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# Biodiversity and environment in cities—a case study of birds in urban and suburban areas of Japan

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**Abstract:** In Japan, the environmental degradation in the urban and urban fringe area advanced from rapid economic growth to begin at the mid-1950s. The environmental aggravation such as large-scale development of the city with little consideration of environment, air pollution and the noise and so on had a big influence at the biological diversity. The habitation space of the creature is decreased or disappeared, and biological diversity suddenly is decreased. This tendency continued after stability of the economic growth of the mid-1970s. The environment of the urban area was not desirable space for the creatures. In addition, it decreased the ecosystem service. However, this problem lies in administration and private consciousness, and improves the consciousness of inhabitants and the reduction of the pollution, as well as the maintenance and creation of the urban greening advanced, and the environment of the urban area was improved.

**Keywords:** biodiversity, environment; bird; green open space; patch; corridor; matrix; urban landscape

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## 1. Introduction

Before exploring the topic of this paper, it is necessary to understand “biodiversity” [1] and “cities”. Biodiversity is the biological habitat in a variety of living environments, adapt to their living environment and site, through the delicate balance between organisms can be formed. It takes biology as the medium, and constructs regional terroir and landscape together with materials directly related to fuel, food, medicine and materials. It is also a valuable thing that presents culture and art and enriches people’s life [2, 3].

Biodiversity has three dimensions, namely, ecosystem, species and genes [4]. “Ecosystems”, such as the diversity of biological ecosystems for the flow of energy and information. “Species” can be said to be the diversity of species, different species of size, shape, body will be different, simply put, the difference between sparrow and crow species can be said to be species diversity. “Gene” refers to the fact that even similar organisms have different living habits and habitats due to geographical differences. In other words, genetic diversity is based on diversity within genetically distinct species, and there are three levels.

Secondly, cities are shaped by the development of human economic activities such as commerce, logistics and production. They are spatial places where people together in a limited area. This space is not an environment centered on human territory, but a place where many living things coexist. With the change of urban environment, species may decrease, but there are also some special species increase. In the current big cities, many spatial environments have been improved, and Spaces suitable for living things in the city have been created and restored.

This paper will discuss the research results and future research directions of biodiversity based on birds from the perspective of cities.

## 2. Urban environment in Japan

Ya Mada pointed out that Japanese cities after 1945 could be divided into five periods according to economy and land development [5]: The period of post-war reconstruction and resource development from 1945 to 1955 (Showa 1920s), industrial development and rapid economic growth from 1955 to 1966 (Showa 1930s), regional development and suburbanization from 1966 to 1976 (Showa 1940s), A period of steady growth and local development from 1976 to 1983 (Showa 1950s), followed by a period of high concentration and bubble in Tokyo after 1983 (late Showa 1950s).

**Table 1.** Environment and biodiversity chronological.

The western	Japan:	Japan	The world
1896	The Meiji 29 years	Rivers Act	
1911	The Meiji 44 years	The Factory Act	
1931	Showa 6 years	National Parks Act	
1948	Showa 24 years		International Union for Conservation of Nature (IUCN)
1949	Showa 25 years	Tokyo Municipal Public Hazard Prevention Ordinance	
1950	Showa 26 years		The International Union for the Conservation of Birds
1952	Showa 28 years		International Monetary Fund (IMF) Japan joins International Bank for Reconstruction and Development (IBRD) Japan joins
1955	Showa 30 years		General Agreement on Tariffs and Trade (GATT) Japan joined
1956	Showa 31 years	City Park Law Capital Area Reconditioning Law	
1957	Showa 32 years	Nature Park Law	
1962	Showa 37 years	National Integrated development Plan	
1963	Showa 38 years	Kinki Circle Reconditioning Act	
1967	Showa 42 years	Basic Law on Public Hazard Countermeasures	
1968	Showa 43 years	Air Pollution Prevention Law Urban Planning Law	
1969	Showa 44 years	Osaka Prefecture Public Hazard Prevention Ordinance	
1971	Showa 46 years	Establishment of the Environment Agency	The Ramsar Convention
1972	Showa 47 years	Natural Environment Preservation Act	Official Statement of the Japan-China Conference on the Normalization of

			Human Environment (Stockholm Conference)
1973	Showa 48 years	Urban Green Space Preservation Act	Washington Convention (CIT S)
1974	Showa 49 years	Land Use Planning Law Production Green Land Law	
1976	Showa 51 years	Land use planning	
1978	Showa 53 years		Japan-china Treaty of Peace and Friendship
1982	Showa 57 years		United Nations Environment Conference
1985	Showa 60 years	Second land use plan	Montreal Protocol to the Vienna Treaty
1992	Pp.47–53 4 years	Species Preservation Act	Earth Environment Summit Agenda 21 Convention on Biological Diversity (CBD)
1993	Pp.47–53 5 years	The Basic Environmental Law was enacted	
1994	Pp.47–53 6 years	The Basic Law on the Environment	
1995	Pp.47–53 7 years	National Strategies for Biodiversity	
1996	Pp.47–53 eight years	The Third National Land Use Plan	Kyoto Protocol
1997	Pp.47–53 nine years	Environmental Impact Assessment Act	
1998	Pp.47–53 10 years	A grand design for the 21st century homeland	
2001	Pp.47–53 13 years	Ministry of Environment established Soil Countermeasure Method Natural Regeneration Promotion Method	
2002	Pp.47–53 14 years	New national strategy for biodiversity: Revised Bird and Animal Protection Law	
2003	Pp.47–53 15 years	Natural Regeneration Promotion Act	Cartagena Protocol
2004	Pp.47–53 16 years	Landscape Act Alien Organisms Act Urban Green Space Law (Revised Urban Green Space Preservation Law)	
2005	Pp.47–53 17 years	The Kyoto Protocol entered into force	
2007	Pp.47–53 19 years	The Third National Strategy for Biodiversity	
2008	Pp.47–53 20 years	The Basic Law on Biodiversity Formulated the Law on Promoting Biodiversity Conservation Activities	Nagoya Protocol
2010	Pp.47–53 22 years	Strategic Plan for Biodiversity 2010	

2012	Pp.47–53 24 years	Strategic Plan for Biodiversity 2012–2020	
2015	Pp.47–53 27 years		The Sustainable Development Goals (sdgs) were adopted
2017	Pp.47–53 29 years	Sdgs Action Plan 2018 made public	

Among them, the economic growth from the mid–1950s to the mid–1970s brought great changes to the urban space and environment in the city and surrounding areas (near the city), which was the era of breakthrough development of land development and heavy and chemical industries. In addition, Japan joined the International Monetary Fund (IMF) and the International Bank for Reconstruction and Development (IBRD) in 1952 as a foundation for the previous stage, ushering in an era of rapid national economic recovery.

During this period, Japan concentrated on changing land use in urban and suburban areas to stimulate economic development such as industrial land. As for industrial land, the government is promoting land development through land preparation and landfill in the surrounding agricultural land, mountain forests, and the coast. This is also an era of continuous economic development. In addition, this was an era of high concentration of population into cities, characterized by the marked progress already made in urban sprawl.

However, the flip side of the improving economy is the deteriorating environment in cities and suburbs. Urban public hazards and environmental pollution such as air, water quality and noise continue to emerge. The deterioration of living environment in Japan has led to a series of social problems. This kind of public hazard problem and environmental pollution not only affect human beings, but also cause a significant reduction of various organisms living in cities and suburbs, and even the disappearance of some species. Moreover, while urban expansion has led to the development of suburban areas, the green space once known as village land and village hills, which are important to urban residents, has been declining. A series of human activities, such as the abolishment of mountain areas (secondary vegetation forests) as fuel forests, the construction of artificial revetments in coastal areas and the construction of concrete Spaces on three sides in river areas, have led to changes in the natural environment, which is also an era of urban biological reduction [3].

With the economic growth, the urban environment has changed a lot, as shown in **Table 1**, which shows the environment and biodiversity. In order to ameliorate the deterioration of the environment, Japan has tried to enact various laws to cope with it. For example, the government implements management according to the Basic Law on Public Pollution Countermeasures (1967) and the Air Pollution Prevention Law (1968), while promulgation of the Urban Parks Law (1957, revised in 2017), the Urban Planning Law (revised in 1968, revised in 2006), the Natural Environment Preservation Law (1972), and other laws. The Urban Green Space Preservation Law (1973, 2014) and other laws provide legal basis for “environmental governance” and promote the protection of urban environment. In addition, the emphasis on “making good use of the environment” has promoted active land planning policies.

### 3. Green space in the city

From the mid-1950s to the mid-1970s, public hazards and environmental pollution were aggravated, and people's awareness of the problem of public hazards and citizens' awareness of the protection and countermeasures of nature and natural environment were also deepened. On this basis, the importance of urban green space can be seen in the promulgation of "Urban Green Space Law", and the recommendation of green space protection and greening work also reflects this point.

The importance of urban green space [6] is reflected in its function of improving the environment. In addition, it can reduce the heat island effect, purify the air, prevent noise and vibration, protect the living environment and maintain biodiversity. It also has the function of safety and disaster prevention. It can also be used as a refuge and evacuation place in case of earthquake, play a role of partition in case of fire, and prevent the occurrence of natural disasters such as floods [7]. In the function of landscape composition, green space is used in a variety of flexible ways, such as helping to create a warm street full of cultural and historical atmosphere, and creating opportunities for recuperation and contact with nature in the function of providing comfort.

Before giving better play to the function of green space in cities, local governments in Japan have formulated and implemented the "Green Basic Plan" based on the urban green space Law, aiming at how to ensure and protect green space in metropolitan areas. The plan sets goals for green space protection and greening, and introduces a series of measures such as maintenance, management and protection of urban parks needed to ensure green space, greening promotion, and protection of productive green space. These measures not only improve the quality of green space, but also provide a good living environment for urban residents and living creatures there. The importance of urban green space is also very important for living things. From this point of view, it is also necessary to fully consider the issue of environmental improvement.

However, in Japan's large cities with concentrated population, there are still many cities promoting the construction of residential land. Especially in large cities, the green space is constantly reduced, and the living space of various organisms is oppressed from time to time. To compensate for this, Tokyo and Osaka have begun to develop existing green Spaces and create new urban green Spaces, hoping to create ecological green Spaces for living organisms to live and reproduce [8-10] (Figures 1-3).



**Figure 1.** Keio plaza hotel No.4 street space, Shinjuku Tokyo.



**Figure 2.** Otemachi forest, marunouchi Tokyo.



**Figure 3.** Grand front Osaka's garden, umeda osaka.

The initiative to create green space will provide a place for urban residents and users to “get in touch with nature.” It will also provide “ecosystem services” to all of us. It is also good for the living creatures living in the city.

#### **4. The importance of urban biodiversity**

It can be seen from the urban environmental problems in Japan that the concentration of urban population after rapid economic growth leads to population increase, environmental deterioration, and reduction of green space; urban expansion leads to a sharp reduction of green space such as woodland and agricultural land in the surrounding areas; and the abandonment of villages and agricultural land leads to no management and other negative situations. At the same time, it leads to the deterioration of living environment, habitat environment fragmentation and the resulting reduction of species also disturbed the ecosystem, ultimately leading to the low quality of urban biodiversity. For citizens and users living in cities, it can also be said that the quality of ecosystem services has declined.

However, in recent years, progress has been made in the implementation of policies such as the “Basic Green Plan” and in the creation, protection and protection of urban green Spaces, not only in cities, but also around cities. Slowly but surely, the living space is being protected. In other words, the city's biodiversity is gradually recovering. However, in order to guarantee and protect the biodiversity of the city, various measures should be taken. It is also necessary to comprehensively consider the spreading of the breeding green patches and the green corridors connected with them,

as well as the greening status of the space outside the patches and corridors, namely the matrix space [11]. Patches are parks (**Figures 4, 5**), corridors such as trees on both sides of roads (**Figures 6, 7**), urban river space (**Figures 8, 9**), etc.

In order to eliminate the differences in the habitat of organisms, the importance of green space network is self-evident, which is the key to better use of green space in parks and ensure the quality of biodiversity. In addition, green space is not only needed for the physical environment, but also has certain value for the practical use of regional learning, information transmission and other popular education. The embodiment of ecology network in the city [12], the active use of patches, corridors and the existence of substrates are also extremely important for the future development of urban biodiversity.



**Figure 4.** Umekoji park, Kyoto.

Biodiversity is important for urban dwellers and urban users, as many reports have shown. Although the urban green area of some Japanese cities is decreasing, some big cities such as Tokyo and Osaka are also continuously promoting green space construction. The following will further introduce the research results and research methods in this field at home and abroad.



**Figure 5.** Kamogawa park, Kyoto.



**Figure 6.** Trees of kamo kaido road, Kyoto.



**Figure 7.** Trees of shimeidori street, Kyoto.



**Figure 8.** Kamogawa delta, Kyoto.



**Figure 9.** Kamogawa river, Kyoto.

## **5. Current situation and topic of biodiversity based on birds in cities**

Biodiversity in urban environments, as measured by Birds, is one of the various

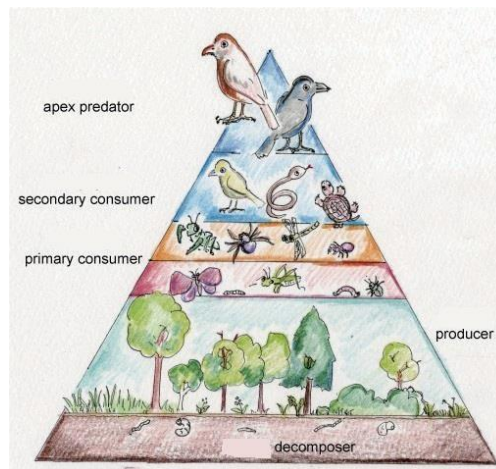


methods of identification. When identifying urban biodiversity, birds are used as indicators because birds are the upper species at the top of the ecological pyramid, which can be used to judge the status of the lower ecological groups (**Figure 10**). In short, by surveying birds, we can observe a variety of conditions, namely, the underlying flora of the birds, insects and other ecosystems.

In addition, birds also play a role as a barometer of urban conditions, reflecting such conditions as “ecosystem richness”, “conditions and states of ecosystems” and “green space conditions” in cities.

So far, taking birds as an indicator is the practice of using them as a research tool to conduct research and investigation. There are many cases at home and abroad. From this point of view, there are a lot of accumulation from the perspective of green space planning and landscape ecology, and the confirmation of research and the convenience of utilization are also very important.

Looking back, various researchers at home and abroad have published many studies of cities and their suburbs using birds as indicators. The author has shown that about 30% green space (including urban fields, etc.) in the city can improve the diversity of birds [13]. This is to create a detailed land use database through a geographic information system (GIS) and analyze the correlation between this data and the bird data obtained from the survey, in order to clarify the importance of urban green space.



**Figure 10.** Ecological Pyramid.

So far, the authors have conducted a series of studies on biodiversity in urban and rural areas using birds as indicators. Firstly, a study on the relationship between land use and birds in urban and suburban areas was conducted in Kobe City and Akashi City in Hyogo Prefecture, Kansai Circle, Japan from 1994 to 1999 [13]. This research is based on the landscape ecology perspective of the application of geographic information system (GIS) research. In this study, GIS is first used to distinguish the land use of the survey area, and the spatial database of the actual society is used as detailed spatial information, and the virtual reality space is constructed digitally. At that time when raster data was the center, although rough data were acquired in the vast ground space, this study used GIS vectors to conduct detailed data combination analysis. In addition, the extensive use of vectors in landscape ecology research at that

time was almost pioneering in terms of operational time and large data extent.

Second, to explore the relationship between space and ecosystem, the study investigated birds. Bird survey is conducted by point census and line transect [14] to obtain detailed data of bird species and individual numbers, so as to grasp the living conditions of birds in the present situation. In addition, by classifying birds into urban, waterfront, grassland, mountain and various nature categories, we can also grasp the differences between birds and their habitat environment. Through the combination of survey results and GIS spatial information, the main factors of land use to improve bird diversity were explored.

The research results show that the existence of urban and suburban green space can improve the diversity of birds, at the same time, from the analysis results also understand the various forms of land use also can increase the types of birds, especially has been clear about the 30% of green space in the city (including urban land, etc.), can improve the diversity of birds, this in the future urban green space planning in, The benchmark for green space area to improve biodiversity has been clarified.

In the previous studies of other researchers, Ichinose investigated the bird ecosystem from the green coverage area of the city. When the green coverage area reached 0.2 hm<sup>2</sup> or more, the bird flock became abundant, which reported the importance of the proportion of surrounding woodland in the scale of patch area [15,16]. In addition, K Atho et al. Obtained the status and relationship of isolated forests around cities [17–19], and Blake et al. Also obtained the research result that the number of birds would increase with the increase of patch area [20].

The author and Terashima investigated the impact of factory green space and bird diversity in Osaka Prefecture, Japan [21]. According to the Japanese Factory Site Law (revised in 1959 and 2016), the ratio of green space to floor space must be at least 20 percent for factories with floor space of more than 9000 square meters or floor space of more than 3000 square meters. This study showed that the diversity of bird species was improved in the limited green space environment of the factory. At the same time, it was clear that the increase of greening improved the land use environment of the factory.

In previous studies by other researchers, Rudisse et al. Showed the relationship between land use and birds from the perspective of landscape [22], and MorTberg et al. Reported that forest area and interforest connectivity were important for birds [23].

In addition, according to a series of studies conducted by Sasaki and the author in the Osaka World Expo Memorial Park using aerial laser measurement, the structure of forest layer also has an impact on birds. When leaf groups are not concentrated in a specific hierarchical structure but scattered in various levels, the overall diversity of birds will be affected [24,25]. This is obvious in the current study, but it can also be said to be important in the two-dimensional space of flat green space. This study shows that the quality of 3D space is an important hierarchical structure, and the hierarchical structure is an important reference for considering the future green space planning.

In other previous studies, Loman et al. Further pointed out that depending on the size of the habitat [26], and Fer Nandez's study showed that the higher the frequency of human visits, the lower the diversity of birds [27], indicating the negative impact of anthropogenic pressure.

On this basis, fernandez [28, 29] study of city parks, such as traffic impact the

trees of the park nest and animal species, at the same time, s park facilities and park area will also affect, and concluded “should not only protect the park of large area, but also protect the old park” this interesting conclusion. Buxton et al. Concluded that urban land cover debris affected grassland birds [30], and Grafius et al. Also conducted relevant studies on the relationship between urban landscape composition and birds [31].

According to the investigation of Njoroge and the author, who took the large-scale green space Osaka Expo Memorial Park as the object, the appearance of forest birds is related to deciduous forest and mixed forest, and the lawn like square is the preferred choice of urban birds [32,33]. Therefore, the author made a detailed analysis of the land use cover (**Figure 11**) and investigated the relationship between the land use cover state and birds based on the annual changes of the park using aerial laser GIS data [34]. The results showed that the land use cover and bird species composition changed from the long-term bird survey and monitoring data. It was also pointed out that umbrella species are returning to urban centers and the habitat range of birds is also recovering. This study indicates a new direction in the application of three-dimensional measurement data such as aerial laser measurement in field research, and it is also a new attempt in combination with green space planning.



**Figure 11.** Airborne lidar GIS data of Osaka expo ‘70 Park’.

In previous studies related to other parks, Strahbach et al. Reported that more birds live in small green Spaces than in large green Spaces [35]. The author conducted a detailed vegetation survey of the main urban parks and urban trace parks in Fukuoka, Kyushu, Japan, and established a database of their vegetation structure through GIS [36,37]. In addition, the survey of birds was carried out by the method of fixed-point recording, and the relationship between the results of the survey of birds and the vegetation condition was analyzed by multiple comparisons. The results showed that

the size of green cover area was correlated with the increase of diversity.

In addition, the author conducted a field survey on how bird habitat parks improve diversity in major urban parks and wetland parks in Xiamen, Fujian Province, China [38,39]. Firstly, the planting situation and surrounding environment of the park were investigated deeply, and the composition of planting and surrounding environment was established by GIS. In addition, the present situation of birds was grasped by the method of spot recording in the survey park and the survey of bird years, and the relationship between the birds and the planting situation was analyzed. The results showed that the diverse vegetation patterns of Xiamen park green space increased the habitat of birds. At the same time, Xiamen attaches great importance to the development of eco-system city planning “Xiamen City Ecological Civilization Construction 13th Five-Year Plan” also shows that these parks play an important role.

Miyamoto and the author clarified the importance of green corridors and patches by exploring the relationship between linear green Spaces, namely small-scale parks and birds in cities [40–43]. In particular, the presence of birds in urban block parks confirms the effective use of small linear green Spaces as passageways for birds, and also shows the importance of urban green networking. In addition, in view of the Kyoto city pipa lake hydrophobic and the hydrophobic side in some place of the relationship between green space and birds also carried on the detailed investigation, the results show that for the linear green space green network, is to help the Kyoto city biodiversity has increased, at the same time, in consideration of plaques in the city is on the way has a certain reference value. The linear green patches and small-scale green corridors in Kyoto city enhance the diversity of bird species. It can be seen that these green space networks lead to the improvement of biodiversity to some extent, which is a representative study. Because Jingcheng City is a city with a long history, its urban development behavior is limited to a certain extent, and green space allocation is conducive to the planning and design of urban parks and greenways in the future.

In addition, as one of the studies on linear green space, Terada and the author [44] investigated whether the green belt along the urban expressway in Osaka Prefecture had an impact on birds. Despite the existence of a large number of artificial Spaces such as the expressway, the green cultivation area provided a good environment for birds. In such a city, the green space attached to the highway, which is an artificial structure, plays the role of moderating the artificial structure itself, and also provides a certain reference for the planning of urban environment improvement and biodiversity promotion.

In addition, the research conducted by Hamada (H A M A D A) and the author shows that the existence of the shrine forest, which also serves as a corridor in Kyoto city, is of certain importance to bird habitat [45]. As for the importance of green patches, the author and Nish I no clarified the existence of street trees in urban linear green Spaces in Kyoto, which are also very important for birds [46]. As Takabasyashi and this author pointed out in their study of linear green Spaces along urban rivers, even small Spaces are likely to become habitats for bird flocks by balancing the height difference between trees with a good configuration of tall trees, medium trees and grass. The above is a study on green space planning of urban rivers and hydrophilic Spaces, and the results clarify the correlation between green space along urban rivers

and forest facies [47].

In the previous studies of other researchers, Sharma et al. [48], in order to better explain the relationship between birds in small-scale protected areas within cities, Jokimaki's study, which considered biodiversity, explained the importance of urban parks during the breeding period of birds [49].

In the process of promoting urban greening in the future, when the ground green area can not be guaranteed, roof greening in urban areas can be used as a supplementary means. However, greening should not be blindly promoted. It must be fully researched and mastered in advance in terms of quantity and quality. Motegi et al. Studied the environmental characteristics and roof greening in Tokyo, and explored the relationship with birds [50]. However, there are not many detailed studies on the quality of roof greening and birds. On this basis, a series of studies by Matsumoto and the author analyzed in detail the correlation between roof greening and birds in downtown Osaka [51–53]. The GIS information of the trees and shrubs planted on the roof was used to survey the birds by the method of fixed-point recording, and the birds and other species were mastered. Through the analysis of GIS spatial data and bird data, it is found that it is difficult to improve the diversity of birds by planting trees only in the tree layer. In addition, the study also clarified that the quality of the shrub layer is the key to improve the diversity of birds.

In other previous studies published at the same time as this study, Br Ian et al. reported the possibility of roof greening of this urban green space as a new habitat [54]. From these results, it can be seen that roof greening also plays an important role in the urban ecological network.

Although the importance of urban green space has been confirmed by many people, the author has conducted a series of studies on the land use of rural areas in urban suburbs in the existing research on green space in agricultural areas in urban suburbs [55–58]. In recent years, S Akashita and the author have studied the bird habitats in the rural areas and suburbs of Takatsuki cities in Osaka Prefecture [59]. In addition, in the detailed survey of agricultural land, Ha Mada and the author [60–62] conducted a series of studies on the rural space in Kyoto city and its suburbs, not only the flat agricultural land conditions in the suburbs, but also the continuity of agricultural land, that is, the diversity of birds has been improved in the green space. Even in underutilized agricultural land such as fallow fields, bird diversity will increase.

The research of Loman et al. Showed that agricultural land had an important contribution to the life of birds [26], and Borges et al. Also conducted a study to explore the adaptability of ecological environment from the perspective of agricultural landscape [63].

According to the current status of biodiversity in urban and suburban areas, birds that once abandoned urban life are returning to urban centers, and some species are also returning. As can be seen from a series of studies conducted by the author, the regression of the Common Kingfisher (*Alcedo atthis* Linnaeus, 1758/Common Kingfisher) in urban rivers (**Figure 12**), *Dendrocopos kizuki* Temminck (1836/Japanese Pygmy Woodpecker) (**Figure 13**) regression, Variegated tits (*Parus varius* Temminck & Schlegel, 1848/Varied tit) (**Figure 14**) breed in park green fields. Meanwhile, nesting sites of the large bird raptor *Accipiter Gentilis* (Linnaeus,

1758/Northern Goshawk) were found in large parks. In addition, in recent years, the expanded nesting environment of the Blue Rock Thrush (*Monticola Solitarius* Linnaeus, 1758/Blue Rock Thrush) has appeared in the city center (**Figure 15**).

As other previous studies since 2000 have demonstrated, the cases are not particularly rare. This is because the environment of Japan's big cities has become stable, and the lost species are returning to the cities. "Urban return" has evolved into "expanding habitat to the cities".



**Figure 12.** Common kingfisher.



**Figure 13.** Japanese pygmy woodpecker.



**Figure 14.** Varied tit.

## 6. Conclusions

With regard to urban and suburban biodiversity, in addition to protecting and improving the quality of existing green Spaces, safeguarding and creating new ones are also important. In addition, it is a recognized fact that the urban environment must be improved and enhanced, with measures such as roof greening being important factors (**Figures 16, 17**). It can be said that considering the above factors, Japanese

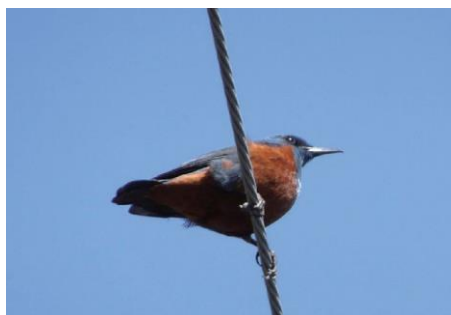
cities and urban suburbs are developing in a positive direction of biodiversity. However, it is more important to not only improve the urban environment in advance, but also to cultivate the soil for biological return.



**Figure 15.** Blue rock thrush.



**Figure 16.** Futago tamagawa rise roof garden, Setagaya Tokyo.



**Figure 17.** Grand front Osaka south tower's roof top garden, Umeda Osaka.

For example, the Bird and Animal Protection Law (the Wildlife Protection and Management Law promulgated in 1918, comprehensively revised in 2002, and implemented in 2015) stipulates the protection and management rules of animals, which has greatly changed Japanese people's understanding of cities and natural environment [57]. The return of birds has improved the quality of urban biodiversity, but at the same time, it is necessary to confirm the status of biodiversity in urban and non-urban surrounding areas. It is possible that the environmental deterioration in the surrounding areas of the city has led to bird migration. At the same time, it cannot be ruled out that the biological strategic expansion of living habitat and other reasons.

Before planning to improve urban and suburban green space, we need to grasp the current situation, including a series of previous studies by the author, aiming at confirming the relationship between the current urban situation and the area and

quality of green space by using birds as a tool, and then seeking the proper development mode of urban and suburban green space in the future. Based on the relationship between urban and suburban green space, farmland status and birds, what kind of environment is beneficial to biodiversity? That is, for urban residents, what kind of direction the good environment will develop, and it is also the subject explored by biodiversity research service. Biodiversity can only be established if a delicate balance is achieved, and the above research results are still in the stage of accumulation, and further exploration and research are needed in the future. From the perspective of green space planning and landscape ecology, it is necessary to accumulate these studies in order to formulate better biodiversity strategies in cities and suburbs in the future.

**Conflict of interest:** The author declares no conflict of interest.

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