Proceedings of CONF-MCEE 2027 Symposium: Innovative Environmental Engineering Strategies for a Sustainable Future
DOI: 10.54254/2755-2721/2027.MA39336

Environmental Drivers of Bird Communities in Beijing Urban Parks: Habitat, Landscape, Disturbance, and Seasonality

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Abstract. A park's birdlife reflects more than what is planted or built inside its boundaries. In Beijing, studies have linked different features to different aspects of bird communities: park area, the range of vegetation heights, nearby land use, and visitor pressure do not all have the same effect. Findings from other cities point to similar influences, including urban development, vegetation, and links between habitats, but the results are not consistent everywhere. The differences may partly reflect local conditions and the way bird communities are measured. Season matters too. Migratory birds come and go, so a survey taken in one month may give a very different picture from one taken in another. For these reasons, no single factor is likely to explain how urban parks support birds. Repeated surveys in the same parks, carried out across seasons, would show more clearly which parks serve resident birds, which attract migrants, and whether management changes benefit either group.

Keywords: urban birds, urban parks, habitat diversity, landscape connectivity, Beijing

1. Introduction

Urbanization changes natural landscapes by replacing or dividing habitats with buildings, roads and other forms of development. These changes can affect where wildlife lives and how it uses available resources. Birds are an important part of urban ecosystems. They can contribute to ecological processes such as insect consumption and seed dispersal, although the importance of these services varies among species and environments [1]. Because birds occur in many different habitats and are often observable, they are also useful for studying how wildlife responds to urban environments.

Urban parks can provide birds with vegetation, food and potential nesting sites within built-up areas. However, parks do not function as isolated islands. Conditions inside a park, as well as the surrounding landscape, may influence which species use it. Park area, vegetation structure and habitat variety may affect the resources available to birds. At the same time, roads, buildings and other forms of urban development may influence the movement of some species between green spaces. Human activity is another possible influence, though its effects may vary depending on the location, timing and intensity of disturbance.

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In a study of 29 Beijing parks, Xie et al. surveyed birds during the breeding season and considered environmental conditions both within parks and in the surrounding landscape [2]. Their results varied depending on how the bird community was measured and which feeding group was considered. Park size was associated with total species abundance, whereas foliage height diversity was an important correlate of species diversity. They also reported lower species diversity in parks with more human visitors. Taken together, the findings point to several distinct associations which point out the fact that not a single park feature that explains every aspect of the bird community.

Seasonal migration can change which birds are present in Beijing over the course of a year. To track this movement, Liu et al. recorded nocturnal flight calls at a site in central Beijing, monitoring birds during four migration seasons [3]. Their study illustrates how acoustic monitoring can provide information about nocturnal migration that may not be captured by daytime observations alone. However, evidence from a recording station does not by itself demonstrate that a particular park is an important stopover, feeding or breeding site. Such claims require surveys carried out at the relevant sites and times of year.

Research from other Chinese cities offers useful comparisons, while also showing why local context matters. For example, a study of 37 parks in Nanjing found that park area, habitat diversity and distance from the city centre were positive predictors of bird species richness, while several other measured characteristics had little or no influence in that study [4]. A recent review of urban-park bird research also identifies season, vegetation, surrounding land use and other environmental characteristics as important themes in the literature [5]. These findings do not necessarily apply in the same way to every city or park.

This review examines published research on environmental factors associated with bird communities in Beijing's urban and peri-urban parks. It focuses on park habitat, surrounding landscape, human activity, connectivity and seasonal migration. It does not present new field data or claim to measure ecological stability. Instead, it considers what existing studies can support and identifies questions that require further site-specific research, such as how individual parks are used by migratory birds and whether improved habitat connections benefit particular species.

Recent studies outside China similarly show that the surrounding built form, impervious surfaces, tree cover, and urban disturbance can shape bird richness in green spaces, reinforcing the need to consider both local park characteristics and the wider urban matrix [6, 7].

Recent field surveys in four urban parks in Beijing's Chaoyang District also documented clear differences in bird-community composition among parks and pronounced seasonal variation during migration periods, providing additional direct evidence that habitat heterogeneity and season can structure urban bird communities in Beijing [8].

2. Review approach

This paper uses a narrative review approach. It discusses published studies relevant to bird communities in urban parks, with particular attention to research conducted in Beijing and other Chinese cities. The selected literature covers park area, vegetation and habitat characteristics, surrounding landscapes, human activity, habitat connectivity and migration.

This is not a systematic review, and it does not claim to include every publication on the topic. Studies from outside Beijing are included as comparisons, not as direct evidence about Beijing's parks. Since the studies differ in location, season and research methods, their results are compared cautiously. Findings from one city or site are not assumed to apply automatically to another.

The synthesis prioritizes evidence that can directly inform interpretation of Beijing's park bird communities, including empirical work on park area, vegetation structure, human disturbance,

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surrounding urban form, connectivity, and seasonal migration. Evidence from non-Beijing cities is used to illustrate comparable mechanisms or patterns rather than to substitute for local observations. Apparent consistency across studies is treated as supportive rather than conclusive because differences in sampling design, spatial scale, season, and focal bird groups can change the associations that are detected. This approach keeps the review focused on what the available literature can support while also identifying questions that require repeated, site-specific monitoring in Beijing.

3. Factors associated with urban bird communities

3.1. Park area and habitat diversity

Park size is often considered when explaining differences in bird richness, but size alone does not determine habitat quality. Larger parks may contain a wider range of habitats and resources, although the characteristics of each park also matter. In a study of 37 parks in Nanjing, park area, habitat diversity and distance from the city center were positive predictors of bird species richness. By contrast, park isolation, park shape and environmental noise had little or no influence in that study [4].

Research in Beijing also shows the importance of considering more than one park feature. Xie et al. surveyed birds in 29 urban parks during the breeding season and examined factors at both park and surrounding-landscape scales [2]. Park size was important for total species abundance, while foliage height diversity was an important factor associated with species diversity. These findings support a multi-factor view of urban bird communities. However, they describe the parks and season included in that study, rather than every park or season in Beijing.

3.2. Vegetation and local habitat

Vegetation can provide food, nesting locations, shelter and places to forage. Different layers of vegetation may offer different resources, so the presence of green space does not mean that all parks provide the same habitat. In Beijing, Xie et al. identified foliage height diversity as an important factor associated with bird species diversity [2]. The Nanjing study also found a positive relationship between habitat diversity and species richness [4].

Together, these findings suggest that park management should consider the structure and variety of vegetation, not only the total area of green space. However, the studies do not establish one ideal vegetation design for every park. Resident birds, migratory visitors and different feeding groups may have different habitat requirements. Local surveys are needed before making detailed recommendations for a particular site.

3.3. Surrounding landscape and connectivity

Birds may use habitats beyond the boundaries of an individual park. The surrounding landscape can provide additional habitat, but roads and built surfaces may make movement more difficult for some species. In their Beijing study, Xie et al. found that features of the landscape around parks were associated with some measures of bird richness. They also reported that different feeding groups responded differently to landscape patterns [2]. This supports the idea that park-level management should be considered alongside the wider urban landscape.

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Connectivity is relevant, but it should not be treated as a guaranteed benefit. Grafius et al. modelled connectivity for two woodland bird species in three urban areas in the United Kingdom and compared the model results with observed bird abundance [9]. They found a weak but positive agreement between modelled connectivity and the combined abundance of the two focal species. Relationships were weaker for other woodland species. Their research suggests that connectivity models may help inform planning, while also showing the importance of testing model predictions against field observations.

This evidence does not show that a particular corridor in Beijing increases bird populations or improves ecological stability. Nor does it establish that corridors harm reproduction. The effects of a corridor should be assessed for the relevant species and location, using site-specific evidence where possible.

3.4. Human activity and disturbance

Human visitation is one factor that may affect how birds use parks. In the Beijing study, Xie et al. found a negative association between human visitation and species diversity during the breeding season [2]. This finding makes human activity a relevant consideration in park planning. However, it does not show that every form of human use has the same effect, or that reducing visitation will always increase bird diversity. The relationship may depend on where and when people use a park, the habitat available and the bird species present.

Management decisions should therefore avoid relying on a single general rule. Where disturbance is a concern, future site-specific research could record both bird observations and patterns of human use. Such information could help determine whether certain areas or times require additional protection, while recognizing that parks also serve important recreational and social purposes.

3.5. Migration and seasonal change

Bird communities may change across the year as migratory species pass through or remain in an area. Liu et al. monitored nocturnal flight calls at a recording site in central Beijing across four migration seasons [3]. Their study shows that acoustic monitoring can provide information about nocturnal migration in the region. However, records from one station cannot establish how individual forest parks are used by migrating birds.

More broadly, the East Asian Flyway supports many migratory land bird species, while important aspects of their distribution, habitat use and conservation needs remain incompletely known [10]. Repeated surveys in Beijing's parks across different seasons would help distinguish resident birds from seasonal visitors and assess how individual sites are used. A survey conducted in only one season would not answer these questions fully.

4. Synthesis and implications

Published research suggests that bird communities in urban parks are associated with a combination of local habitat conditions and the wider landscape. Studies in Beijing and other Chinese cities identify park area, vegetation structure, habitat diversity, surrounding land use and human activity as relevant factors. However, their importance is not identical in every study. Results may vary according to location, season, survey design and the bird groups being considered. Broad findings can therefore guide conservation questions, but they should not be treated as direct predictions for every park.

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The Beijing study by Xie et al. is particularly useful because it examined birds at both park and landscape scales [2]. It found that different environmental factors were associated with different measures of bird communities and different feeding groups. Research in Nanjing similarly found that park area and habitat diversity were positive predictors of species richness, while some other measured characteristics had little or no influence in that study [4]. Together, these studies support a multi-factor approach rather than a single explanation for urban bird diversity.

Evidence about connectivity also requires caution. Modelling can help identify possible movement routes, but the relationship between predicted connectivity and observed bird abundance may be weak or species-specific [9]. Ecological corridors should therefore be considered a planning option to evaluate, not a guaranteed solution. Claims about their effects on bird populations or breeding success require direct evidence from the sites concerned.

Migration also needs to be considered when assessing Beijing's bird communities. Liu et al.'s recordings of nocturnal flight calls show how acoustic monitoring can document migration in the region [3]. However, data from a single station cannot tell us whether particular parks are used as stopover or breeding sites. Surveys repeated across seasons could help answer that question.

A later survey of four parks in Chaoyang District found that bird communities differed considerably from one park to another. Species richness and community composition also shifted during migration periods. The authors highlighted wetlands and habitats with varied vegetation structure as valuable features [8]. These results support monitoring parks in different seasons and paying attention to their specific habitats. They do not, however, show that one management approach will work equally well across Beijing's parks.

5. Conclusion

A limitation of this review is that it does not include new fieldwork and is not a systematic review of all available publications. It cannot measure bird-community stability or determine causal effects for specific parks. Future research could combine repeated bird surveys with measurements of vegetation, human activity and surrounding landscape conditions. This would help researchers and park managers assess local conservation needs more confidently. Until then, the most responsible conclusion is that urban bird conservation requires context-specific planning, careful monitoring and conclusions that remain within the limits of the available evidence.

Taken together, the reviewed evidence indicates that no single park characteristic can explain urban bird-community patterns across Beijing. A larger park may offer more space and a wider range of habitats, but size alone does not determine which birds will use it. Vegetation structure, habitat diversity, nearby land use, human disturbance, and seasonal movements all matter. Their importance can vary between parks, seasons, and groups of birds, so findings from one setting should not automatically be applied to another. It is more useful to consider park conditions alongside the surrounding urban landscape and the seasonal turnover of species.

Management choices should be tied to specific goals and checked against what happens in the field. Adding structural variety to vegetation, retaining different habitat types, limiting disturbance in sensitive areas or at particular times, and improving connections between habitats are all possible approaches—not guaranteed fixes. Their effects need to be assessed at the sites and for the species concerned. Surveys conducted in both the breeding season and migration periods could help distinguish regular use by resident birds from more temporary use by migrants. Recording bird observations alongside vegetation, human activity, and surrounding land cover would also make it easier to see which patterns recur across parks. This kind of monitoring can guide changes in

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management while keeping conclusions about ecological stability or improvement appropriately cautious.

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