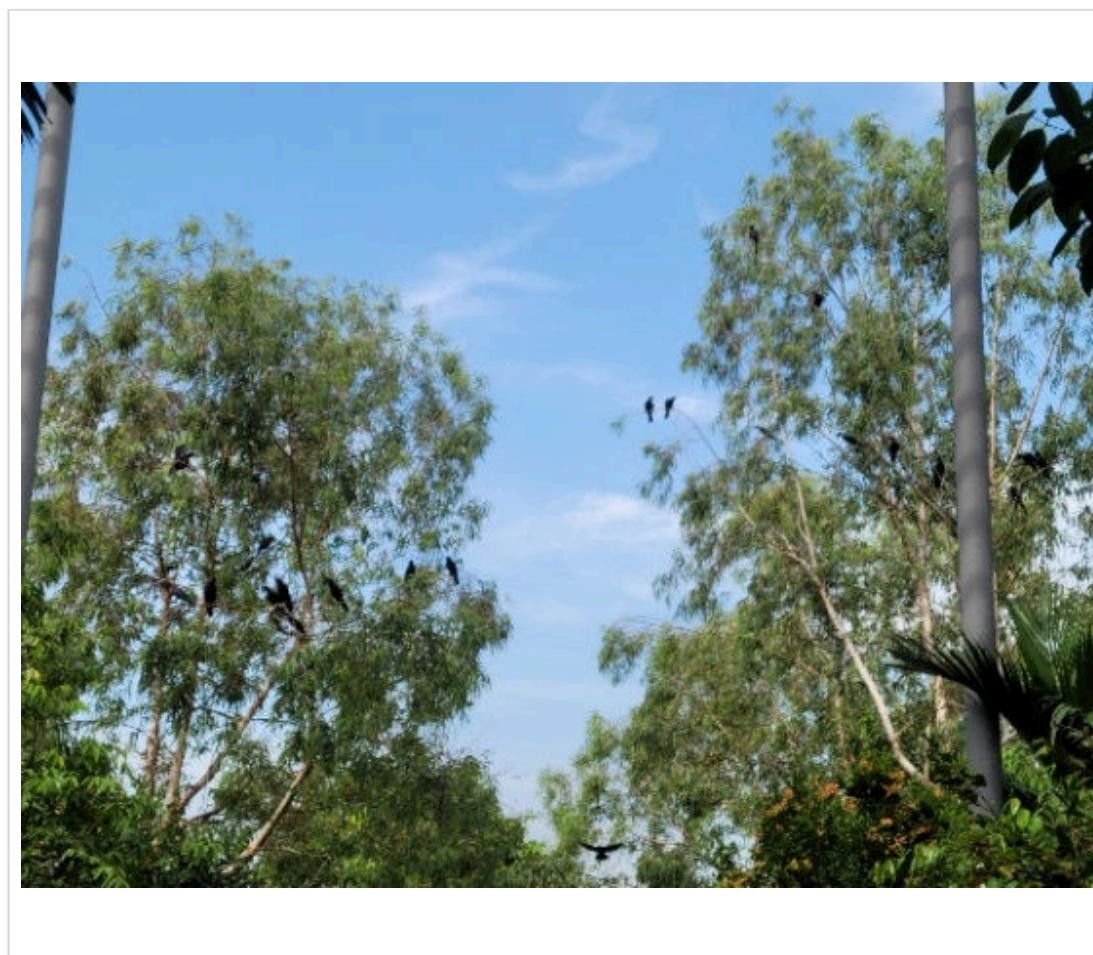


Figure 3. House Crow roosting on *Eucalyptus camaldulensis*



Figure 4. House Crow roosting on *Syzygium grande*(left)

Figure 5. House Crow roosting on the Meeting Room Rooftop(right)

From the perspective of the spatial distribution of house crows, the number of crows was the highest in the parking area, while the number of crows in the other three areas was not significantly different. In addition to vegetation, a large number of house crows also briefly rested on building structures such as the cantilevered meeting room roof (see [figure 5](#)).

Selection and avoidance of tree morphological characteristics by house crows

To further explore the potential mechanism underlying the crows' tree species preference, this study compared the morphological characteristics of high-utilization tree species (*Eucalyptus camaldulensis* and *Syzygium grande*) with those of low-utilization tree species (*Cinnamomum iners*). The results are shown in [table 3](#).

Table 3. Comparison of key morphological characteristics of *Eucalyptus camaldulensis*, *Syzygium grande*, and *Cinnamomum iners*

Characteristic	<i>Eucalyptus camaldulensis</i> (High-utilization)	<i>Syzygium grande</i> (High-utilization)	<i>Cinnamomum iners</i> (Low-utilization)
Crown morphology	Sparse, open	Dense, rounded	Dense, compact
Branch structure	Spreading horizontally, wide branching angles	Dense branching, horizontal to ascending branches	Narrow branching angles, slender and dense branches
Tree height (m)	12-15	8-12	8-10
Crown width (m)	8-10	6-8	5-7

Influence of tree species on house crows

In this study, *Syzygium grande*, *Cinnamomum iners*, and *Eucalyptus camaldulensis* were identified as the main dominant tree species. Field observations further revealed that *Eucalyptus camaldulensis* and *Syzygium grande* were the trees most often selected by house crows, highlighting their importance as key landscape elements influencing crow gatherings. On the other hand, *Cinnamomum iners*, although relatively abundant in some sites, was seldom used. The following discussion will explore the potential roles of these

three major tree species in shaping the distribution of house crows.

Our observations of this study show house crows frequently choose *eucalyptus camaldulensis* as their nesting trees in the sample area. This choice may be related to the tree morphological characteristics, branch-leaf structure, and tree ecological functions ([Kaur and Khera 2020](#)). *Eucalyptus camaldulensis* typically features tall and straight trunks, open crown structures, relatively sparse leaves, and sturdy branches ([Bhojvaid 2014](#)). In our study area, these trees reached heights of up to 15 meters, the tallest tree in the industrial park. Their tall trunk offers

crows secure and stable roosting sites while minimizing the risk of attacks from ground predators (Peh and Sodhi 2002; Saiyad, Soni, and Radadia 2017). This finding is consistent with studies in multiple regions. For example, Kaur and Khera (2020) reported that Eucalyptus and Populus accounted for 42.2% of all nesting trees. Kaur (2020) also recorded house crows in Ludhiana, Punjab preferred the exotic tree species Eucalyptus tereticornis for nesting. Yosef et al. (2019) pointed out that house crows nested successfully in Eucalyptus in the arid city of Eilat. Moreover, studies on the habitat selection during non-breeding periods also support this conclusion. Behrouzi-Rad (2010; 2013) found that non-breeding house crows and non-breeding season of Indian house crows both showed a strong roosting preference in Eucalyptus species. In summary, eucalyptus-like plants, due to their safety and suitability provided by their morphology and structure, have become a key factor influencing the habitat selection of house crows.

This study also found that Syzygium grande is one of the commonly used roosting trees for house crows. Although there is currently no direct documentation of the specific preference of house crows for this tree species, relevant indirect evidence supports this observation. For instance, in Malaysia, one study examining the influence of small urban park characteristics on bird diversity, it mentioned that fruit-bearing trees like Syzygium genus attract various bird species including the house crow (Jasmani, Ravn, and van den Bosch 2017). Additionally, according to information provided by the National Parks Board of Singapore (NParks), Syzygium grande is a large tree species that can grow up to 45 meters tall, a height that may align with house crows' preference for tall trees to perch and possibly build nests (Saiyad, Soni, and Radadia 2017). Therefore, its ecological characteristics, which combine a tall structure and fruit characteristics, may jointly constitute the key factors that attract house crows to choose it as a habitat and potential nesting site. However, regarding the specific utilization methods of house crows for Syzygium grande and its importance as a habitat and breeding in Southeast Asia, further systematic research is needed to clarify these issues.

Although Cinnamomum iners is second in abundance among all tree species and is widely distributed across the parking lot and courtyard, house crows rarely use this tree species. This

shows that the crows' roosting selection is not determined by the abundance of tree species but is more influenced by the tree's morphological structure of the trees (Dutta and Raut 2015). According to NParks (2024), Cinnamomum iners is a small, evergreen tree with a thick crown and relatively slender branches. These features may make it unfavorable for roosting or nesting by house crows. Therefore, even though this tree species is dominant in this site, it fails to serve as an effective habitat resource. As shown in table 2, the tree crown structure and branch morphology of Eucalyptus camaldulensis and Syzygium grande provide the crows with a wider field of vision and more space for perching, while the dense canopy and slender branches of Cinnamomum iners may limit its utilization.

The Influence of spatial environment on house crow

Although the four research spaces have different layouts, they all form stable and less disturbed microhabitats due to their surrounding buildings and shading blinds. This structural feature helps to mitigate external disturbances such as wind and rain, creating a safe shelter. This finding is consistent with previous research. House crows tend to choose areas surrounded by tall buildings for their roosting, which helps to create a stable nighttime environment (Tan et al. 2020). Based on this, the safety and stability provided by the study site are likely to constitute an important foundation for the behavior pattern of the house crow, which disperses for foraging during the day and returns in groups at night.

Additionally, some building components (such as the edges of the meeting room roof) are used as nesting sites by house crows. These locations not only provide a stable support surface but also allow them to keep watch over the surrounding environment, which is beneficial for maintaining alert to respond to potential threats or human disturbances.

Implications for landscape modification

Based on the findings of this study, in order to reduce the number of house crows in cities, the following systematic management strategies can be proposed from the perspectives of urban planning and landscape design.

First, Tree species selection and planting strategies. As house crows have strong preferences for Eucalyptus camaldulensis and Syzygium grande, it is recommended to avoid

large-scale and continuous planting of such highly attractive tree species in urban residential areas, commercial districts, and public spaces with high human activity (Lim and Sodhi 2009; Kaur and Khera 2020). Instead, species such as *Cinnamomum iners*, which are less attractive to crows, could be prioritized. Based on the morphological comparison in table 1, tree species with slender branches and dense tree crowns, which are unfavorable for crows to perch (Kaur 2020a), should be selected. In terms of planting methods, a mixed planting model is recommended to avoid the formation of continuous canopies by a single tree species, thereby reducing the overall attractiveness of certain areas to crows.

Second, Spatial regulation. Research showed that house crows tend to choose spaces with safe and stable microclimate conditions as their gathering areas. Therefore, in landscape and urban design, it is advisable to avoid deliberately creating spaces that provide long-term shelter. By reasonably arranging vegetation and hard surfaces, and balancing the openness of the space, the sense of security and stability of the environment can be weakened, thereby reducing its suitability as a night habitat or gathering place.

Finally, Adjust the detailed design of buildings and structures. The building elements such as the platform edges and louvers can easily be used by crows as resting places or for providing shelter. It is suggested that in architectural design and renovation, the application of wide horizontal components should be reduced, or measures such as adding anti-nesting facilities and optimizing surface materials (such as using smooth and inclined surfaces) can be adopted to reduce the usability of these components, thereby limiting their large-scale aggregation around buildings.

In conclusion, urban landscapes and planning can systematically reduce the habitat conditions conducive to the aggregation of crows by coordinating the regulation of vegetation composition, spatial form and architectural details.

Research limitations

This study has the following limitations: Firstly, the investigation period was only one day, and the data collection time was relatively short, making it difficult to comprehensively reflect the activity patterns of house crows under different seasons and weather conditions. Secondly, the morphological characteristics of the trees were

mainly estimated by visual observation and described qualitatively, lacking precise quantitative measurements, which may affect the scientificity and reproducibility of the analysis.

Future research should extend the observation period and conduct multi-season and long-term tracking surveys; at the same time, tools such as laser distance meters should be used to accurately measure indicators such as tree height, crown width, and canopy density, elevating the morphological characteristics from qualitative descriptions to quantitative data, thereby providing more scientific technical support for tree species selection and urban planning.

Conclusions

This study took the Paramit Factory in Penang as a case to systematically analyze the landscape factors influencing the congregation of house crows in urban. The research found that the congregation behavior of house crows has direct correlation with the overall number of *Eucalyptus camaldulensis* and *Syzygium grande*. At the same time, the stable and safe semi-enclosed microenvironment formed by buildings and shading systems further promotes their aggregation behavior.

Based on these findings, this study proposed targeted planning strategies: In areas where house crows tend to gather, the scale of planting tree species preferred by house crows should be reduced, and tree species that are not suitable for their habitat should be prioritized; at the same time, by enhancing spatial openness and adjusting architectural details, the safety and stability factors of the environment can be reduced. These strategies can provide a sustainable landscape regulation approach for managing the aggregation of house crows while maintaining the ecological functions of urban green spaces.

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Author(s) contribution

Junhong Yao contributed to the research concepts preparation, methodologies, investigations, data analysis, visualization, articles drafting and revisions.

Nooriati Taib contribute to the research concepts preparation and literature reviews, data analysis, of article drafts preparation and validation.

Siti Nasuha Hamzah contribute to methodology, supervision, and validation.

Mohd Zulhafiz Said contribute to methodology, supervision, and validation.