

Bird biodiversity Conservation on Older Urban Settlements Renewal

A Case Study of Yu'er Village, Shenzhen

Lulu CHEN, School of Architecture and Design, Harbin Institute of Technology; Key Laboratory of National Territory Spatial Planning and Ecological Restoration in Cold Regions, Ministry of Natural Resources, China

Haoting TANG, School of Architecture and Design, Harbin Institute of Technology, China

Qing YUAN (Correspondence), School of Architecture and Design, Harbin Institute of Technology, Key Laboratory of National Territory Spatial Planning and Ecological Restoration in Cold Regions, Ministry of Natural Resources, China; hityuanqing@hit.edu.cn; Tel.: +86-135-0450-2966

Abstract

The complicated ecological challenges of high-density urban environments severely hinder the conservation of bird biodiversity in older urban settlements. The work presented in this study focuses on how to enhance and conserve bird biodiversity based on the ecological renewal of older settlements in densely populated metropolitan settings. This study employed field surveys, online data collection, literature reviews, case studies, and data analysis to evaluate urban renewal strategies for protecting bird biodiversity in old settlements on a community scale. First, the study identified the key bird distribution hotspots and habitat characteristics of birds in Yu'er Village. Next, the grid analysis method was utilized to select 10 research points within Yu'er Village to investigate spatial morphology and bird biodiversity. Then, the study explored the mechanisms by which spatial morphological indicators that can be adopted for the renewal of older urban settlements influence the conservation of local bird biodiversity through data analysis. The qualitative and quantitative results verified the correlation between spatial morphological features and bird biodiversity in older urban settlements. Moreover, from the perspective of bird survival needs, renewal measures such as creating a habitat chain system between high-density coastal urban areas and inland areas, creating rooftop gardens for birds and humans, and intervening in artificial water sources and habitats are beneficial for bird biodiversity conservation and enhancement.

Keywords

Bird biodiversity, Renewal, Yu'er Village, Old settlements, Rooftop gardens.

1. Introduction

The services of urban ecosystems are related to healthy living standards and social well-being (Ives, Giusti, Fischer, *et al.* 2017). Rapid urbanization has led to fragmentation of natural habitats and loss of habitats, resulting in a serious decline in urban biodiversity (McKinney 2006). Birds are important indicator species of urban biodiversity (Blair 1999; Gregory, Noble, Field, *et al.* 2003). The conservation and enhancement of bird diversity is an important part of the urban biodiversity conservation system, which is of great significance for maintaining the ecological safety and balance of the urban system and improving the urban habitat (Gan and Wu, 2018).

High-density construction in Shenzhen has led to a serious decline in urban biodiversity in urban areas, especially in old settlements (Ferreira, Walsh & Ferreira 2018). For example, the lack of consideration for natural space and urban biodiversity in the Fisherman's Village settlement in Shenzhen has led to ecological problems in the old settlements, which have had a negative impact on bird diversity (Su et al., 2023). The Circular on Urban Renewal Demonstration Work issued by the Ministry of Finance of the People's Republic of China proposes to "strongly support the renewal and reconstruction of old districts with the goal of eco-livability", which provides policy support for the renewal of old districts and the implementation of avian biodiversity conservation, and ushers in a new opportunity for the ecological renewal of Shenzhen's old urban districts. Therefore, this study aims to investigate how to propose a mechanism for influencing bird diversity in high-density urban old settlements based on old settlement renewal actions, and to propose a renewal strategy for bird biodiversity conservation in old settlements.

Therefore, this study aims to investigate how to propose a mechanism for influencing bird biodiversity in high-density urban old settlements based on the renewal of older urban settlements, as well as a strategy for the renewal of older urban settlements aimed at bird biodiversity conservation.

This study selects Yu'er Village as the object of empirical research, analysing the characteristics and problems of the spatial form elements and bird biodiversity of Yu'er Village through field research. By combining methods such as literature review, field investigation, case study, and statistical data analysis, we systematically propose a renewal strategy for older urban settlements oriented toward the conservation of bird biodiversity, from the perspective of birds' survival needs. This strategy aims to integrate the conservation of bird biodiversity into spatial planning and renewal implementation to enhance and preserve bird biodiversity through the renovation of older urban settlements. The goal is to balance the relationship between human settlements and urban ecosystems, gradually forming an urban habitat network, and ultimately achieving the enhancement and conservation of bird biodiversity through the renewal and renovation actions of older urban settlements. We systematically propose a strategy for the renewal of older urban settlements to protect bird biodiversity from the perspective of birds' survival needs, aiming to integrate bird biodiversity protection into spatial planning and renewal implementation. This will enhance and protect bird biodiversity through the renewal and renovation of older settlements, balancing the relationship between human habitats and urban ecosystems, gradually forming urban habitat networks, and ultimately achieving the purpose of bird biodiversity protection and the construction of ecological settlements.

2. Literature review

Currently, most urban regeneration studies on bird biodiversity conservation focus on urban and regional scales (macro). At these scales, bird biodiversity conservation aims to strengthen the horizontal landscape connectivity (Tarabon, Calvet, Delbar, *et al.* 2020) of urban blue-green spaces through the establishment of nature reserves or ecological corridors (Hostetler, Allen & Meurk 2011; Soulé, Bolger, Alberts, *et al.* 1988). For example, greenway networks (Lopes et al., 2023) are constructed to connect ecologically relevant urban green areas, and potential ecological corridors are generated using the least-cost distance model to improve urban ecological networks (Cui et al., 2020). Some neighbourhood-scale bird biodiversity conservation studies have focused on the structure or characteristics of bird habitats at the meso-micro scale, such as urban green parks (Luo, Wu, Bai, *et al.* 2019; Pšeničková & Horák 2022), exploring the influence mechanisms (Puan et al., 2019) of different habitat characteristics on bird biodiversity. However, fewer studies have been conducted on settlements. For instance, Lu (2007) found that vegetation structures with good growth, an abundance of shrub and grass layers, and proximity to water sources are more suitable for bird survival (Lu et al., 2007). Nonetheless, few studies have

examined the micro-scale of older urban settlements to integrate bird biodiversity conservation with their renewal, based on the survival needs of birds.

The current research on the renewal of older urban settlements has significant limitations in terms of bird biodiversity conservation. Existing studies have focused on optimizing the horizontal connectivity of urban green infrastructure, such as ecological corridors and ecological network systems, while the construction of small-scale vertical ecological zones, such as three-dimensional greening and green building façades, has received insufficient attention, and systematic studies are lacking (Salisbury et al., 2023). Additionally, in modern urban environments, particularly in easily recognizable green spaces like urban green areas, certain bird species show significant urbanization adaptations. However, direct design studies on urban bird habitats are still scarce. Urban environments offer a diverse range of potential habitats, including man-made environments such as rooftops and building façades, as well as more natural environments like urban wastelands. Yet, the effective utilization of these environments to create artificial habitats supporting avian biodiversity has not been fully explored. In current research on renewal strategies for older urban settlements, the integration of ecological landscapes and urban construction management is often used as the entry point, with human needs as the main research perspective. However, there is a lack of planning from a biological perspective (Douglas and Evans, 2022), an overemphasis on management, and insufficient public participation, leading to ineffective implementation in the end.

3. Methodology

3.1. Case selection

Yu'er Village (22°48'45"E, 113°92'92"N) is a neighbourhood in the geographic middle of Shekou Street, Nanshan District, Shenzhen City, Guangdong Province, and spans roughly 9 hectares. The residential area is bordered by Golden Century Road and Zhengwang Commercial City to the east, Dajinchuan Apartment and Old Street New Apartment shops to the west, Nanshui Pedestrian Street and Shekou to the north, and Wanghai Road to the south (Figure 1). It is 300 meters from the coastline port, 500 meters from Shekou Mountain, and just two kilometres from Shenzhen Bay's green recreational zone. The study area's eastern limit is near Shekou Square, a "stepping stone"(Saura, Bodin & Fortin 2014) in Shenzhen's bird migration corridor.

Yu'er Village is located in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA), which is rich in bird resources and is considered the wintering ground and transit station for the global migratory route of migratory birds, "East Asia-Australia-West Asia". Due to its proximity to natural landscapes and ports, it may attract a broad range of birds to roost and stay, which is a natural geographical advantage for Shenzhen's bird biodiversity conservation.

The existing buildings in Yu'er Village were completed in 2007, totalling 64 buildings and relatively high-quality structures with a 17-year building age. However, the building density is high and varies in height, the distance between buildings is between 1-2 meters, there are many illegal buildings, and the illumination is inadequate. Above all, Yu'er Village embodies the characteristics of Shenzhen's older urban settlements and serves as a model for the renewal of other older urban settlements.

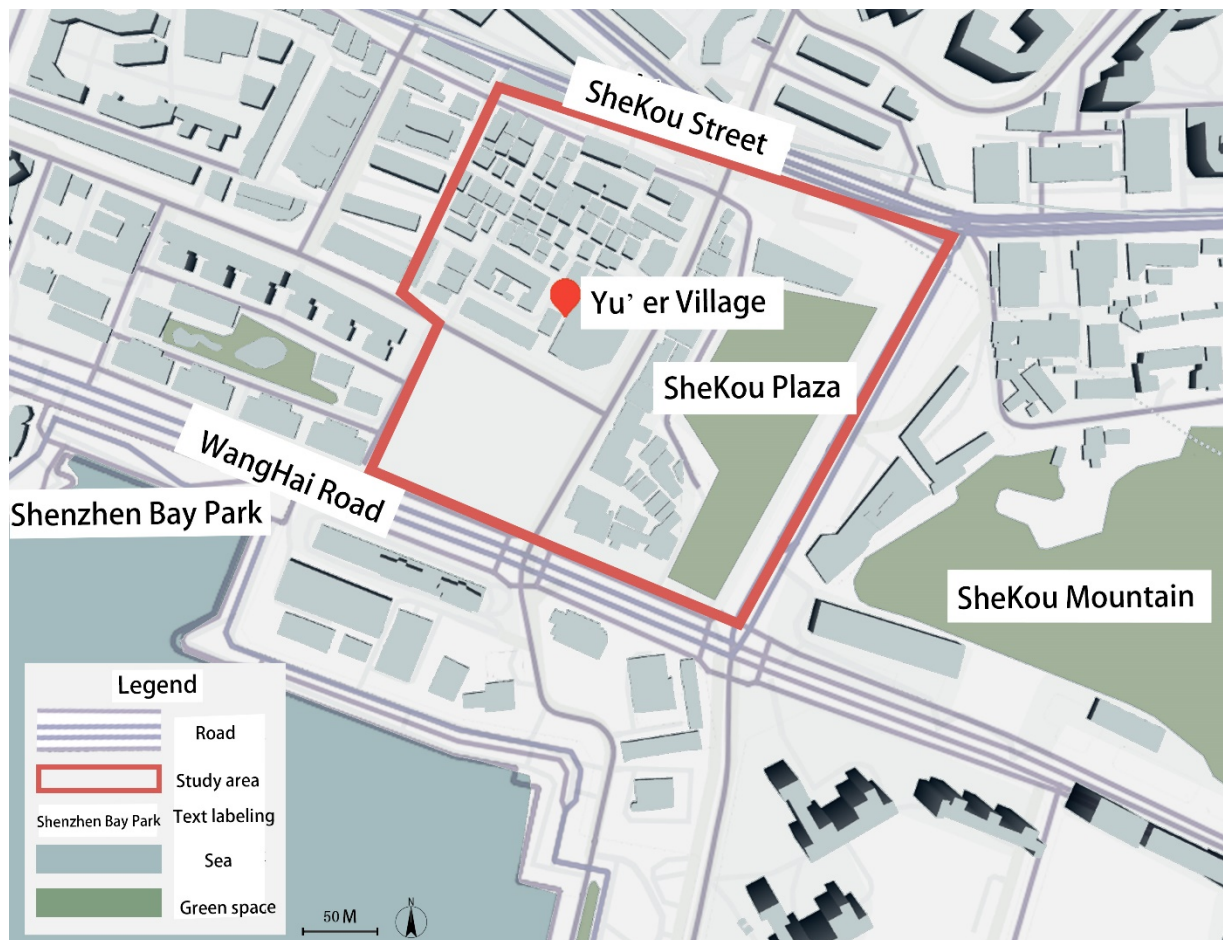


Figure 1. Study area. Source: Drawn by the author.

3.2. Research framework

Firstly, this study identifies the research scope and biodiversity indicators through a pre-survey. Utilizing a Baidu map and street photos, the study analyzed the spatial morphology and ecological situation of older settlements in Shenzhen and selected the Yu'er Village as the study area. It also evaluated the spatial morphology characteristics and problems of the Yu'er Village. It also conducted a qualitative analysis of the relevant literature and standards to determine that birds are indicative of urban biodiversity and the index of bird biodiversity measurement.

Secondly, the case study method is used to explore the existing cases of bird biodiversity conservation in the context of urban renewal of older settlements, focusing on the physical and spatial carriers and strategies of renewal, and summarizing the experience.

Again, the field research method was used to record the material space elements and collect data on bird biodiversity. Ten research sites in the Yu'er Village were selected to record the characteristics and current condition of the physical space in the Yu'er Village, cluster the physical space elements based on bird survival needs, and identify physical space carriers that can be used for renewal. The point count method was used to combine field observation and data collecting on bird biodiversity through video and audio capture.

Finally, taking the Yu'er Village as an example, we propose a strategy for the renewal of older settlements oriented to the conservation of bird biodiversity, based on the existing problems and characteristics of the village, the necessary conditions for bird survival (water, food, nesting sites, and living space), and the data and information gathered from the field research (Figure 2).

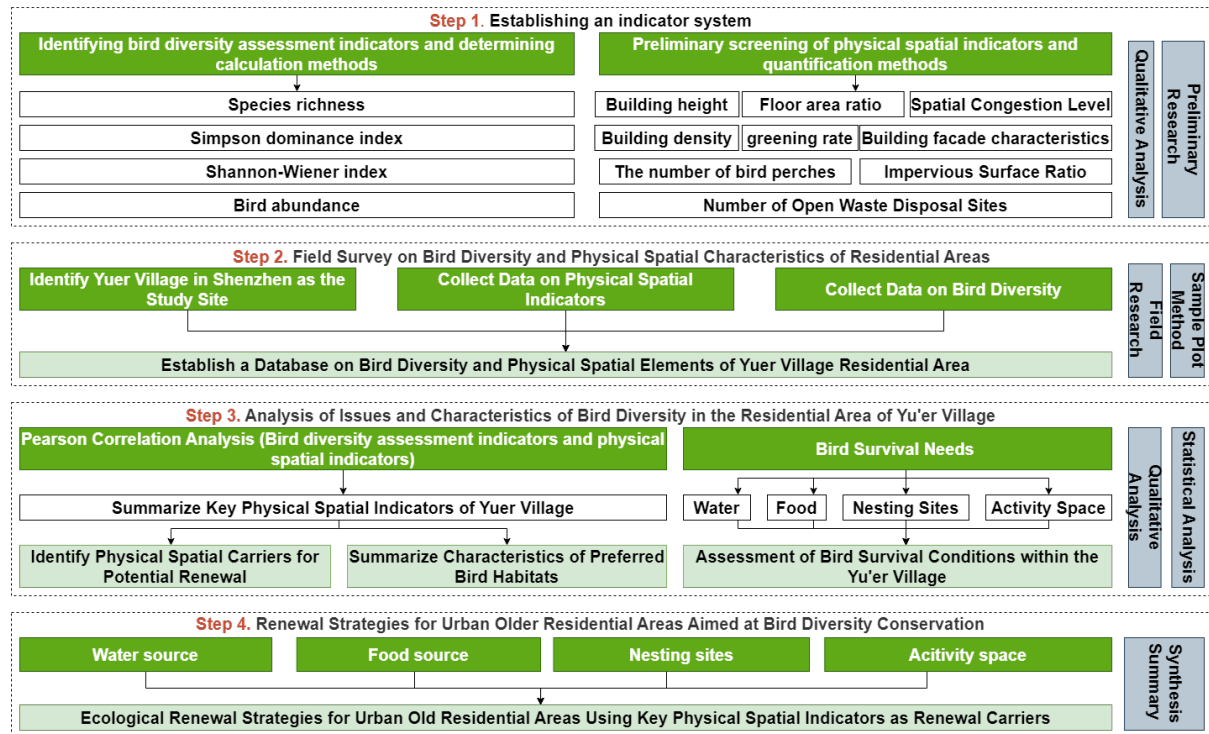


Figure 2. Research Framework. Source: Drawn by author.

3.3. Data collection

A Grid Sampling method was used to select 10 research points (FID) in Yu'er Village, and the land type and location of the research points were recorded (Table 1), with a 50-meter separation between them. The survey data and information were categorized, with bird observation records as the bird biodiversity survey data, and settlements environmental characteristics as plant environment elements, built environment elements, and other environmental aspects. Bird observation records include species names, numbers, and location descriptions of birds. Vegetation environmental elements include vegetation hierarchy, vertical greening percentage, greening management level, and vegetation species. Other environmental components were open trash cans, bird-stopping poles, and asphalt types.

The bird data survey was conducted from April 11, 2024 to April 17, 2024 from 6:00 a.m. to 9:00 a.m. (after sunrise) and from 16:00 p.m. to 19:00 p.m. (before sunset), for a total of six days of bird data survey. The weather during the six days was sunny or cloudy with no precipitation, the average temperature was between 22°C and 28°C, and the air quality was excellent, which was suitable for the bird diversity survey. During the survey, we traveled at a speed of 25 meters per minute and stayed at each site for 8-15 minutes, depending on the habitat of the site, to identify and record bird diversity data through 8x binocular observation, photography and video and audio recording.

Table 1. The land type and location information of Research points. Source: Author.

Research points	Land type	Location information
FID 1	(A) Construction land	Building 1 in the north of the residential area, mid-rise roof area. Close to the road, traffic and human interference.
FID 2	(A) Construction land	Roof of Building 42, mid-level roof area, north of the residential area.
FID 3	(A) Construction land	Building 24 in the northwest of the residential area, mid-level roof area, near the Dajinchuan apartment on the west.
FID 4	(B) Public land	The entrance of the building gathering area is open, the environment is open, but the flow of people is large and the interference is more.
FID 5	(B) Public land	In the middle of the residential area, the empty space between the buildings is surrounded by high-rise buildings, and the space is depressed.
FID 6	(C) Office land	Marina Building (abandoned) in the middle of the residential area, super high-rise roof area.
FID 7	(A) Construction land	Building 38 in the middle of the residential area, the roof area of low-rise buildings is surrounded by commercial shops, and human interference is greater.
FID 8	(D) Ecological land	Shekou Square has complex vegetation structure and good ecological environment.
FID 9	(A) Construction land	Commercial buildings in the south of the residential area, low-rise building roof area, surrounded by commercial shops, human interference is greater.
FID 10	(D) Ecological land	It is located in the entrance area of Shekou Square, with large human disturbance and good ecological environment.



Figure 3. Research points location. Source: (Drawn by author).

3.4. Data analysis

By combining the field research data with the bird statistics of Shenzhen, the study conducted descriptive statistical analysis and Pearson correlation analysis on the environmental factors and bird richness and abundance in the Yu'er Village, and identified the key distribution hotspots and habitat characteristics of birds in the Yu'er Village. Based on non-linear regression analyses, the study summarizes the mechanisms by which spatial morphological indicators that can be adapted in the renewal of older urban settlements influence the conservation of local bird biodiversity. The results indicate that rational spatial planning, vegetation arrangement, and water source management, among other factors, have a significant impact on bird biodiversity.

4. Findings and discussions

4.1. Analysis of Bird Preferred Habitat Characterization Elements

Combining literature studies and field research, this study identified four types of habitat characterization elements in older urban settlements that have a greater impact on the conservation of bird biodiversity, including distance to a specific site, vegetation environment elements, green space characterization elements, anthropogenic disturbance elements, and built environment elements. Among them, the negative impacts of built environment elements and the positive impacts of vegetation environment elements were the most significant.

Bird diversity preferred ecological habitats have the following characteristics (Table 2): (1) proximity to water bodies and food sources; (2) large green space areas; (3) rich vegetation communities with complex structures; (4) semi-natural habitats with low management intensity; (5) low anthropogenic

interference and low noise; (6) aggregation of green space patches and strong connectivity; (7) low building density.

Table 2. Habitat characteristics of bird biodiversity. Source: Author.

Habitat characteristics		Correlation	bibliography
Distance to specific sites	water source	+ : The closer you are to the water source, the richer the bird diversity is	(Xie et al., 2022; Zhuang et al., 2012)
	food source	+ : Closer proximity to food sources increases bird diversity	(Ortega-Álvarez and MacGregor-Fors, 2009)
	flowering plant	+ : The more flowering vegetation, the greater the diversity of birds	(Mbiba et al., 2021)
Vegetation environmental elements	vegetation structure	+ : The more complex the vegetation structure (e.g., tree-shrub-grass), the greater the diversity of birds	(Han & Keeffe 2021)
	Plant species	+ : Native tree species, the more nectar species, the greater the bird diversity	(Zorzal, Diniz, Oliveira, et al. 2021)
	vertical greening	+ : The higher the percentage, the greater the diversity of birds	(Salisbury et al., 2023)
	planting density	+ : The higher the planting density, the greater the diversity of birds	(陆, 唐, 史, et al. 2007)
Green Space Characterization Element	area	+ : The larger the area, the greater the diversity of birds	(Zorzal et al., 2021)
	degree of separation	- : The higher the level of isolation, the more deprived the bird diversity is	(Janus & Lesinski 2018)
	heterogeneity	+ : The higher the heterogeneity, the greater the diversity of birds	(Callaghan et al., 2019)
	degree of aggregation	+ : The more aggregated the green space patches, the greater the bird diversity	(Soifer et al., 2021)
Elements of human interference	static (in a signal)	- : The more noise there is, the less bird diversity there is.	(Janus & Lesinski 2018)
	flow of people	- : The more people there are, the less bird diversity there is	(Bötsch, Tablado & Jenni 2017)

Elements of the built environment	Notches/holes	Notched holes can provide shelter for birds	(Janus & Lesinski 2018)
	plot ratio	- : The greater the plot ratio, the greater the lack of bird diversity	(Mbiba et al., 2021)
	distance between buildings	- : The greater the distance between buildings, the less bird diversity there is	(Mbiba et al., 2021)
	Open garbage spots	Human food scraps and other trash can provide food for birds	(Ortega-Álvarez and MacGregor-Fors, 2009)
Other environmental elements	bird holding pole	Staying poles can provide resting places for birds	(Schaub, Pradel, Jenni, <i>et al.</i> 2001)
	landscape light	Landscape lighting negatively affects nighttime rest of birds	(Wilson et al., 2021)
	impervious surface	The higher the cover of impervious surfaces (e.g., concrete), the more deprived the bird diversity is	(Souza et al., 2019)

Note: "+" indicates positive correlation and "-" indicates negative correlation.

Source: Organized by the authors based on research findings.

4.2. Status of Bird Survival Conditions in Yu'er Village

According to the literature and habitat characterization that affects the diversity of birds, the ecological needs of birds include sufficient water and food, suitable nesting sites, and a suitable environment for their survival. According to the results of the study, there are no conditions for birds to live and roost in the settlement of Yu'er Village.

In terms of water source, the fresh water resources near the coast mainly rely on the residents' domestic water, which is often accompanied by high intensity human interference, resulting in the lack of necessary water sources for birds to survive in the village and the distance from the water source.

In terms of food conditions, the vegetation cover in Yu'er Village is sparse, with street trees dominating the area, and from the results of the study, there are few flowers and fruit trees that rely on insects for pollination, which makes it difficult to attract insects, resulting in a lack of adequate food sources for birds in Yu'er Village. Research has shown that human leftovers can provide some food for urban birds, including food crumbs, bread crumbs and watermelon rinds in garbage. but this does not mean that all birds can benefit from it. This part of human leftovers alone is not enough to serve as the main food for birds.

In terms of nesting sites, the Yu'er Village settlement was not built with birds' nesting needs in mind, and therefore there are no natural nesting sites and conditions for birds. Spontaneous nesting activities were observed in a small number of street trees and building recesses and holes, but the number of birds was sparse. In addition, the nesting materials used by birds are dead branches and hay, etc. However,

urbanization has reduced the number of nesting sites and made it difficult to find nesting materials, which has a significant impact on the survival of the birds. At present, the Yu'er Village settlement has low vegetation cover, low greening rate, impermeable surface accounting for 80% of the total surface volume, and low ecological service function. A few residents practice rooftop farming on their own initiative, however, the main purpose is to grow vegetables and fruits, etc., and the number is scarce, most of the roofs are used for drying clothes or idling, and the unused space on the roofs can provide space for birds to roost. The research also found that the building facades of Yu'er Village settlements have a complex composition with elements such as concave and convex shape features, holes and window frames, pipes and eaves, which can be utilized to provide nesting space for birds.

From the perspective of suitable living environment for birds, the survival of birds also requires suitable temperature, air and enough living space. The climate of Shenzhen attracts a large number of migratory birds to spend the winter here, so the temperature and air conditions will not be discussed too much. In the city, birds are mainly active in the parts of buildings and structures below 16 meters (including building façades, sky gardens and passages, etc.), and more than 90% of the birds are active in the heights below six storeys, with the largest number of birds stopping at the fifth storey, which is the area and height where birds are mainly active. However, Yu'er Village has more than 5 storeys, with 8 storeys being the most common, and the overall lighting quality of the village is poor.

5. Conclusions

The renewal of older urban settlements for bird diversity conservation is a long-term and arduous systematic project, and the practice of bird diversity conservation can be effectively implemented through urban renewal, and the results of renewal can benefit both residents and birds. How to promote the harmonious coexistence of human habitat and bird habitat in the ecological regeneration of older urban settlements with high-density construction is an important direction for the development of ecological regeneration planning in Chinese cities nowadays. Starting from the survival needs of birds and taking Yu'er Village settlement as the empirical object, this study explores the habitat characteristics of bird diversity conservation at the scale of urban settlements through case study and data analysis, and proposes a renewal strategy for older urban settlements oriented to bird diversity conservation by combining the survival needs of birds with the current physical space status of Yu'er Village settlement. The study initially proposes corresponding renewal strategies, such as constructing 3D ecological corridors, enhancing the ecological connectivity between the coast and the inland, intervening in artificial water sources and artificial habitats, and providing food sources for birds. The results of the study can provide new ideas and references for urban renewal oriented to the conservation of bird diversity, which can further support the urban renewal strategy and the sustainable development of cities, and supplement the lack of biological perspectives in the ecological renewal of settlements in urban renewal studies.

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