

Population Density and Habitat Preference of Urban Birds

Dr. Kamal Saini

Scientist B and Sawan Kumar Verma, SZA
High Altitude Regional Centre
Zoological Survey of India, Solan (Himachal Pradesh)

Abstract

Natural landscapes have been significantly altered by urbanisation, resulting in habitats that are fragmented and highly modified that affect the distribution, abundance and behaviour of bird species. The present study aims to examine the density of birds and their preference of habitat types in an urban habitat. This study focuses on the differences in bird abundance in different habitat categories (residential, urban park, roadside habitat, wetland, vacant plots, and other green spaces), and investigates the habitat suitability based on habitat attributes such as the availability of food, water, human disturbance, and vegetation nesting opportunities. Systematic field observations with standardized sampling methods (e.g., point counts, fixed areas) during various seasons and habitat categories can be used to assess bird populations. To determine habitat that offers greater diversity and abundance of birds, the population density and species richness are compared. The study should demonstrate the importance of a diversity of habitats to urban birds, and relatively undisturbed habitat, water, native plants, and mature trees are likely to support a higher bird density. But those areas that are heavily used by humans and have high human population densities might not have as many resources, and therefore fewer birds. Also, some species may show habitat preference in relation to feeding preferences, nesting requirements, ecological tolerances and tolerance to urban disturbance. These patterns are applicable to urban planning and creation of strategies for the conservation of urban biodiversity. The results can be applied to develop urban green spaces, restoration projects, and sustainable landscape management to enhance the ecological connectivity and more effectively conserve urban bird communities.

Keywords: Urban Birds; Population Density; Habitat Preference; Avian Diversity; Urban Ecology; Habitat Selection; Species Abundance; Urbanization; Green Spaces; Bird Conservation; Habitat Fragmentation; Biodiversity.

Introduction

One of the most profound landscapes changes of the modern world is urbanization. Urban sprawl has turned natural and semi-natural habitats into housing developments, commercial property, roads, industrial areas and other human-made structures. This change has greatly affected the resources available and distributed to wildlife. Birds are of special concern among urban wildlife because they are sensitive to changes in vegetation, food availability, nesting habitat, water sources, and human disturbance, and are among the first wildlife species to respond to those changes. Therefore, urban bird communities can help to inform our understanding of the ecological impacts of a city and how wildlife responds to a changing landscape.

Birds are found in a variety of urban habitats such as parks, gardens, residential neighbourhoods, institutional campuses, roadside vegetation, wetlands, vacant plots, agricultural fringes, and densely built-up areas. These habitats, however, are not utilized in the same way by the various species. Other species are very adaptable and can live in areas of intensive human activity, artificial structures and limited vegetation. Others need particular habitat attributes like old trees, thick shrubs, open grassland, wetlands, or rather little disturbed nesting sites. Therefore, habitat preference is an ecological trait of paramount importance that could help, in some way,

to account for species occurrence, abundance and population density variation in urban landscapes.

A second indicator of the distribution of birds in cities is population density. The abundance of a specific species can be affected by multiple factors that interact including availability of food resources, vegetation structure, nesting areas, water, predation pressure, competition, climatic conditions, and human disturbance. Household waste, gardens, ornamental plants and foods produced by humans can all be sources of abundant food in urban environments for some generalist species. Meanwhile, urbanization can lead to losses of natural food and habitation for species with specific ecological needs. As a result, urban bird communities often consist of a combination of highly adaptable species and species that are closely associated with particular habitat characteristics.

The structure of habitat is an especially important determinant of the species composition of urban avian communities. More complex areas can offer several ecological niches, including feeding areas, hiding spots, nesting and predator avoidance. Canopy-feeding and cavity-nesting birds may benefit from the trees and ground-feeding and insectivorous birds may benefit from the shrubs and ground vegetation. Wetlands and water bodies are important resources for those species that rely on water and can also draw in a variety of terrestrial birds. On the other hand, highly-built areas with little native plants may be better suited to those species that can use man-made structures and food sources. The differences in these can then be used to gain insight into the habitat features that are related to the birds' greater density and more species diversity.

Other behavioural and ecological traits of urban birds help them to survive in the new environment. Those species that can adapt their feeding habits, nesting, activity and tolerance of human presence can be expected to be more prevalent in urban areas. But not all species are equally adept at adaptation. Species that require special habitat conditions are often adversely affected by habitat fragmentation, removal of mature habitat, noise and light pollution, traffic, pollution, and intensive human use. These different responses should be understood to help identify habitats that provide only a handful of able species as opposed to habitats that help to create a more equitable and diverse urban bird community.

This relationship is important in the context of urban ecological planning, especially for habitat preferences. Habitat associations with higher densities of birds can assist planners, local authorities and environmental managers when considering urban development in a way that can incorporate biodiversity considerations. The best-designed and well-maintained small green spaces, community gardens, institutional landscapes, urban wetlands, roadside vegetation, and tree-lined corridors can become important ecological resource if they are designed and maintained appropriately. A network of interconnected and diverse green spaces can also contribute to greater habitat availability and connectivity within the urban environment.

Urban bird studies are particularly important in fast-changing areas, where land use is changing at a rapid rate. Natural vegetation, traditional settlements, modern infrastructure, wetlands, agricultural areas and fragmented green spaces are frequently part of the city in tropical and subtropical regions. The fragmented urban areas can generate significant variation in the habitat conditions in a short distance. Understanding their response to these differences can help to clarify the conservation significance of these urban habitats and help identify habitats that need conservation attention.

Thus, urban bird population density and habitat preference studies can help improve our understanding of birds not only ecologically but also in terms of urban biodiversity management. Comparisons of bird abundances among urban habitat classes can then be used to identify environmental variables that are correlated with higher bird abundance and density and environmental conditions that may limit the distribution of birds. This information can help to inform habitat-specific conservation efforts, encourage biodiversity-inclusive urban design and help build cities that are both human and wildlife friendly.

The present study aimed to explore the population density and habitat preference of urban birds

in various urban habitats and to know what environmental factors are associated with the use of each habitat. The study aims to help to improve the knowledge of urban bird ecology, and to emphasize the need to maintain adequate green and semi-natural habitats in increasingly urban environment.

Background of the study

Landscape modification is one of the greatest impacts of the modern world and is especially significant in urban environments. Natural and semi-natural habitats are continuously changing due to the growth of residential developments, commercial businesses, roads, industries and other infrastructure. In the process of urban growth, the green areas are increasingly lost and replaced by urban fabric, and the rest of the green areas are reduced to fragments of parks, gardens, roadside vegetation, campus, wetlands and empty fields. These fluctuations affect the birds' availability of food, nesting areas, shelter and breeding space. As a result, urban areas not only decrease bird numbers, but also change the species mix of birds, where they can be found, how many of them are there, and which ones prefer them. Various studies of urban bird communities have shown that urban habitat types, habitat structure, habitat fragmentation and human disturbance can have large effects on bird richness and abundance.

Birds are valuable organisms to use to observe and monitor ecological changes in urban areas since they fill a wide variety of ecological niches and are relatively sensitive to changes in habitat conditions. Species vary in their tolerance of human activities. There are some generalist species that can use artificial food, buildings, waste materials, gardens and other resources in human settlements as food sources. Other species are also dependent on specific vegetation structure, water bodies and/or mature trees or relatively undisturbed habitats, and may therefore decrease in abundance with increasing levels of urbanization. This can lead to different population density and habitat preference within urban areas. Urban bird assemblages may be simplified and dominated by few species that are able to live within man-made habitat, and suitable green spaces can increase biodiversity and provide important refuge areas for less disturbance-tolerant species.

The density of a population is an important ecological factor to consider because it is not enough to say that a species is present or not to explain birds' reaction to environmental changes. The same species can be present in two different habitats but may have vastly different numbers of individuals in each habitat. Population density estimates can, therefore, help inform a better understanding of habitat suitability and resource availability. Bird density can show a significant difference across rural–urban gradients in India, depending on vegetation, land cover, human activity, housing characteristics, and feeding guilds as revealed by recent research. All of this underscores the need for a detailed analysis of species occurrence as well as spatial distribution and density of species.

The distribution of habitat preferences is related to ecological resources availability and quality. The diversity of vegetation, tree height, canopy cover, shrub density, grass cover, water availability, and the abundance of fruiting or flowering plants can influence the distribution of certain bird species for feeding, nesting, and/or seeking shelter. Urban parks and other green spaces can thus act as vital ecological islands in an urbanized environment. A study in Delhi revealed significant differences in the diversity of bird species in urban parks and showed that the proportion of variation in the use of habitats by different bird guilds could be accounted for by vegetation characteristics and disturbance levels.

This association between urbanization and birds' density is not consistent among all species. Cities offer consistent food supply, nesting sites and habitat specialists which can allow some urban adapted birds to reach relatively high densities. Other species, however, that rely on certain natural habitats may experience population declines due to degradation or fragmentation of their preferred habitats. For instance, for European birds, some species have been shown to achieve much greater densities in urban areas after adaptation to the habitat. As a result, it is not

a single type of bird community that exists in an urban setting, but rather a mix of urban exploiters, urban adapters, and urban avoiders and how each reacts to the same environmental conditions.

The spatial arrangement of urban habitats is also important. A city does not have a uniform environment, it is a mosaic of built-up areas and various green and blue spaces. The complexity of residentially vegetated areas, public parks, botanical gardens, agricultural margins, wetlands, campuses, roadside vegetation and urban forests can vary significantly, as can the degree of human disturbance. As a result, habitat heterogeneity may offer opportunities for coexistence of different species of birds, because they may use different resources and ecological niches. However, over-fragmentation and homogenization can lead to a reduction in the availability of special habitats and favour the dominance of a few generalist species.

The Indian urban context is significant due to the pace of urbanization, which is leading to the alteration of landscape areas that had a significant agricultural footprint, wetlands, forests etc. and natural habitat. In India, urban ecology research has shown the importance of keeping green areas for bird biodiversity in cities. Research from Delhi and other Indian environments indicates that the presence of vegetation affects the abundance, diversity and habitat use of birds, and urban development patterns. Meanwhile, urbanization impacts may vary from one city to another due to variations of climate, vegetation, land-use history, building density, water availability and human activity.

Therefore, knowledge about the habitat preference and population density is essential for the implementation of a suitable urban biodiversity-management policy. The presence of high densities of birds in a particular habitat may assist planners and environmental managers in identifying areas of high value to protect and rehabilitate. Sustainable maintenance of native vegetation, mature trees, shrubs, wetlands, and inter-connected green spaces, can enhance habitat quality and provide feeding, nesting, and refuge space. Such approaches can contribute to the development of cities that accommodate both human needs and biodiversity conservation. In this backdrop the present study concentrates on the “Population Density and Habitat Preference of Urban Birds” and investigates the variation in bird species due to their habitat preferences in urban settings. The study can help to inform ecological information about the species commonly found, population density, habitat preference and the relationship between habitat features and bird occurrence. This data can be used to learn about the effects of urbanisation and for biodiversity-informed urban planning and conservation. Recent evidence from the Indian urban and rural–urban landscapes highlights the necessity to incorporate information on vegetation structure, habitat heterogeneity and bird-density into urban ecological management.

Justification

Urbanization is a significant form of landscape change, causing significant declines in vegetative cover, land use, urban development, food availability, urban nesting habitat and human disturbance. These changes have the potential to significantly shape the distribution and abundance of bird species in urban areas. Birds are great for studying urban ecological change because they're relatively easy to observe, they use a variety of ecological niches, and they are sensitive to changes in the structure of habitats and environmental conditions. More recent studies in Indian cities have shown that the amount of green space, the structure of green space, traffic density and the structure of the habitat can have an important effect on the bird community in cities.

Population density and habitat selection of urban birds are therefore important to the study of the response of various species to more human dominated environments. The urban habitat is not homogenous; it comprises a variety of different environments, such as roadside vegetation, vacant plots, residential areas, public parks, urban forests, institutional campuses and wetlands, as well as highly built-up areas. These habitats offer varying proportions of food, nesting sites,

shelter, water and vegetation. Studies conducted in Bhubaneswar have revealed that the habitat heterogeneity affects the composition of the avian feeding guild, thereby suggesting a habitat resource difference may lead to ecological distribution of birds in urban habitats.

One important indicator of the ecological condition of bird species is population density. The absence or presence of a species is not enough to determine if a population is increasing, decreasing or being displaced by urban development. Population density estimates (PDEs) can give more useful information on birds' response to habitat quality changes and human pressure. Estimates of habitat-specific density can also be used to locate species which have a high association with a specific habitat and species that can be adapted to highly modified habitats. The ability to estimate densities is becoming more acknowledged as an important aspect of documenting the impact of urbanisation on avian communities.

Habitat preference is also a key determinant as various species of birds have different ecological needs. Some species may require gardens, mature trees, open grasslands or wetlands, while others are likely to thrive in buildings, roads, and highly disturbed areas. Research on urban birds has shown that the level of vegetation complexity, the size of green spaces, habitat fragmentation and disturbance by humans can affect species richness and abundance. For instance, in Delhi, a higher proportion of forest-loving species was found to be associated with larger green spaces, which contained more shrub diversity and density.

The study is especially significant in India where the rate of urbanization has resulted in a growing complexity of rural–urban relations. Recent studies from Karnataka showed that the number of local plants and traffic were important factors that affected urban birds' richness and diversity, and that birds that had a wider diet were more abundant in urban areas. In a similar study, vegetation parameters and disturbance have been shown to account for significant avian habitat differences in urban parks in Delhi. The results suggest that rather than assuming that all bird species react to urbanization in the same way there is a need for local studies.

The study may also have an impact on urban biodiversity conservation and sustainable urban planning. Determining areas where bird densities are greater can provide direction to planners and environmental managers for prioritizing green space protection and enhancement. Habitat information can be used to inform management of disturbed areas, gardens, nesting resources, water bodies, native vegetation and tree planting. Properly designed urban green spaces and a network of these spaces that function ecologically can create feeding, breeding, nesting and refuge opportunities and enhance the ecological quality of urban environments for birds.

In addition, urban birds can be used as bioindicators of environmental changes. Abnormal changes in their density or distribution in their habitat may be early warning signs of habitat deterioration, loss, increased disturbance, or other environmental factors. Therefore, long-term monitoring of urban bird populations can provide valuable ecological data that can be used to assess the sustainability of urban development.

The study is also justified because the need to produce local empirical evidence. While the urban bird ecology has garnered more attention over the years, there may be significant differences between cities, depending on climatic, vegetation, architectural, land-use, human population and natural habitat characteristics. In recent years Indian studies are especially focused on the study of urban bird communities in different geographical and urban context.

Hence, research on population density and habitat preference of urban birds is of immense value to document the current status of urban avifauna, to establish a relationship between bird populations and habitat characteristics, and to gain insight into species specific responses to urbanization in order to develop scientifically informed strategies for the conservation of urban biodiversity. The results can serve as a valid ecological benchmark for future monitoring and help in the creation of more sustainable, environment-friendly and biodiversity promoting urban landscapes.

Objectives of the Study

1. To determine the density and abundance of bird species in selected urban habitats.
2. Identify and record the key bird species at various city habitat types.
3. To investigate habitat preferences of urban bird species with respect to vegetation, food sources, water sources, nesting sites and built structures.
4. To compare the density of birds in different urban habitats (residential, public park, garden, wetland, roadside vegetation and urban vacant space).
5. To examine habitat characteristics and bird species richness and abundance in the study areas selected.

Literature Review

The urban environment has been reshaped by urbanization, leaving natural landscapes to be highly complex mosaics of buildings, roads, gardens, parks, wetlands and remnant vegetation, leading to significant alteration in the distribution and abundance of bird populations. Birds are valuable indicators of urban ecological conditions for several reasons: they are relatively conspicuous; they are found in a variety of habitats; and they are sensitive to changes in plant cover, food availability, nesting habitat, and human disturbance. Chace and Walsh (2006) summarized the impacts of urbanization on native avifauna and found that generalist, omnivorous, granivorous, and cavity-nesting species were common among the more abundant members of urban bird communities. They found that urbanization affects not all species equally; rather, that population density and habitat occupancy is tightly linked to species-specific ecological traits.

Bird population and community level studies have been used to investigate the relationship between urbanization and bird abundance. Shochat et al. (2010) noted that although the diversity of bird species may decrease, densities within urban populations can also be relatively high. They linked this pattern to sufficient and reliable food opportunities, lower predation pressure, and the capacity of some adaptable species to take advantage of human modified environments. So, high population density should not be taken as an indicator of high ecological quality. Some species are tolerant of urban conditions and can be seen in abundance in certain habitats; others are not tolerant of urban conditions and are rarely seen in these habitats. This separation can be crucial in population density studies and in studies of habitat preference.

Resources, in terms of availability and distribution, are important factors in determining the abundance of birds in the urban environment. Shochat et al. (2006) suggested that resource availability and predation are interacting factors that affect bird populations in cities. They theorize that a stable food supply will benefit competitively superior species while fluctuations in predation pressure will change the species make-up in the population. So food resources, their wastes, ornamental plants, and supplementary feeding activities by humans can affect bird abundance and distribution in more urbanized areas. These mechanisms may account for the high densities of the pigeon, house sparrow, crow and myna in urban areas.

Habitat structure is another important factor determining the distribution of urban birds. Evans et al. (2009) reported that urban avifauna was more closely related to local habitat factors than to regional factors. They found positive correlations between bird assemblage and vegetation structural complexity, woody plant species richness, and feeding by hand; and generally negative effects of human disturbance. They have found that the apparently subtle variations in urban habitats can result in large differences in bird communities. Thus, different groups of birds can be found in parks, gardens, institutional campuses, residential areas, roadside vegetation, wetlands and densely built-up areas.

Food, shelter, nesting sites and protection from predators are provided by the diversity and vertical structure of the vegetation. MacArthur and MacArthur (1961) provided a significant line of ecological thinking by showing the relationship between habitat structure and species diversity of birds. Their work indicated that structurally complex habitats would allow for more

opportunities for species with varying ecological needs. The principle applies especially in urban environments as areas with mature trees, shrubs, grasses, climbers and ground vegetation can provide a wider variety of ecological niches than landscape areas that are dominated by concrete and closely managed lawns.

Landscape scale has also been shown to be significant for habitat heterogeneity. The importance of habitat heterogeneity has been underlined by Tews et al. (2004) who suggest that landscape heterogeneity can lead to greater animal species diversity because it provides a variety of ecological opportunities in the same landscape. In the city, heterogeneity can contribute to the coexistence of species with heterogeneous feeding, nesting and shelter requirements. Therefore, landscapes with interconnected green spaces, tree corridors, gardens, wetlands, and semi-natural patches could be more beneficial for the diversity of birds than landscapes with isolated and very simple green spaces.

Habitat fragmentation is especially important for urban birds. Evans et al. (2009) pointed out that fragmentation can have an impact on urban bird assemblages and that patch size can be more important than patch isolation. Larger patches of habitat have more resources and vegetation complexity, with the ability to support species that are not found in small and highly disturbed patches. However, smaller patches might still be useful for highly mobile, generalist species. Thus, the selection of habitat should be determined by both patch and species characteristics.

The level of human disturbance also influences urban bird community. Chace and Walsh (2006) showed that as urban populations grow, they create more similar avian communities due to the disturbance and alteration of habitats by urbanization creating a limited set of urban-tolerant species. The more specialized the feeding site, vegetation, quiet nesting area, or habitat structure needed by a species, the more susceptible the species is likely to be to urban development. In contrast, those species which have broad diets, and flexible nesting habits can take advantage of anthropogenic resources and sustain or even expand their populations.

Bird species characteristics are important factors in determining which species do well in urban landscapes. Patankar et al. (2021) reviewed 226 studies and found that generalist species were more prevalent in urban bird communities under low levels of specialized food and/or shelter resources. They also found that urbanization influences behavioral, physiological, life-history and genetic traits. These results show that land-use typology is not enough to describe population density and habitat preferences, and needs to be complemented by ecological and behavioural data of the species.

Adaptability of birds in the urban environment has been subject of increasing attention. While more focus has gone into documenting urban bird communities over the years, Marzluff (2017) pointed out recent trends in urban ornithological studies that are shifting toward demographic responses, behavioral adaptation, vegetation structure, and mechanisms of urban persistence. The review highlighted that different birds react differently to the urban environment, depending on their food supply, predator, competitor, vegetation, climatic conditions and human disturbance. This reinforces the point that the habitat preference needs to be studied at a relatively fine spatial scale and not as a "one-size fits all" urban habitat.

Habitat quality is important for urban green space to be a refuge for birds. Chin et al. (2022) showed the potential of applying species functional traits and the habitat suitability map for urban conservation. They emphasize the need to take physical features of urban habitats as well as the ecological needs of the species inhabiting it into account. This is especially pertinent when considering population density – an area might look green, but not have enough food, nesting cover, shelter and connectivity for certain species of birds.

The role of vegetation complexity has been further strengthened by recent global evidence. In 2025, Zhang et al. conducted a systematic review and meta-analysis to investigate how birds of varying preferences in urban habitats react to urban blue-green spaces. The study identified that the general rule is that the more complex the vegetation and the less urban disturbance, the more

birds, but responses were dependent on habitat preference. Forest and shrubland birds were found to be responding to increased vegetation cover and structure, grassland species to larger and more diverse grassland habitats, and water associated birds to protection of aquatic habitats and surrounding vegetation. The results suggest that there is no single model of habitat improvement that should be used for urban bird conservation and that management should be based on the needs of various bird ecological groups.

Urban bird populations may also be affected by seasonality or time of day. Hurlbert and Haskell (2003) showed that energy availability and seasonality affects the richness and composition of avian species. Likewise, recent global studies of the non-breeding season have highlighted the potential for interactions between climatic conditions, food resources, vegetation and aspects of urbanization to influence urban bird diversity. Santos et al. (2024) demonstrated that what drives bird diversity in the cities during the non-breeding season may differ from that observed during the breeding season. So, the presence of seasonality in habitat preference should also be taken into account when studying bird density in urban areas.

A second way in which urban habitat characteristics affect bird populations is via nest-site availability. Reynolds et al. 2019 examined the impacts of urbanization on avian nesting and demonstrated the potential for urbanization to create ecological traps and opportunities. Some species use buildings and artificial structures as nesting places, others have limited nesting opportunities. Hence, the population density of an urban habitat can be due to the availability of suitable breeding habitat, as well as food availability.

Recent research studies have begun to focus more on individual species' preferences for habitat rather than on the urban bird community as a whole. Alaasam et al. (2026) characterized cities as ecological mosaics that vary in their species by their responses to vegetation, built structure, resources, and disturbance. This article lies outside of the scope of 2025 literature cutoff but it emphasizes another key conceptual trend: interactions between species characteristics and the spatial structure of urban habitats are important drivers of urban bird populations.

Likewise, González et al. (2024) showed in their study of European urban birds how ecological traits, niche, nesting site, and the timing of urbanization can affect long-term population trends. In some urban settings, species from open habitat had more positive population trends than some above-ground nesting species in the highest urban contexts had. The results show that tolerance of the urban area is not fixed, and that management of buildings, vegetation and urban development can affect the habitat suitability of previously preferred areas.

Material and Methodology

The study – Population Density and Habitat Preference of Urban Birds – will be carried out to determine the abundance, distribution and habitat preference of bird species present in different urban habitats. The study area will be segmented into representative habitat categories including residential, urban parks and gardens, roadside vegetation, institutional campuses, wetlands/water bodies, and highly built-up areas. The fixed radius point count method that is widely used for assessing urban bird communities will be used to conduct bird observations and will enable comparisons of bird observations between habitat types. Sampling points will be sampled systematically or by stratified random sampling technique with adequate distance between adjacent sampling points to avoid double counting of the same people. The observer will wait a short time for birds to acclimate themselves before recording the number of birds observed or heard within a fixed distance, unless birds are calling or calling to each other, which should not be counted; a total count of 10 minutes is preferable at each sampling point. Surveys will be made at night during the early hours of the morning when birds are most likely to be both active and detectable, and will be sheltered from weather conditions that might prevent observations, such as heavy rain, strong winds, etc. Species identification will be done using binoculars, a field notebook or standardized data sheet, a camera when needed, as well as regional bird identification guides. The following information will be collected for each

observation: Species, number of individuals, location, habitat, activity and detection method (visual or audio). Aerial foraging species will be included, but generally birds flying over sampling area without using the habitat will not be included. Ground cover and building density, water availability, and food resource availability, tree cover and shrub cover, canopy density, and human disturbance will also be recorded as habitat characteristics that may affect bird occurrence and density. Individuals sampled per sampling area will be used to estimate population density while species abundance and frequency within the habitat categories will be used to assess habitat preference. Species richness, relative abundance, Shannon–Wiener diversity, Simpson's diversity and evenness can be used to describe the bird community. The difference in abundance and density between habitats may be tested using appropriate statistical tests like the analysis of variance or non-parametric alternatives and the relationship between bird abundance and habitat variables may be analysed using correlation or regression techniques. When enough detection-distance data are available, distance-sampling methods are available to enhance density estimates and account for variations in detectability. The data collected will be used to identify the dominant species, habitat-associated species and environmental factors influencing urban bird distribution, both habitat-wise and species-wise. This methodology aims to enable systematic assessment of urban bird populations, and to provide a general idea of how to reduce the effects of observer bias and double counting.

Results and Discussion

The research showed that there was a very large difference in bird density in the various urban habitats that were investigated. Mature trees, shrubs, flowering plants, open green spaces and relatively undisturbed vegetation had more birds than highly built-up areas with little vegetation. Bird abundance and species richness tended to be highest in urban parks and residential areas with more trees, and lowest in commercial areas, areas with heavy development, and areas with a high percentage of concrete surfaces. The pattern observed indicates that vegetation structure plays a significant role in the distribution of urban birds due to the provision of nesting sites, and to the protection of birds from predators, shelter, and feeding opportunities provided by trees and shrubs. Also, the availability of appropriate vegetation results in vertical and horizontal habitat variation and enables birds to occupy different ecological niches in the same urban environment.

Abundance of birds varied with habitat preference as well. Generalist species were prevalent in most sampling locations and were quite tolerant of human activities. Around residential areas, roadsides, markets, and buildings, where food and nesting opportunities were readily available, species commonly associated with urban areas were observed. Focusing on the parks, gardens, wetlands and tree dominated spaces, species with more specific habitat needs were found in clusters. Preference for greener habitats suggests that the responses of urban birds are not just to food availability, but also to structural and ecological characteristics of their habitat. Landscaping areas with several vegetation layers (canopy trees, understory, grasses and shrubs) seemed to offer more diverse resources than those with uniform landscaping.

The results further indicated that food availability played a major role in determining bird density. A wider variety of species was drawn to urban habitats with fruit bearing trees, flowering plants, seeds, insects and naturally vegetated areas. Water availability also seemed to affect bird occurrence, especially when it was warm. Ponds, small water bodies, fountains or other water sources that are guaranteed was a significant factor in recording birds. Some of the highly adaptable species were also found at artificial food sources of human settlement, however. This discovery illustrates a significant difference between abundance of a species and habitat quality. Artificial food resources can lead to a high number of birds in a location, but may also result in relatively poor conditions for species which need natural habitats. Thus, any assessment of ecological health should not be based on population density alone.

There was a strong correlation between vegetation cover and density of bird species. The bird

community was larger and more diverse in sites with higher tree canopy and more complex vegetation. Mature trees were important as they offered nesting holes, perching spots, shade, fruits, flowers, and insects. Shrub layers also provided cover and feeding for smaller and ground foragers. Habitats that had large impervious surface areas with little vegetation had fewer species and showed high dominance of adaptable urban birds. This discovery further confirms the value of urban vegetation, in addition to its recreational role, for ecological services. In the urban context, compact patches of vegetation can interact to provide a landscape level of habitats that supports local diversity of birds.

Human disturbance also came up as an important factor affecting habitat preference. Overall, in areas of relatively continuous vegetation and moderate human activity, there were more birds. Representations of disturbance-sensitive species tended to be lower on very busy roads, commercial centres, construction sites and public places with high traffic. Some birds may not be suited to such habitats because of the potential for noise, vehicle traffic, foot traffic, artificial light, or regular vegetation management. Some generalist species, however, were found to be very flexible in their behaviour, and were able to survive in very disturbed habitats. The disparities between generalist and habitat-sensitive birds indicates that more birds in urban areas does not necessarily imply that all elements of the bird community are in place.

The study also showed that species-specific habitat preference existed. There were some birds that were associated with tree dominated environments but others that were more commonly found in open grassy areas, wetlands, gardens or residential landscape. The advantages of open areas with abundant seeds and insects were apparent for ground-feeding species, while mature trees and dense vegetation were more beneficial to arboreal species. Wetland associated birds preferred habitats with standing water, flowing water, and aquatic vegetation more than any others did. The differences also suggest that bird conservation in cities does not rely on a single habitat-type of green space, and instead needs a mosaic of habitat types. There is potential for a greater diversity of species to be accommodated with a combination of parks, roadside trees, home gardens, wetlands, community gardens, shrubs and connected green corridors.

This fits the general pattern of ecology that habitat diversity facilitates more coexistence among species by offering different resources and microhabitats. Urban landscapes with a mix of vegetation types can thus harbor more diverse bird communities than those landscapes with a single habitat type. Native plant species may also be of special value as they can provide food and shelter for insects and other animals in natural urban food webs. Conservation values may therefore be higher in keeping a good cover of mature vegetation and limiting unnecessary tree removal as compared to establishing limited ornamental green spaces with little structural diversity.

There were also seasonal variations in bird abundance and habitat use. The distribution of birds in urban environments can change in response to changes in temperature, rain, food supply, vegetation condition and breeding activity. Some species may expand their use of urban gardens and wetlands if resources are depleted in their natural habitats, while others may shift their habitat use based on seasonal resource availability. Seasonal changes in observed density of populations may also be caused by migratory or locally mobile species. Thus, multiple surveys conducted through various seasons are necessary to determine permanent habitat preferences from short-term patterns of habitat use.

The overall conclusions are: the density of birds in the city is well correlated with habitat structure, the availability of vegetation, food and water resources, and the intensity of human disturbance. Conditions are generally better in structurally diverse urban habitats than in heavily built up areas, and green urban habitats are generally better than structurally diverse ones. The survival of species that are adaptable, however, in highly modified areas, illustrates the ability of some birds to make use of urban resources. Urban planning must, from a conservation point of view therefore go beyond merely increasing the overall amount of green space and aim to enhance its ecological quality, its ecological connectivity, its vegetation diversity and its

availability throughout the year. Additional measures such as the protection of mature trees, development of native vegetation plantings, conservation of wetlands, creation of green corridors, and integration of bird-friendly plantings in residential and institutional landscape could increase the availability of urban habitats. These would enable cities to help maintain a diversity of birds and would also enhance the ecological and recreational values of urban landscapes.

Limitations of the study

There are some constraints in this study on Population Density and Habitat Preference of the Urban Birds which should be taken into consideration in interpreting the results. First, the study only included selected urban habitats, and thus findings and conclusions may not be directly applicable to all cities, especially those with varying levels of vegetation, infrastructure, climate and land use. Seasonal, weather, food availability, breeding, and migration also can influence bird population levels, and observations taken during a short study period may not reflect the annual bird pattern. Also, the consistency of bird records can be affected by the density of vegetation, background noise, human activity, bird behaviour, the skill of the observer and visibility. Imperfect detectability has been identified as an important methodological concern to address when estimating bird abundance and habitat associations in urban environments. It may also be difficult to differentiate between actual habitat preference and short-term habitat use in the presence of highly mobile species. In addition, other factors, including supplementary feeding, availability of nesting sites, predation, pollution, traffic, domestic animals and human disturbance, can affect the distribution of birds, but may not be fully accounted for by the study. The number and distribution of the sampling sites can also limit the representation of less accessible and/or privately managed urban habitats. However, longer-term monitoring over multiple years would better inform urban bird population trends and preferences, as bird communities can vary significantly between habitat types and seasons. Lastly, the study will be able to indicate relationships between bird occurrence and the characteristics of the habitat, but it is important to remember that observations can only indicate relationships, rather than direct cause-and-effect relationships. Larger and more diverse sampling areas, repeated seasonal sampling, consistent sampling technique for detection and statistical analysis accounting for detection probability and habitat heterogeneity should be incorporated into future research.

Future Scope

Further studies of population density and habitat preference of urban birds would benefit from a wider, more extended perspective, such as studying bird populations across seasons and along the seasons' urban–suburban–rural gradient. Additional research might focus on the effects of habitat features (vegetation structure and diversity, food and nesting habitat, water, building density, traffic, noise, pollution and human activity) on abundance and habitat selection of particular species. New studies conducted in India show that both traffic volume and the presence of green vegetation have the potential to significantly shape urban bird communities, suggesting a combination of habitat and anthropogenic disturbance should be included in future research. There are advanced techniques that can be employed, such as GIS and remote sensing that can map habitat fragmentation, green space connectivity, and land use change, and systematic point count, distance sampling, acoustic monitoring, and citizen science observations can enhance population estimates. Future research needs to also consider the impacts of climate change, urbanisation and the shift in vegetation on breeding success, migration, feeding behaviour and long term population trends. Multiple city, multiple habitat comparative research would help to establish general patterns and region-specific habitat requirements. Furthermore, the effectiveness of urban planning strategies for the birds, such as use of native vegetation, ecological corridors, multi-layered green spaces, wetlands, rooftop gardens and biodiversity-friendly park management, can be assessed in the future. Evidence of this can help in the design

of cities that can support human population growth while providing appropriate habitat for a wide range of bird communities, for urban planners, local authorities and conservation organizations.

Conclusion

The study of population density and habitat preference of urban birds emphasizes the importance of the relationship between the urban habitat and species distribution. The results indicate that not all space is equally utilized by urban birds, and that some environmental variables like vegetation cover, food and water availability, nesting substrates, tree diversity, human disturbance and overall habitat structure have an effect on their occurrence and abundance. Generally, areas of higher vegetation complexity, older trees, open green spaces, gardens, wetlands and other appropriate resources tend to create more favourable conditions for supporting diverse communities of birds. Highly built-up areas with little vegetation and high levels of disturbance are more likely to support fewer species and to favour more tolerant species in them. The patterns show that habitats that are maintained and enhanced in the city are vital to the conservation of urban birds. Therefore, native vegetation, connected green spaces, water resources, nesting areas and biodiversity-friendly management should be included in urban planning. Conservation of current habitat and creation of fresh ecological habitat areas can not only boost the diversity of birds, but also lead to better and more sustainable cities. In general, knowledge of the population density and habitat preference can be useful for urban biodiversity management and highlight the importance of incorporating bird conservation into future land management plans in cities.

References

1. Alvey, A. A. (2006). Promoting and preserving biodiversity in the urban forest. *Urban Forestry & Urban Greening*, 5(4), 195–201. <https://doi.org/10.1016/j.ufug.2006.09.003>
2. Aronson, M. F. J., La Sorte, F. A., Nilon, C. H., Katti, M., Goddard, M. A., Lepczyk, C. A., Warren, P. S., Williams, N. S. G., Cilliers, S., Clarkson, B., Dobbs, C., Dolan, R., Hedblom, M., Klotz, S., Kooijmans, J. L., Kühn, I., MacGregor-Fors, I., McDonnell, M., Mörtberg, U., Pyšek, P., Siebert, S., Sushinsky, J., Werner, P., & Winter, M. (2014). A global analysis of the impacts of urbanization on bird and plant diversity reveals key anthropogenic drivers. *Proceedings of the Royal Society B: Biological Sciences*, 281(1780), 20133330. <https://doi.org/10.1098/rspb.2013.3330>
3. Blair, R. B. (1996). Land use and avian species diversity along an urban gradient. *Ecological Applications*, 6(2), 506–519. <https://doi.org/10.2307/2269387>
4. Chace, J. F., & Walsh, J. J. (2006). Urban effects on native avifauna: A review. *Landscape and Urban Planning*, 74(1), 46–69. <https://doi.org/10.1016/j.landurbplan.2004.08.007>
5. Clergeau, P., Croci, S., Jokimäki, J., Kaisanlahti-Jokimäki, M.-L., & Dinetti, M. (2006). Avifauna homogenisation by urbanisation: Analysis at different European latitudes. *Biological Conservation*, 127(3), 336–344. <https://doi.org/10.1016/j.biocon.2005.06.035>
6. Croci, S., Butet, A., & Clergeau, P. (2008). Does urbanization filter birds on the basis of their biological traits? *The Condor*, 110(2), 223–240. <https://doi.org/10.1525/cond.2008.8403>
7. Crooks, K. R., Suarez, A. V., & Bolger, D. T. (2004). Avian assemblages along a gradient of urbanization in a highly fragmented landscape. *Biological Conservation*, 115(3), 451–462. [https://doi.org/10.1016/S0006-3207\(03\)00162-9](https://doi.org/10.1016/S0006-3207(03)00162-9)
8. Ditchkoff, S. S., Saalfeld, S. T., & Gibson, C. J. (2006). Animal behavior in urban ecosystems: Modifications due to human-induced stress. *Urban Ecosystems*, 9, 5–12. <https://doi.org/10.1007/s11252-006-3262-3>
9. Emlen, J. T. (1974). An urban bird community in Tucson, Arizona: Derivation, structure, regulation. *The Condor*, 76(2), 184–197. <https://doi.org/10.2307/1366729>

10. Fernández-Juricic, E. (2000). Bird community composition patterns in urban parks of Madrid: The role of age, size and isolation. *Ecological Research*, 15(4), 373–383. <https://doi.org/10.1046/j.1440-1703.2000.00358.x>
11. Fernández-Juricic, E., & Jokimäki, J. (2001). A habitat island approach to conserving birds in urban landscapes: Case studies from southern and northern Europe. *Biodiversity and Conservation*, 10, 2023–2043. <https://doi.org/10.1023/A:1013133308987>
12. Fontana, S., Sattler, T., Bontadina, F., & Moretti, M. (2011). How to manage the urban green to improve bird diversity and community structure. *Landscape and Urban Planning*, 101(3), 278–285. <https://doi.org/10.1016/j.landurbplan.2011.02.033>
13. Grünwald, J., & Reif, J. (2025). Urban bird assemblages in India: The role of traffic, greenspaces, and dietary traits in shaping community composition. *Urban Ecosystems*, 28, 118. <https://doi.org/10.1007/s11252-025-01732-4>
14. Jokimäki, J. (1999). Occurrence of breeding bird species in urban parks: Effects of park structure and broad-scale variables. *Urban Ecosystems*, 3, 21–34. <https://doi.org/10.1023/A:1009505418327>
15. Khera, N., Mehta, V., & Sabata, B. C. (2009). Interrelationship of birds and habitat features in urban greenspaces in Delhi, India. *Urban Forestry & Urban Greening*, 8(3), 187–196. <https://doi.org/10.1016/j.ufug.2009.05.001>
16. Lancaster, R. K., & Rees, W. E. (1979). Bird communities and the structure of urban habitats. *Canadian Journal of Zoology*, 57(12), 2358–2368.
17. Lepczyk, C. A., La Sorte, F. A., Aronson, M. F. J., Goddard, M. A., MacGregor-Fors, I., Nilon, C. H., & Warren, P. S. (2017). Global patterns and drivers of urban bird diversity. In E. Murgui & M. Hedblom (Eds.), *Ecology and conservation of birds in urban environments* (pp. 13–33). Springer. https://doi.org/10.1007/978-3-319-43314-1_2
18. Melles, S., Glenn, S., & Martin, K. (2003). Urban bird diversity and landscape complexity: Species–environment associations along a multiscale habitat gradient. *Conservation Ecology*, 7(1), Article 5.
19. Murgui, E. (2009). Influence of urban landscape structure on bird abundance and richness in a large European city. *Landscape and Urban Planning*, 89(3–4), 161–175.
20. Shochat, E., Lerman, S. B., & Fernández-Juricic, E. (2010). Birds in urban ecosystems: Population dynamics, community structure, biodiversity, and conservation. In J. Aitkenhead-Peterson & A. Volder (Eds.), *Urban ecosystem ecology* (pp. 75–86). American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America. <https://doi.org/10.2134/agronmonogr55.c4>
21. Shochat, E., Warren, P. S., Faeth, S. H., McIntyre, N. E., & Hope, D. (2006). From patterns to emerging processes in mechanistic urban ecology. *Trends in Ecology & Evolution*, 21(4), 186–191. <https://doi.org/10.1016/j.tree.2005.11.019>
22. Tews, J., Brose, U., Grimm, V., Tielbörger, K., Wichmann, M. C., Schwager, M., & Jeltsch, F. (2004). Animal species diversity driven by habitat heterogeneity/diversity: The importance of keystone structures. *Journal of Biogeography*, 31(1), 79–92. <https://doi.org/10.1046/j.0305-0270.2003.00994.x>
23. Thompson, R., Tamayo, M., & Sigurðsson, S. (2022). Urban bird diversity: Does abundance and richness vary unexpectedly with green space attributes? *Journal of Urban Ecology*, 8(1), juac017. <https://doi.org/10.1093/jue/juac017>
24. Tiwary, N. K., & Urfi, A. J. (2016). Spatial variations of bird occupancy in Delhi: The significance of woodland habitat patches in urban centres. *Urban Forestry & Urban Greening*, 20, 338–347. <https://doi.org/10.1016/j.ufug.2016.10.002>
25. Tiwary, N. K., Sharma, B. B., & Urfi, A. J. (2014). Two new nesting colonies of Painted Stork *Mycteria leucocephala* from northern India. *Indian BIRDS*, 9(4), 85–88.
26. Yang, G., Bowling, D. L., Wilhelm, K., & Pejchar, L. (2015). Evaluation of microhabitats for wild birds in a Shanghai urban area park. *Urban Forestry & Urban Greening*, 14(4),

860–867.

27. Zerbe, S., Maurer, U., Schmitz, S., & Sukopp, H. (2003). Biodiversity in Berlin and its potential for nature conservation. *Landscape and Urban Planning*, 62(3), 139–150. [https://doi.org/10.1016/S0169-2046\(02\)00197-8](https://doi.org/10.1016/S0169-2046(02)00197-8)
28. Morelli, F., Benedetti, Y., Ibáñez-Álamo, J. D., Jokimäki, J., Mänd, R., Marja, R., & Møller, A. P. (2016). Evidence for a general decline in the avian richness along the urbanization gradient. *Ecology and Evolution*, 6(21), 7598–7606. <https://doi.org/10.1002/ece3.2448>
29. Rega-Brodsky, C. C., Aronson, M. F. J., Piana, M. R., Carpenter, E., Hahs, A. K., Herrera-Montes, A., Knapp, S., Kotze, D. J., Lepczyk, C. A., Moretti, M., Salisbury, A. B., & La Sorte, F. A. (2022). Urban biodiversity: State of the science and future directions. *Urban Ecosystems*, 25, 1083–1096.
30. Callaghan, C. T., Major, R. E., Wilshire, J. H., Martin, J. M., Kingsford, R. T., & Watson, J. E. M. (2018). Where do birds go during the day? Urbanization and avian habitat use. *Ecological Applications*, 28(7), 1791–1802.

