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Advances in Urban Ornithology Research in China: A Postprint

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Abstract

Urban ornithology in China originated in the 1980s and has developed rapidly with the acceleration of urbanization. To comprehensively and systematically understand the history, current status, and development trends of urban ornithology research in China, articles published between 1950 and 2015 were retrieved from the China Journal Full-text Database using “urban” and “birds” as subject terms, with 128 articles selected for review. The results demonstrate that the number of published articles on urban ornithology has gradually increased since the 1980s, rising from an annual average of 0.7 articles during 1981-1990 to 11.6 articles during 2011-2015. Study sites encompassed 57 cities across 29 provincial-level administrative regions nationwide. The primary research topics include: community structure and distribution of urban birds, key environmental factors influencing urban birds, and conservation practices for urban birds. The review reveals that different urban zone locations and various habitat combinations within cities affect urban bird community structure; environmental factors at multiple scales exert diverse influences on bird distribution, reproduction, foraging, and physiology, with urbanization serving as the primary driver affecting these environmental factors; bird habitat planning facilitates avian conservation by protecting natural habitats within cities and enhancing landscape connectivity, while bird attraction techniques primarily promote bird conservation through supplementation of nesting and food resources. However, resource constraints have resulted in relatively few long-term studies on urban birds. Furthermore, ecosystem services provided by urban birds have been rarely addressed in existing research. Accordingly, three prospects for the development of urban ornithology in China are proposed: urban ornithology research should intensify investigations into the ecological impacts of bird attraction measures in urban green spaces, further explore the nature experience and environmental education values of urban birds, and promote participation by citizen enthusiasts in long-term systematic urban ornithology surveys.

Full Text

Preamble

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Urban Ornithological Research in China: A Review

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Abstract

Urban ornithological research in China began as early as the 1980s and developed rapidly with accelerating urbanization. To systematically understand the history and trends of this field, we conducted a comprehensive review by searching the China National Knowledge Infrastructure database using the keywords “urban” and “birds” for articles published between 1950 and 2015, retrieving 128 relevant papers. Our analysis summarizes publication trends, major research topics, and key findings in Chinese urban ornithology. Publications increased from an annual average of 0.7 articles during 1981–1990 to 11.6 articles during 2011–2015. Studies covered 57 cities across 29 provincial-level administrative regions. Major research topics include urban avian community structure and distribution, effects of environmental factors on urban birds, and urban avian conservation practices. Key findings reveal that: (1) urban-rural gradients and different habitat groups significantly affect avian community structure; (2) environmental factors at various scales influence bird distribution, breeding, feeding, and physiological conditions; and (3) habitat conservation in urban areas and bird attraction measures, such as setting up feeders, contribute to urban avian conservation. However, long-term studies remain rare due to resource limitations, and few studies have examined ecosystem services provided by urban avifauna. We propose three future research directions: investigating the ecological impacts of bird attraction measures in urban green spaces, exploring the natural experience and environmental education value of urban birds, and promoting citizen scientist participation in long-term systematic urban bird surveys.

Keywords: Ornithology; urban; China; review

Introduction

Birds are highly sensitive to habitat composition and environmental changes, serving as important indicator species for urban ecological environments and

biodiversity [1]. As the most common wildlife in urban settings, birds are easily accessible and serve as crucial mediators for urban residents to connect with nature, providing educational and recreational social functions that significantly contribute to human well-being [2-4]. Following World War II, global urbanization accelerated dramatically [5-6], and China's rapid urbanization since the reform and opening-up period has attracted widespread interdisciplinary attention [7]. Given birds' importance to urban ecosystems and resident welfare, urban ornithology has gained increasing research focus internationally, yielding substantial 成果 [8-9]. While Chinese ornithological research has traditionally focused on natural habitats, urban-based studies have grown rapidly with increasing publications, making a systematic review essential for further advancing the field.

1. Temporal Dynamics of Research Publications

Urban ornithology publications in China developed slowly before 2000, after which article numbers increased rapidly. From 1981-1990, the annual average was 0.7 articles, rising to 11.6 articles during 2011-2015. Examining research topics, basic studies on urban birds emerged earliest and consistently produced the highest publication numbers across all periods. Research on environmental factors affecting urban birds began increasing rapidly after 2000, while conservation practice articles remain relatively few, representing an emerging research area.

2. Current Status of Urban Ornithology Research in China

Our review analyzed 128 articles, with Beijing and Guangxi publishing the most studies. Provinces with 5 or more publications include additional regions. Urban ornithology articles concentrate in zoology, biodiversity, and ecology journals, with 58.6% published in Chinese core journals.

2.1 Geographic Distribution of Study Areas

Research sites span 57 cities across 29 provincial-level administrative regions [Figure 2: see original paper].

2.2 Major Publishing Journals

Key journals include *Zoological Research*, *Biodiversity Science*, and *Chinese Journal of Ecology* [Figure 3: see original paper].

3. Main Research Topics in Chinese Urban Ornithology

From the 128 articles, we identified three major research themes: basic research on urban birds, environmental factors affecting urban birds, and urban bird conservation practices. Basic research dominates Chinese urban ornithology, and this review examines each theme's development.

3.1 Basic Research on Urban Birds

As important components of urban ecosystems and indicator species [1], studies of bird ecological habits form the foundation of urban ornithology. Research focuses on behavioral ecology and population ecology of common urban species. Behavioral studies address breeding [10-14], feeding [15-16], vocalizations [17], and flight initiation distance [18]. Population studies examine abundance changes and distribution [19-20]. Study species include the Eurasian Tree Sparrow (*Passer montanus*), Chinese Nuthatch (*Sitta villosa*), Eurasian Magpie (*Pica pica*), Mandarin Duck (*Aix galericulata*), White Wagtail (*Motacilla alba*), Chinese Blackbird (*Turdus mandarinus*), Great Tit (*Parus major*), Light-vented Bulbul (*Pycnonotus sinensis*), Brown-headed Parrotbill (*Sinosuthora webbiana*), Red-flanked Bluetail (*Tarsiger cyanurus*), Chinese Hwamei (*Garrulax sannio*), Daurian Redstart (*Phoenicurus auroreus*), White-cheeked Starling (*Spodiopsar cineraceus*), Yellow-billed Grosbeak (*Eophona migratoria*), and Rook (*Corvus frugilegus*). All except the Chinese Nuthatch and Rook are common urban species, with the Light-vented Bulbul being the most studied (14 articles). These descriptive surveys constitute the most fundamental component of urban ornithology.

Bird community structure and dynamics provide the basis for understanding urban bird-environment relationships [21]. Studies examine urban avifauna, community structure, and seasonal or interannual dynamics. Comparisons of bird communities across different urban green spaces or habitats are particularly common. Research shows significant differences in species diversity among habitat types. Green spaces dominated by broadleaf trees, such as schools and parks, typically support the highest species richness and diversity, while built-up areas and residential neighborhoods have the lowest and most homogeneous communities [1, 22-30]. Some studies found shrub habitats had highest diversity [31-32], while others identified wetlands as most diverse [33-35]. These variations reflect differences in dominant habitat types across study areas. Habitat type combinations affect species richness, individual abundance, and bird assemblages. Habitats with well-developed tree and ground layers, or tree and shrub layers, support more species [36]. Wetland habitats can be classified into river beaches, shorelines, and water-filled sand pits, with river beaches supporting wading birds, shorelines hosting common urban species, and sand pits attracting swimming birds [35-36].

For urban green belts, suburban green spaces show highest bird diversity and evenness, followed by outer suburbs, with central urban green spaces lowest [1, 37-39]. Larger green patches with rich vegetation structure support higher species richness [40-42], though the relationship between patch area and bird encounter rate is not always statistically significant [43]. Human disturbance, such as construction, pollution, and water resource exploitation, clearly reduces bird abundance and diversity, simplifying community structure [34, 44-48].

3.2 Environmental Factors Affecting Urban Birds

Researchers have examined habitat-bird relationships and urbanization impacts from two perspectives, which we review accordingly. Different habitat factors affect urban birds at multiple scales [49].

City Scale: At the city scale, bird diversity and evenness are primarily influenced by habitat patterns, including connectivity, fragmentation, and landscape heterogeneity. Connectivity, measured by shape index and mean minimum nearest-neighbor distance, affects bird movement and foraging—higher connectivity supports more resident and migratory birds [49–53]. Fragmentation, measured by mean patch area and aggregation index, reduces habitat area and quality, decreasing species diversity [50–51]. Landscape heterogeneity, representing non-uniformity and variability of landscape features and measured by Shannon diversity and evenness indices, positively correlates with bird species richness [49–52].

Green Space and Habitat Patch Scales: At the green space scale, spatial heterogeneity, naturalness, and human disturbance are key factors [49–50, 54–63]. Higher spatial heterogeneity—encompassing microhabitat types, vegetation vertical structure, and topography—increases species richness [29, 49, 54–55, 61]. Greater tree canopy cover, shrub cover, and total vegetation cover correlate with more bird species [30, 49, 56–58, 61]. Findings on water area proportion are mixed: some studies report positive effects [30, 57], while others find no significant relationship [56, 59]. Richer plant species diversity reduces bird dominance [61] and increases species diversity [29, 49]. Naturalness, classifying environments into built, farmland, natural, and water areas, significantly affects species richness—higher naturalness supports greater diversity and community stability [29, 51, 54]. Human disturbance, indicated by visitor flow, building index, and distance from city center, negatively impacts bird density and richness [29–30, 51, 57, 59].

At the habitat patch scale, plant composition, vegetation structure, distance to other patches, and disturbance level influence bird occupancy. Richer plant composition supports more species and higher diversity [63, 66–67]. Different bird guilds—species groups with similar resource use, breeding, or vegetation layer preferences—show distinct habitat use patterns [68]. For example, canopy-nesting guilds prefer tree crowns, shrub-nesting guilds favor shrub layers, and ground-nesting guilds use ground cover [59]. Multi-layered vegetation benefits foraging and breeding [62, 66–67]. Distance to other forest patches is critical for small birds' reproduction and distribution, with closer distances facilitating predator avoidance and food access [65]. Disturbance from pedestrians and vehicles affects birds differently—most tolerate daytime disturbance but avoid human activity at night roosts [64]. Smaller birds are more disturbance-sensitive than larger species [49], and in highly disturbed patches, most birds prefer foraging and roosting in tall trees to minimize impacts [64–66].

Urbanization Effects: Urbanization alters numerous environmental factors,

affecting habitat availability and quality for plants, insects, and other organisms [70–71]. Studies focus on urbanization's impacts on bird distribution, community structure, species diversity, and physiology. Urbanization intensity, assessed through artificial lawn area, high-rise building coverage, hardened ground, and population density, negatively correlates with bird abundance and richness in commercial districts and major roads [72–75]. However, ancient building areas and low-rise residential zones with diverse vegetation and numerous cavities maintain high bird abundance despite high urbanization [72–76]. Distance from city center serves as a comprehensive urbanization indicator, with species richness and individual abundance increasing with distance [76–78].

Urbanization changes habitat stability and food availability [77, 79]. Building index negatively affects ground-nesting guilds but benefits cavity-nesting species like sparrows that nest in air conditioners [72, 76, 80–81]. Habitat stability, indicated by plant community complexity, positively correlates with bird species richness [79]. Food availability, enhanced by fruiting trees, human feeding, and kitchen waste, increases overall bird abundance, particularly benefiting omnivorous ground-foraging guilds [77–80]. Urbanization also affects bird physiology—urban sparrows show lower body mass, higher heterophil-to-lymphocyte ratios, and higher stress indices compared to suburban conspecifics [83], with body condition indices significantly lower in high-rise residential areas and university campuses than in suburbs [22].

3.3 Urban Bird Conservation Practices

Beyond regional studies, 26 review articles introduce international conservation experiences and frameworks. Conservation practice research integrates findings from basic studies and environmental factor research to explore planning, management, and protection measures.

Urban Biodiversity Conservation Strategies: As human-dominated landscapes, cities face acute conflicts between human activity and biodiversity conservation. Biodiversity assessment studies evaluate green space diversity through habitat diversity, species diversity, and saturation indices [83–84], while biodiversity value assessments monetize rare bird species [84]. Comprehensive surveys of insects, amphibians, reptiles, and plants identify conservation challenges including habitat destruction, pollution, lack of public awareness, and inadequate protection mechanisms [85–89]. Recommended measures include scientific planning, environmental restoration, strengthened law enforcement, and public engagement [85, 87–88].

Urban Wetland Protection: Wetland protection research addresses management complexity, lack of coordination, weak public legal awareness, and monolithic land use that reduces ecosystem services [88–96]. Solutions include clarifying departmental responsibilities, establishing ecological buffer zones, zoning protected areas for multiple functions, and enhancing public awareness through education [88–94].

Urban Bird Habitat Planning and Design: Green spaces, though highly natural areas [55], have been underappreciated as wildlife habitat despite their importance for visitor nature experiences [95–96]. Bird-oriented green space planning enhances both avian habitat and recreational experiences. Habitat planning focuses on protecting natural habitats and increasing connectivity through green belts, riparian corridors, and road greenways [97–101]. Green roofs also show potential for connectivity enhancement [101]. Habitat design targets urban wetlands and parks, emphasizing ecological restoration, soil quality improvement, and vegetation configuration tailored to different bird guilds [102–106]. Bird attraction techniques include planting food-source plants, installing nest boxes, providing water sources, and setting up bird observation facilities [96, 106–107]. While these techniques are now well-developed, more case studies are needed to test and refine planning approaches.

4. Summary and Outlook

Chinese urban ornithology has advanced considerably, accumulating extensive data in major cities and achieving progress in understanding community distribution patterns and species diversity-habitat relationships. Some planners have applied these findings to bird attraction projects with positive results [95, 102]. However, limited resources constrain long-term studies, and ecosystem services of urban birds remain understudied. We propose three future directions:

4.1 Natural Experience and Environmental Education Value of Urban Birds

Connecting with nature is a primary motivation for park visits [108–109]. Rich bird diversity enhances visitor experiences and provides outdoor environmental education opportunities, helping residents learn about local biodiversity rather than exotic flagship species. Research should examine how different bird diversity levels affect visitor satisfaction and environmental awareness, and how park design influences nature experiences at comparable diversity levels.

4.2 Ecological Impacts of Bird Attraction Measures in Urban Parks

Despite high bird diversity in urban parks [28, 36, 50, 56, 59], few studies address the ecological impacts of park management on birds. Parks serve as habitat patches providing food and shelter, yet their management differs fundamentally from natural reserves. Increased collaboration between planners and ornithologists is needed to understand how design and management affect birds, optimizing both recreational and conservation functions.

4.3 Citizen Science for Long-Term Systematic Research

Most existing studies span short timeframes (seasonal or annual), limiting understanding of long-term responses to urban landscape changes. Resource constraints hinder extended monitoring. Recent citizen science initiatives, such

as coastal waterbird surveys [112-113] and the China Biodiversity Observation Network (Sino BON), demonstrate the potential for large-scale data collection. Leveraging urban green spaces' accessibility to engage citizen scientists in long-term urban bird monitoring would provide valuable data while promoting public awareness and birdwatching activities.

5. Conclusion

This review synthesizes Chinese urban ornithology research across three core themes: basic research, environmental factors, and conservation practices. The field began later in China than internationally, initially dominated by zoologists focusing on community structure, later expanding to include ecologists examining urbanization impacts and landscape architects exploring habitat design. Future research should prioritize the natural experience and education value of urban birds, ecological impacts of conservation measures, and citizen science engagement. These efforts will provide scientific foundations for maintaining urban bird habitats, enhancing ecosystem services, and improving resident well-being, ultimately contributing to sustainable urban development.

References

- [1] 芜湖市鸟类的生态分布. 安徽师大学报, 1989, (4): 41-49.
- [2] Shwartz A, Turbé A, Simon L, Julliard R. Enhancing urban biodiversity and its influence on city-dwellers: an experiment. *Biological Conservation*, 2014, 171: 82-90.
- [3] 基于鸟类栖息地保护的城市公共绿地设计. 湖南农业大学学报 (自然科学版), 2010, 36(2): 105-107.
- [4] Fuller R A, Irvine K N, Devine-Wright P, Warren P H, Gaston K J. Psychological benefits of greenspace increase with biodiversity. *Biology Letters*, 2007, 3(4): 390-394.
- [5] Seto K C, Fragkias M, Güneralp B, Reilly M K. A meta-analysis of global urban land expansion. *PLoS One*, 2011, 6(8): e23777.
- [6] Grimm N B, Faeth S H, Golubiewski N E, Redman C L, Wu J G, Bai X M, Briggs J M. Global change and the ecology of cities. *Science*, 2008, 319(5864): 756-760.
- [7] 中国典型区域城市化过程及其生态环境效应. 科学出版社, 2017.
- [8] 城市鸟类群落生态学研究展望. *动物学研究*, 2000, 21(2): 165-169.
- [9] Marzluff J M. Worldwide urbanization and its effects on birds // Marzluff J M, Bowman R, Donnelly R, eds. *Avian Ecology and Conservation in an Urbanizing World*. US: Springer, 2001: 19-47.
- [10] 鸳鸯利用城市建筑物繁殖初步观察. *动物学杂志*, 2009, 44(3): 135-137.
- [11] 农田麻雀繁殖期间的种群动态. *陕西农业科学*, 1983, 3(2): 165-172.
- [12] 黑头 生态繁殖习性 & 招引技术. *动物学研究*, 1996, 42(6): 42-42.
- [13] 杭州城市环境中白头鹤的繁殖生态. *动物学研究*, 2013, 34(3): 182-189.
- [14] 城市小型斑块环境下喜鹊育雏前期巢内行为的观察. *黑龙江畜牧兽医*, 2015, (6): 233-235.
- [15] 长江师范学院校园白头鹤的生境分布及取食生态位研究. *安徽农业科学*, 2014, 42(15):

4669-4670, 4698-4698.

- [16] 杭州市区白头鹎鸣声的微地理差异. 生物学杂志, 2012, 29(3): 20-23.
- [17] 黑尾蜡嘴雀冬季对树木果实的取食作用. 动物学研究, 2005, 26(5): 453-459.
- [18] 杭州常见鸟类对人为干扰的适应性. 动物学研究, 2004, 25(3): 214-220.
- [19] 四川南充地区白头鹎种群数量增长原因分析. 信阳师范学院学报 (自然科学版), 2006, 25(3): 594-596.
- [20] 四川南充市郊区灰椋鸟生态的初步研究. 动物学杂志, 2007, 42(5): 125-130.
- [21] 广州地区鸟类资源本底调查及其整体特征分析. 动物学研究, 2005, 26(1): 17-24.
- [22] 北京市麻雀体质水平沿城市化梯度的变化. 北京师范大学学报 (自然科学版), 2007, 43(2): 671-677.
- [23] 城市公园夏季鸟类的群落结构. 安徽大学学报 (自然科学版), 2004, 27(4): 93-95.
- [24] 城市园林与夏季鸟类群落结构研究. 河北农业大学学报, 2005, 29(6): 94-99.
- [25] 北京的公园鸟类群落结构研究. 动物学杂志, 2008, 43(1): 122-133.
- [26] 北京地区珍稀鸟类生态分布的. 北京林业大学学报, 2015, 37(5): 119-125.
- [27] 环境噪音对鸟类鸣声的影响及鸟类的适应对策. 生态学杂志, 2011, 30(4): 831-836.
- [28] 广州市中心城区公园鸟类多样性及季节动态. 动物学研究, 2012, 32(9): 2788-2795.
- [29] 焦作城市园林夏季鸟类多样性初探. 焦作师范高等专科学校学报, 2007, 23(3): 76-78.
- [30] 上海闵行区园林鸟类群落嵌套结构. 云南大学学报 (自然科学版), 2008, 29(2): 203-211.
- [31] 云南楚雄市鸟类多样性的研究. 动物学杂志, 1998, 20(5): 392-394.
- [32] 武汉市金银湖水鸟多样性及其与水环境关系的初步研究. 长江流域资源与环境, 2010, 19(6): 671-677.
- [33] 扰动因子对龙凤湿地鸟类影响的研究. 中国农学通报, 2013, 29(26): 190-194.
- [34] 城市绿地空间格局对鸟类群落影响的研究进展. 南京林业大学学报 (自然科学版), 2012, 36(6): 733-739.
- [35] 苏州城市公园秋冬季鸟类与生境特征的关系. 上海交通大学学报 (农业科学版), 2009, 27(4): 368-373, 393-393.
- [36] 澳门地区鸟类生境的景观格局. 生态学杂志, 2009, 28(3): 483-489.
- [37] 广西龙象谷南晓片区景观格局变化及其对鹭鸟生境的可能影响. 云南农业大学学报, 2015, 30(3): 325-332.
- [38] 景观生态学: 尺度与等级. 高等教育出版社, 2007: 19-20.
- [39] 镇江市环境结构对鸟类群落的影响研究. 环境科学与管理, 1989, 9(4): 285-289.
- [40] 北京城市及近郊区环境结构对鸟类的影响. 北京师范大学出版社, 2012: 343-349.
- [41] 北京绿化隔离地区鸟类群落与环境因子关系研究. 北京林业大学学报, 2007, 29(5): 121-126.
- [42] 柳州城市公园冬季鸟类群落特征与生境的关系. 安徽农业科学, 2012, 19(2): 180-186.
- [43] 城市中不同生境下鸟类群落特征研究. 城市环境与城市生态, 2011, 38(3): 137-138.
- [44] 柳州城市园林不同微栖息地类型冬季鸟类群落结构研究. 湖北农业科学, 2007, 20(2): 25-27, 31-31.
- [45] 长广溪国家城市湿地公园鸟类群落结构及季节动态. 安徽农业科学, 2013, 52(1): 134-138.
- [46] 江西鄱阳湖共青城市区域鸟类多样性研究. 江西农业大学学报, 2015, 34(4): 541-547.
- [47] 绵阳城市及近郊鸟类初步调查. 绵阳师范学院学报, 2004, 23(5): 67-73, 81-81.
- [48] 渭南市及市郊秋冬季鸟类群落结构及多样性分析. 湖北农业科学, 2013, 52(6): 796-800.
- [49] 天津地区鸟类组成及多样性分析. 河北大学学报 (自然科学版), 2007, 27(4): 417-422.
- [50] 城市公园生境类型对鸟类群落的影响. 生态学杂志, 2015, 35(12): 4186-4195.

- [51] 西安市灞河湿地鸟类生境构成与保护价值评价研究. 干旱区资源与环境, 2010, 22(8): 116-119.
- [52] 河北省承德市鸟类群落多样性研究. 安徽农业科学, 2008, 38(13): 6741-6742.
- [53] 聊城市春季鸟类分布的边缘效应. 聊城大学学报 (自然科学版), 2005, 18(1): 49-51.
- [54] 城市化对冬季鸟类取食集团的影响. 浙江大学学报, 2011, 35(5): 59-63.
- [55] 杭州城市行道树带的繁殖鸟类及其鸟巢分布. 动物学研究, 2014, 25(1): 19-21, 35-35.
- [56] 北京市区绿化带内鸟类食源树种研究. 柳州冬季观果树种应用与鸟类多样性调查研究, 2006, 42(12): 83-89.
- [57] 城市化对生物多样性的影响研究综述. 生态学杂志, 2003, 24(4): 259-264.
- [58] 城市化对城市麻雀栖息地利用的影响: 以北京市为例. 北京师范大学出版社, 2012: 343-349.
- [59] 城市化对麻雀数量与分布的影响: 以北京为例. 生物多样性, 2010, 1(3): 188-197.
- [60] 城市化对鸟类分布的影响. 生物多样性, 2006, 14(5): 372-381.
- [61] 城市化和栖息地结构与鸟类群落特征关系研究进展. 生态学杂志, 2008, 27(11): 2018-2023.
- [62] 城市化对涪陵三峡库区城市鸟类群落结构的影响. 野生动物学报, 2013, 34(6): 327-330.
- [63] 城市化对西安市不同景观鸟类多样性的影响. 野生动物学报, 2004, 40(6): 147-152.
- [64] 哈尔滨市城市化建设对鸟类群落的影响. 安徽农业科学, 2010, 38(3): 1275-1278.
- [65] 城市化对长沙市区城市公园繁殖期鸟类物种多样性的影响. 生态学杂志, 2015, 36(3): 295-302.
- [66] 城市化对鸟类的影响: 从群落到个体. 动物学杂志, 2014, 33(7): 1853-1859.
- [67] 城市化对杭州市鸟类营巢集团的影响. 动物学研究, 2013, 48(5): 808-816.
- [68] 城市公园和郊区公园生物多样性评估的指标. 生物多样性, 2009, 30(3): 295-302.
- [69] 北京市城区与郊区麻雀 *Passer montanus* 环境压力的比较研究. 北京师范大学学报 (自然科学版), 2003, 11(2): 169-176.
- [70] 北京市湿地珍稀鸟类特征与价值评估. 生物多样性, 2007, 43(2): 671-677.
- [71] 香港的生物多样性及其保育工作. 生物多样性, 2000, 8(1): 25-35.
- [72] 中新天津生态城生物多样性现状调查及保护建议. 资源与环境, 2011, 33(7): 1278-1283.
- [73] 北京地区观赏鸟的保护. 城市生态环境中野生脊椎动物保护探究, 1984, 5(1): 23-27.
- [74] 以云南玉溪市红塔区为例. 安徽农业科学, 2013, 23(11): 329-332.
- [75] 安阳城市湿地资源保护网络建设初探. 中国城市林业, 2015, 13(5): 44-47.
- [76] 深圳福田红树林鸟类自然保护区管理策略初探. 生物多样性, 1999, 7(4): 351-354.
- [77] 上海市湿地自然保护区现状及保护对策. 国土与自然资源研究, 2005, (1): 44-45.
- [78] 内蒙古南海子湿地自然保护区现状分析及对策. 内蒙古草业, 2004, 16(4): 39-40, 58-58.
- [79] 哈尔滨市太阳岛湿地生态环境特征及其保护对策. 经济研究导刊, 2010, (4): 153-154.
- [80] 拉鲁湿地生态环境及动植物物种资源变化特征研究. 自然资源学报, 2005, 20(1): 145-151.
- [81] 鸟类对城市公园空间的利用及其对景观设计的启示. 生态城市与绿色建筑, 2014, (4): 121-128.
- [82] 城市园林中鸟类及蜂蝶的重要性及其招引与保护. 中国学术期刊文摘, 2008, 14(10): 2-3.
- [83] 基于过程视角的城市地区生物保护规划: 以浙江台州为例. 生态学杂志, 2010, 29(1): 8-15.
- [84] 基于鸟类边缘种行为的景观连接度研究: 空间句法的反规划应用. 生态学杂志, 2013, 33(16): 5035-5046.
- [85] 城市绿地结构与鸟类栖息生境的营造. 环境科学与管理, 2008, 33(6): 150-153.
- [86] 铁岭凡河新城规划鸟类多样性保护的限定研究. 沈阳农业大学学报 (社会科学版), 2009,

- 11(2): 170-173.
- [87] 城市绿色屋顶生物栖息生境设计与营建研究. 西北林学院学报, 2015, 30(1): 263-267, 292-292.
- [88] 城市湿地生态修复与景观规划研究: 以厦门五缘湾湿地公园为例. 城市湿地公园中鸟类栖息地的营建, 2013, 27(6): 89-94.
- [89] 城市滨水鸟类栖息地的生态设计. 林业科技开发, 2012, (6): 94-96.
- [90] 基于鸟类保护的城市绿地建设与管理: 以柳州市为例. 安徽农学通报, 2012, 18(9): 115-117.
- [91] 鸟类保护的城市园林多样性途径探析. 浙江林学院学报, 2007, 24(4): 511-515.
- [92] 食虫鸟类的保护与招引. 生物学通报, 1988, 23(2): 8-10.
- [93] 公众对植物园功能定位和形象认知的初步调查. 生物多样性, 2010, 18(5): 516-522.
- [94] 中国植物园游客游览动机及满意度调查. 生物多样性, 2011, 19(5): 589-596.
- [95] 西安地区鸟类区系. 动物学杂志, 1999, 43(6): 32-42.
- [96] 中国沿海水鸟同步调查项目组. 1999-2007 中国沿海水鸟同步调查报告. 中国观鸟组织联合行动平台, 2008.
- [97] 中华秋沙鸭调查规划 (1.2010-12.2011). 香港观鸟会, 2015: 1-2.
- [98] 年天津湿地景观格局及水鸟生境变化. 生态学杂志, 2012, 10(3): 350-358.
- [99] 中国沿海水鸟同步调查. (2015-11-24) [2016-11-29]. <http://www.rosefinchcenter.net/newsjt.php?nid=410>.
- [100] Wang G M, Jiang G M, Zhou Y L, Liu Q R, Ji Y S, Wang S X, Chen S B, Liu H. Biodiversity conservation in a fast-growing metropolitan area in China: a case study of plant diversity in Beijing. *Biodiversity and Conservation*, 2007, 16(14): 4025-4038.
- [101] Wood C, Delacy T. 中国沿海水鸟同步调查. (2015-11-24) [2016-11-29]. <http://www.rosefinchcenter.net/newsjt.php?nid=410>.
- [102] 城市化对城市麻雀栖息地利用的影响: 以北京市为例. 生物多样性, 2010, 1(3): 188-197.
- [103] 城市化对麻雀数量与分布的影响: 以北京为例. 生物多样性, 2006, 14(5): 372-381.
- [104] 城市化对鸟类分布的影响. 生态学杂志, 2008, 27(11): 2018-2023.
- [105] 城市化对涪陵三峡库区城市鸟类群落结构的影响. 野生动物学报, 2013, 34(6): 327-330.
- [106] 城市化对西安市不同景观鸟类多样性的影响. 野生动物学报, 2004, 40(6): 147-152.
- [107] 哈尔滨市城市化建设对鸟类群落的影响. 安徽农业科学, 2010, 38(3): 1275-1278.
- [108] 城市化对长沙市区城市公园繁殖期鸟类物种多样性的影响. 生态学杂志, 2015, 36(3): 295-302.
- [109] 城市化对鸟类的影响: 从群落到个体. 动物学杂志, 2014, 33(7): 1853-1859.
- [110] 城市化对杭州市鸟类营巢集团的影响. 动物学研究, 2013, 48(5): 808-816.
- [111] 城市公园和郊区公园生物多样性评估的指标. 生物多样性, 2009, 30(3): 295-302.
- [112] 北京市城区与郊区麻雀 *Passer montanus* 环境压力的比较研究. 北京师范大学学报 (自然科学版), 2003, 11(2): 169-176.
- [113] 北京市湿地珍稀鸟类特征与价值评估. 生物多样性, 2007, 43(2): 671-677.

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