*birds*

MDPI

*Article*

# The Distribution, Population Size, and Habitat Preferences of a Newly Established Population of the Oriental Magpie *Pica serica* in Tomakomai City, Hokkaido, Northern Japan

**Masahiro Fujioka [1,2,*] and Hisaya Murayama [1,3]**

[1] Graduate School of Life and Environmental Sciences, University of Tsukuba, Tsukuba 305-8572, Ibaraki, Japan
[2] Independent Researcher, Negoya 1029-24, Ishioka 315-0132, Ibaraki, Japan
[3] Japan Wildlife Research Center, Sumida Ward, Tokyo 130-8606, Japan
* Correspondence: egretta2000@gmail.com

**Simple Summary:** A non-native species, the Oriental Magpie (*Pica serica*) has established a population in a restricted area of southern Hokkaido, northern Japan, since the 1990s. To clarify the current number and distribution of the population and their major determinants, we conducted intensive field surveys six times during the course of a year from May 2012 in Tomakomai City, the central area of the current distribution. We found 181 to 248 magpies in every survey, and 46 active nests in May. Most of the magpies appeared in residential areas, avoiding commercial and industrial areas. The magpies foraged mainly in short grasslands in public spaces, such as parks, in May and July, and most of the birds preferred house gardens for foraging from November to March. Dogs or cats were often kept outside in the gardens where the magpies foraged, and observations of the magpies stealing pet food were common. It is likely that the magpies rely on anthropogenic food resources such as pet food, especially in winter. This study provides a basis for further monitoring of this non-native magpie species that has invaded urban/suburban habitats in Hokkaido, Japan. As magpies and their nests are easy to find, citizen science could contribute to such monitoring.

**Abstract:** Non-native species have caused various problems for both animal and human communities globally, but their monitoring during the early stages of establishment is often difficult. A population of the Oriental Magpie (*Pica serica*) has established on Hokkaido Island, northern Japan, since the 1990s, offering a rare opportunity for field biologists to monitor the entire history of a colonizing avian population. To clarify the current number and distribution of the population and their major determinants, we conducted bimonthly surveys from May 2012 to March 2013, over a total of 417 h, in Tomakomai City, the central area of the current distribution. We found 181 to 248 magpies in every survey, and 46 active nests in May. Most of the magpies appeared in residential areas, avoiding commercial and industrial areas, and did not show seasonal changes in their distribution pattern. The magpies mainly foraged in short grasslands in public spaces, such as parks, in May and July, but most of the birds preferred house gardens for foraging from November to March. Dogs or cats were often kept outside in the gardens where the magpies foraged, and observations of magpies stealing and hoarding pet food were common. It is likely that the magpies rely on anthropogenic food resources such as pet food, especially in winter. Continuous monitoring of this population will enable further knowledge of the factors that limit the number and range of not only non-native species but also avian populations in general to be obtained.

**Keywords:** non-native species; anthropogenic food resources; pet food; urbanization

check for updates

**Citation:** Fujioka, M.; Murayama, H. The Distribution, Population Size, and Habitat Preferences of a Newly Established Population of the Oriental Magpie *Pica serica* in Tomakomai City, Hokkaido, Northern Japan. *Birds* **2024**, *5*, 656–670. https://doi.org/10.3390/birds5040045

Academic Editor: Jukka Jokimäki

Received: 21 August 2024
Revised: 12 October 2024
Accepted: 12 October 2024
Published: 15 October 2024

**Copyright:** © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

## 1. Introduction

The invasion of non-native species has a significant impact on native communities and is considered one of the main causes of biodiversity loss. Breeding records exist for

43 alien bird species in Japan [1]. Various factors have been cited as relevant to whether a non-native species has been established (in the sense of [2]), including a sedentary habit, plasticity of behavior, food sources, and habitat preferences, as well as similarity to the original environment; however, no consistent trends have been found except for propagule pressure [3–5]. Non-native species often invade urban areas, which offers good opportunities for testing general ecological hypotheses relating to invasion biology and island biology [6]. There are, however, not many examples in which the number and distribution range of a bird population have been monitored from the earliest days of invasion [7–12].

The magpie genus *Pica* is widely distributed in the temperate Northern Hemisphere and is currently divided into seven species, with the Oriental Magpie (*Pica serica*) being an independent species, according to the International Ornithological Committee (IOC) World Bird List [13]. All of them share a conspicuous black and white color pattern, a distinctive voice, omnivorous diet, and highly sedentary habit. Although magpie species are not naturally distributed in Japan, a population of the Oriental Magpie was introduced from the Korean Peninsula approximately 400 years ago, becoming established with a self-sustaining population on northern Kyushu Island, western Japan [14]. Sporadic breeding has been observed in other areas, mainly Kyushu and along the Sea of Japan, but they have since disappeared in all cases [15]. In the Iburi region on the Pacific coast of southern Hokkaido, however, observations and breeding records have been increasing since the 1980s [16,17].

According to an earlier survey conducted in 2011, magpies have become widely established (i.e., self-sustaining) in the urban areas of Tomakomai City, forming the largest population of approximately 200 birds in Hokkaido [18]. Because of their high genetic diversity, the Tomakomai magpies are presumed to have originated from several founding groups of the Oriental Magpie, which is distributed from the Russian Primorye region to the Korean Peninsula and eastern China [19]. Although the process of their introduction is unknown, the Hokkaido population of magpies might have been unintentionally brought in by ships, as Tomakomai City is home to the Tomakomai Port, which handles more than half of Hokkaido's port cargo volume and conducts a large amount of trade with neighboring countries. In this paper, the term "magpies" refers to *Pica serica* individuals, and "magpie species" refers to *Pica* spp., unless otherwise specified.

Magpie species in Europe and Asia originally inhabited rural areas, but in recent decades they have spread into urban areas, often breeding in high densities [20–23]. In Hokkaido, magpies have only become established in urban/suburban areas. In other words, in Hokkaido, the Oriental Magpie is both a non-native species and an urban bird. Magpie species are known to utilize anthropogenic food resources throughout the year in and around urban areas [20,24]. Anthropogenic food resources in winter, when natural food resources are scarce, increase the survival rate of Corvidae species in urban areas, which often leads to population increases [25–27].

It is important to understand the current population size, distribution range, habitat preference, and food resources of magpies in Tomakomai City to predict whether magpies will spread further in the future. We conducted six bimonthly field surveys over a period of almost one year in Tomakomai City, with the aim of understanding (1) the number of magpies in Tomakomai City, (2) the general biology, such as the habitat preferences, flocking, behavior, and communal roosting, of the new population, and (3) the spatial distribution pattern and its causes. We especially focused on the spatial variation in the magpie densities in relation to the foraging habitat and food resources.

## 2. Materials and Methods

### *2.1. Study Area*

The field survey was conducted in Tomakomai City (42°38′03″ N, 141°36′20″ E) in southern Hokkaido, Japan. Tomakomai City is located 52 km south–southeast of Sapporo City, the largest city in Hokkaido, and is a medium-sized city with a total area of 562 km$^2$

and a human population of approximately 170,000 (Figure 1). On the south side, facing the Pacific Ocean, is a plain area about 2–8 km wide, and the Tomakomai Port, a large dug-in man-made port that opened in 1963, is located in the central part of the city. Most of the hills and mountains in the northern parts of the city are covered with deciduous broad-leaved forests, while intact peatlands remain in the eastern part of the plain. Tomakomai City has little farmland that can produce grains.

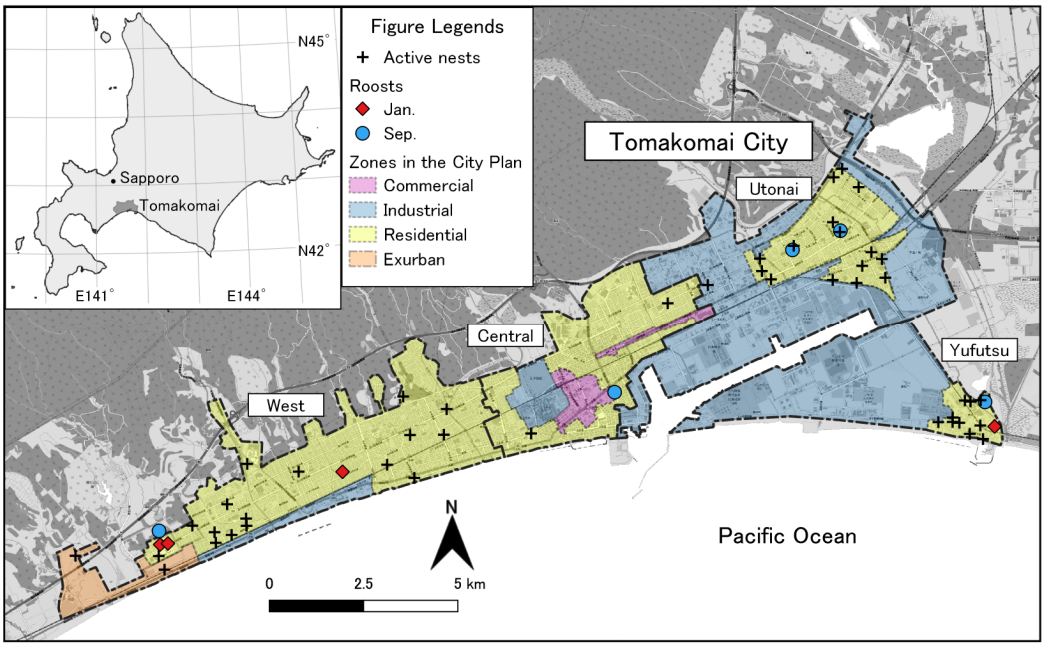



**Figure 1.** The study area, with the locations of active nests of the Oriental Magpie in May 2012 indicated by plus signs and those of roosts by blue circles (found in September 2012) or red squares (found in January 2013). The study area was divided into 11 blocks based on the combination of four sub-areas, of which names are shown in text boxes (West, Central, Utonai and Yufutsu), and four categories of zones in the Urban Planning of Tomakomai City (see Table 1). The background map is a grayscale-converted ©OpenStreetMap, wherein the dark gray represents forested areas.

Because magpies are not observed in continuous forests or peatlands [28,29], the study area was limited to the 79.9 km$^2$ of plains in Tomakomai City (Figure 1). This study area was almost identical to those of Oyake et al., 2024 [24] and Nakahara et al., 2015 [29] except some peripheral parts. Two other species of corvids, the Large-billed Crow (*Corvus macrorhynchos*) and the Carrion Crow (*C. corone*) were common all year round (personal observations). There were several forest patches, consisting mainly of the Japanese oak (*Quercus crispula*), and there were many planted trees such as the manchurian ash (*Fraxinus mandshurica*), Japanese popular (*Populus suaveolens*), Japanese elm (*Ulmus davidiana*), and Japanese lime (*Tilia japonica*) in parks and along major streets (personal observations). There were not many evergreen conifers in Tomakomai City except the Japanese black pine (*Pinus thunbergii*), planted mainly in sand-prevention forests along the Pacific coast in the southeast area.

The study area was divided into 11 blocks, ranging in size from 59 ha to 2114 ha, based on two criteria (Table 1, Figure 1). First, based on aerial photographs from the 1960s provided by the Geospatial Information Authority of Japan [30], the "Central sub-area" was defined as the central area where factories and residential areas were developed before the opening of the Tomakomai Port in 1963. The "West sub-area" was defined as the southwestern area that has been mainly developed as residential since the 1970s. The east side of the central sub-area, which has been mainly developed as industrial land, was designated the "Utonai sub-area" to the north of the Tomakomai Port, and the south side was designated the "Yufutsu sub-area". The study area was then divided into four

zones according to the Tomakomai City Urban Planning Map established in 1984 [31]: "residential zone", "commercial zone", "industrial zone", and "exurban zone". When referring to a specific study block, we used the sub-area zone notation; for example, the Utonai-residential block for the residential zone in the Utonai sub-area.

**Table 1.** Features of the 11 study blocks in the study area.

| Block | Sub-Area [1] | City Zone [1] | Area (ha) | Effort Index [2] | Outdoor Dogs [3] | Human Density [4] |
|---|---|---|---|---|---|---|
| C-C1 | Central | Commercial | 152 | 13.9 | 0 | 26 |
| C-C2 | Central | Commercial | 59 | 11.1 | 0 | 58 |
| C-I | Central | Industrial | 184 | 3.0 | 0 | 5 |
| C-R | Central | Residential | 1114 | 13.8 | 22.0 (2.2) | 52 |
| U-I | Utonai | Industrial | 2114 | 4.2 | 0 | 1 |
| U-R | Utonai | Residential | 741 | 13.9 | 23.5 (3.2) | 29 |
| W-I | West | Industrial | 146 | 1.9 | 1.0 (0.7) | 6 |
| W-E | West | Exurban | 286 | 4.2 | 0 | 4 |
| W-R | West | Residential | 1851 | 18.8 | 45.5 (2.5) | 39 |
| Y-I | Yufutsu | Industrial | 1161 | 2.1 | 0 | 0 |
| Y-R | Yufutsu | Residential | 181 | 15.0 | 11.5 (6.4) | 12 |
| | | Total or mean | 7989 | 9.3 | 105.5 (1.3) | 21 |

[1] See text for the definition of the sub-areas and city zones. [2] Effort index: the mean length of the survey tracks (km) in the three periods, when the entire study area was surveyed, divided by the area ($km^2$). [3] Outdoor dogs: the mean numbers of leashed dogs found in two periods, May and September 2012, and the mean densities per $km^2$ in parentheses. [4] The human population density per hectare as of 2020 in each study block was roughly estimated using government statistics [32], of which the block boundaries did not completely coincide with ours.

### *2.2. Field Surveys*

Field surveys were conducted in six bimonthly periods in May, July, September, and November 2012, and January and March 2013, for 8 to 10 days each. The actual survey time ranged from 33 to 99 h per period, totaling 417.4 h. Of this total, 355.0 h were devoted to "search surveys", in which the study area was systematically visited to search for magpies and their nests. In the three periods of search surveys in May, September, and January, 75.4 to 90.7 h were spent visiting the entire survey area, with the aim of finding all the magpies and nests (in May only). In the remaining three periods of search surveys, only city blocks where individuals or nests had been found in the previous survey were visited. In addition, 34.2 h were spent on "roost surveys", in which individual magpies were tracked before sunset to search for their roosts, and 28.2 h on "ad-lib surveys", in which the nesting status and other notes were recorded.

The search surveys were started 30 min after sunrise and finished no later than 1 h before sunset, taking into account the time it takes for magpies to move between their roosts and daytime feeding sites (see [33]). The survey areas were divided into small sections (called bouts) that could be completed in about 1 h, and the surveys were conducted by bicycle (total 237.4 h), car (total 97.8 h), or on foot (total 19.8 h), depending on the visibility. Of the total 355.0 h of search survey time, 322.7 h (91%) were conducted by the authors, and the remaining 32.3 h were conducted by helpers. Survey tracks were recorded using Global Positioning System (GPS) receivers (Garmin GPSmap 60CSx) during the surveys conducted in May, September, and January, although some data were missing. The total length of the survey tracks was 715.2 km in May, 751.9 km in September, and 915.8 km in January, totaling 2382.9 km. Because the number of nests and individuals may be influenced by survey efforts, a survey effort index was calculated by dividing the survey track distance (km) by the area ($km^2$) for each block (Table 1). The survey effort index was lower in the industrial and exurban zones than in the commercial and residential zones due to better visibility and lower road density in the former.

When magpies were found during the search survey, their location was recorded on a paper map or on a GPS receiver, and the time of discovery, behavior, habitat features (land use and microhabitat), and flock size (number of individuals) were recorded on a field

note. Individuals that were moving together within a few dozen meters were recorded as a single flock. The behaviors were divided into breeding, feeding, food hoarding, resting, preening, flying, and other. Food hoarding behavior was often indistinguishable from feeding behavior, and resting and preening often switched, so they were each combined into one behavior in the later analysis. The habitat features were recorded for each individual at two spatial scales: the major land use within a radius of about 50 m from the individual, and the microhabitat at the spot where the individual was found. The land use was divided into five categories: residential areas, industrial areas (including business and commercial areas), parks (including public space such as schools and golf courses), forests, and open land (including major roads, prepared vacant lands, farmlands, and peatlands). The microhabitat was divided into seven categories: short (i.e., well-managed) grasslands, other grasslands, houses with gardens, bare ground, trees, artificial (including buildings, utility poles, roads, and paved grounds), and other. If a magpie was in flight when it was found, the habitat features where it landed were recorded, and if the landing location could not be identified, only the land use was recorded. If a magpie was not feeding when it was found, observation was continued for up to about 5 min, and if feeding behavior was observed, the feeding habitat was recorded. The food items were recorded whenever they were identified. In addition, we recorded the number of outdoor-reared dogs noted during the magpie search surveys for each bout in May and September.

Magpie nests were searched in May 2012, before the leaves of deciduous broad-leaved trees opened. For the nests found, the type of nest substrate and the heights of the nest substrate and the nest were recorded. The height was measured using an ultrasonic tree height meter (Vertex 4, Haglöf Sweden AB, Långsele, Sweden) or a laser rangefinder (TruPulse360, Laser Technology Inc., Centennial, CO, USA). As old magpie nests can remain in place for a long time, we judged a nest to be active only if we observed a magpie entering or leaving the nest, or if a magpie flew out of the nest when we hit the nest tree. We did not identify the tree species because the nest site characteristics of the population have been reported elsewhere [29].

Roosts were searched for by tracking magpies from about one hour before sunset in September 2012 and January 2013. At the place where magpies were confirmed to be roosting, we counted the magpies roosting from about one hour before sunset to 30 min after sunset on another day as necessary. In addition, some large roosts were checked in the evening or early morning to see if they were in use in the next survey period.

To determine the area composition of the land use and microhabitat in the study area, 1600 random points were plotted within the study area using a geographic information system (GIS, QGIS 3.22). The land use and microhabitat of these points were determined from 2011 aerial photographs of Google Earth, with the aid of the Street View function of Google Maps when necessary.

### *2.3. Data Analysis*

QGIS 3.22 was used for the spatial analysis, and R4.4.1 [34] was used for the other statistical analyses. For the spatial analysis, we used data from only the search surveys in May, September, and January, when the entire area was surveyed. Data from all the search surveys were used for the other analyses.

In this paper, means are shown with 1 SD, $p$ values are shown to three decimal places ($p = 0.000$ was taken as $p < 0.001$), and $p < 0.05$ is considered significant. To evaluate the effect of one or more factors on a dependent variable, we used generalized linear models (GLMs) or generalized linear mixed models (GLMMs) when the block ID should be set as a random effect, together with the "glht" function in the "multcomp" package in R for multiple comparisons. The area of each block was set as an offset term whenever necessary. In these model analyses, models with a ΔAIC of less than 2.0 were considered valid models, and the "performance" package in R was used to ensure that there were no problems with multicollinearity, overdispersion, or zero excess; when any problem was found, we solved it either by removing some independent variables or by applying a different distribution and

a link function to the response variable. The spatial distribution of nests and individuals was determined to be significantly concentrated or uniform based on the z-scores calculated by the "nearest neighbor analysis" function of QGIS. Ivlev's electivity index [35] was used as an index of habitat preference. This index ranges from −1 to 1, with positive values indicating preference and negative values indicating avoidance.

## 3. Results

### *3.1. Nest Features and Nest Distribution*

In May 2012, 76 nests were found, of which 46 were confirmed to be in use. The remaining 30 nests may have also been occupied but were excluded from the following analysis because their status could be varied; ones abandoned in that season or ones used in the last year, for example. Of the 46 nests, 29 were in trees and the remaining 17 were found on man-made structures such as power transmission towers and utility poles (Table S1). The nest heights were around 10 m in broad-leaved trees, coniferous trees, and utility poles, with no significant difference between them (GLM analysis followed by multiple comparisons, all $p > 0.999$). However, the nest height on the transmission towers was an average of 37 m, which was significantly higher than the other three types (all $p < 0.001$). For all the nest substrates, nests were built at about 80% to 90% of the overall height (Table S1).

Of the 46 active nests, 42 (91.3%) were located in the residential zone, and of the remaining 4 nests, 2 were located in the West-exurban block and 2 in the Utonai-industrial block (Figure 1, Table 2). The nest densities in the four residential study blocks were highest in Yufutsu (5.5/km$^2$), followed by Utonai (1.9/km$^2$), West (0.9/km$^2$), and Central (0.2/km$^2$), and the nest density in the entire study area was 0.6 nests/km$^2$ (Table 2). The relationship between the number of nests and the block features was analyzed using GLM. The AIC and Akaike weight of four models with possible combinations of explanatory variables showed that only the full model, including both the sub-area and zone, was valid (AIC = 38.8), while the ΔAIC for the other three models was above 26.4. Multiple comparisons showed significant differences between the sub-areas: Central and Utonai ($p = 0.006$), Central and Yufutsu ($p < 0.001$), and West and Yufutsu ($p < 0.001$). There were also significantly more nests in the residential zones than in the industrial zones ($p < 0.001$). The human population density, which was excluded from the above GLM to avoid multicollinearity, was inversely correlated with the magpie nest density in four residential blocks (GLM analysis, $p < 0.001$; Figure S1a).

**Table 2.** Numbers of Oriental Magpie nests and individuals, with the mean nearest neighbor distances, in the 11 study area blocks.

| | Num. of | Num. of Individuals (Density/km$^2$) | | | Nearest Neighbor Distance (m) [1] | | | |
|---|---|---|---|---|---|---|---|---|
| **Block** | **Nests** | **May** | **Sep.** | **Jan.** | **Nests** | **May** | **Sep.** | **Jan.** |
| C-C1 | 0 | 0 | 1 (0.7) | 2 (1.3) | | | | |
| C-C2 | 0 | 0 | 0 | 0 | | | | |
| C-I | 0 | 1 (0.5) | 2 (1.1) | 0 | | | | |
| C-R | 2 (0.2) | 6 (0.6) | 11 (1.0) | 11 (1.0) | | | | |
| U-I | 2 (0.1) | 13 (0.6) | 23 (1.1) | 14 (0.7) | | | | |
| U-R | 14 (1.9) | 45 (6.1) | 51 (6.9) | 75 (10.1) | 481 (a) | 309 (a) | 349 (a) | 254 [2] |
| W-I | 0 | 0 | 0 | 0 | | | | |
| W-E | 2 (0.7) | 3 (1.0) | 12 (4.2) | 11 (3.8) | | | | |
| W-R | 16 (0.9) | 79 (4.3) | 105 (5.7) | 84 (4.5) | 708 (a) | 355 (a) [2] | 340 (a) [2] | 315 [2] |
| Y-I | 0 | 8 (0.7) | 5 (0.4) | 5 (0.4) | | | | |
| Y-R | 10 (5.5) | 26 (14.4) | 38 (21.0) | 31 (17.1) | 245 (b) [3] | 153 (b) | 148 (b) | 213 [3] |
| Total | 46 (0.6) | 181 (2.3) | 248 (3.1) | 233 (2.9) | 583 ± 480 [2] | 394 ± 382 [2] | 350 ± 316 [2] | 341 ± 330 [2] |

[1] Mean nearest neighbor distances are given for the entire study area (with SD) and for blocks where more than 10 flocks (not individuals) were recorded; different letters (a, b) mean significant difference between blocks. [2] Significantly clumped distribution. [3] Significantly even distribution.

For the entire study area, the mean nearest neighbor distance was 583 m ± 480 SD and showed a strong clustering distribution ($p < 0.001$; Table 2). The shortest distance was 116 m in the Yufutsu-residential block. For the three study blocks in the residential zone where 10 or more nests were found, a GLM analysis showed that the nearest neighbor distances were significantly shorter in the Yufutsu sub-area than in the Utonai and West sub-areas ($p = 0.007$ and $p < 0.001$, respectively; Table 2).

### 3.2. Distribution of Individuals

As a result of the search survey for the entire study area, 181 individuals were found in May 2012, 248 in September, and 233 in January 2013 (Table 2). The location records of flocks in the entire area survey showed that magpies were found almost throughout the entire area, but they were relatively rare in the Central sub-area and the commercial and industrial zones, and they were more abundant in the residential blocks of the sub-areas except Central. This trend did not differ among the three periods of the search survey (Figure 2).

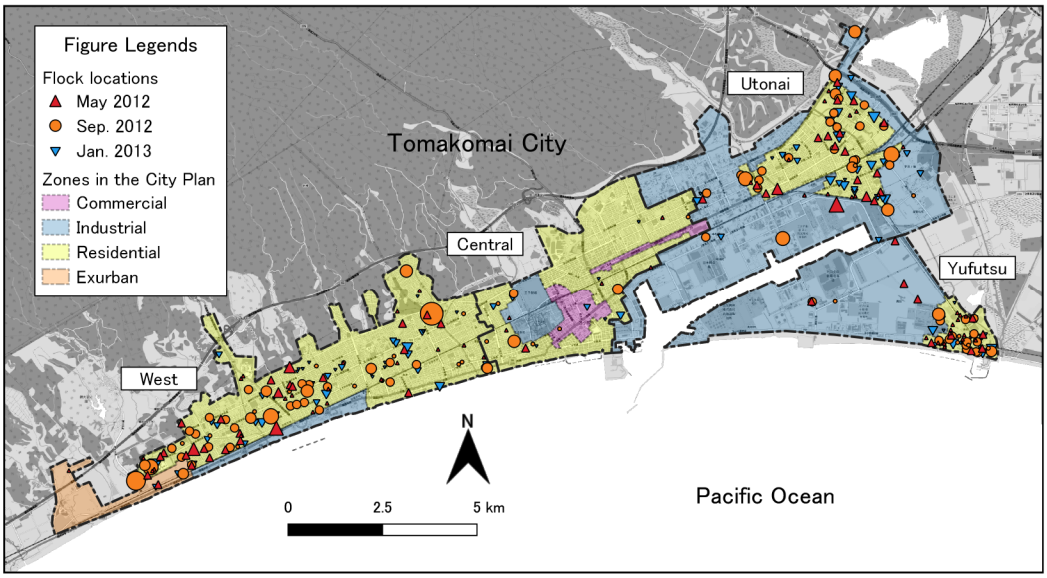



**Figure 2.** The locations where Oriental Magpies were found in May (red triangles), September (orange circles), and January (blue inverted triangles). The symbol size is roughly proportional to the flock size.

The GLMMs showed that only the full model, including the sub-area, zone, and survey period, was valid (AIC = 181.5, Akaike weight = 0.895) out of eight possible models. The other models had ΔAIC values of 5.1 or more and Akaike weights of 0.071 or less. Multiple comparisons showed that there were fewer magpies in the Central sub-area than in any of the other three sub-areas ($p < 0.001$ in all dyads) and significantly fewer magpies in the West sub-area than in the Utonai ($p = 0.044$) and Yufutsu ($p < 0.001$) sub-areas. There was no significant difference between the Yufutsu and Utonai sub-areas ($p = 0.491$). In terms of the zones, there were significantly more magpies in the industrial zone than in the commercial zone ($p = 0.020$) but significantly fewer magpies than the residential and exurban zones (both $p < 0.001$). There were no significant differences between the residential and commercial ($p = 0.613$), residential and exurban ($p = 0.549$), and commercial and exurban zones ($p = 0.963$), although it should be noted that there were only two commercial blocks, both in the Central sub-area, and only one exurban block, in the West sub-area. As in the case of the magpie nest density, the number of magpies was inversely correlated with the human density in the study blocks except the commercial and exurban blocks where few humans live ($p = 0.008$; Figure S1b).

The mean nearest neighbor distance between the locations of flocks found across the entire survey area was 394 m ($n$ = 105) in May, 350 m ($n$ = 109) in September, and 341 m ($n$ = 107) in January, showing little difference among the periods and a significant concentration distribution in each period ($p < 0.001$).

The mean flock size for the entire survey period was 2.1 birds ± 1.4 SD ($n$ = 548 flocks, 1134 individuals). Regarding the flock composition by flock size (Figure S2), the proportion of solitary birds or pairs accounted for the majority of the flocks at all times. Flocks of three or more birds accounted for around 20% (around 40% in terms of the number of individuals) except in May. Multiple comparisons between the behaviors recorded more than 100 times, i.e., flight, feeding, and resting ($n$ = 415, excluding flocks with multiple behaviors recorded), showed that the flock size was significantly larger during feeding (2.24 ± 1.60 SD) than during resting (1.78 ± 1.02 SD; $p = 0.007$). There were no significant differences in flock size between flying (1.71 ± 1.64 SD) and feeding ($p = 0.100$) and between flying and resting ($p = 0.870$).

The percentages of behaviors were, in descending order, 37.5% resting, 34.1% feeding, 21.7% flying, 3.5% breeding, and 3.2% other ($n$ = 1134 individuals). The seasonal changes are shown in Figure S3. In May, which was the incubation period for most nests, breeding behaviors, which were rarely observed in other months, accounted for 14%, while the proportions of feeding and resting were low. In July, when fledglings were seen, the proportion of feeding was high, and in September, which was the molting period, the proportion of resting was high. From November to January and March, the proportion of feeding decreased, and the proportion of resting increased. Chasing between magpies, which was included in "other", was only observed six times by 22 magpies, and none of them were near any nests.

The land use of the locations where magpies were found ($n$ = 1100 individuals) was, in descending order, residential areas (57.6%), parks (20.6%), industrial areas (13.4%), open land (5.5%), and forests (1.7%), with no clear seasonal change apart from a slight increase in the proportion of parks in July. There was a significant difference in the land use ratio between the magpies' locations and random points ($\chi^2$ test, $\chi^2 = 2443.1$, df = 11, $p < 0.001$). Ivlev's electivity index, calculated by comparing the magpie observation points with random points, was 0.410 for parks, 0.265 for residential areas, −0.405 for industrial areas, −0.511 for open land, and −0.546 for forests, indicating that the magpies preferred parks and residential areas and avoided industrial areas, open land, and forests.

There were clear seasonal changes in the microhabitats in which feeding behavior was observed (Figure 3). In May and July, the proportion of feeding on short grasslands exceeded 70%. In September, the amount of feeding on short grasslands was reduced to less than 50%, and feeding on other grasslands increased accordingly. From November to March, the use of grasslands decreased, and the proportion of feeding at houses increased. Moreover, during the snowy season, feeding on snowy surfaces accounted for more than one-quarter of feeding behaviors. Ivlev's selectivity index, calculated by comparing the feeding habitats over the entire season with the microhabitats at random points, in descending order of preference, was as follows: short grasslands (0.763), other grasslands (0.322), houses (−0.159), bare ground (−0.356), trees (−0.491), and artificial structures (−0.784). We excluded snowy surfaces from this calculation because they were only observed during certain seasons, and there were no data on the ratio of snowy surfaces in the habitat.

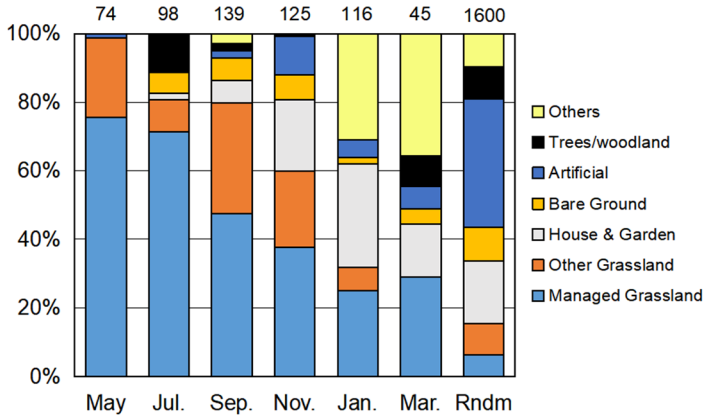



**Figure 3.** Seasonal change in the foraging microhabitat of Oriental Magpies in Tomakomai City. "Others" were mostly on snow in January and March. Sample sizes are given above the bars. "Rndm" means random points.

### *3.3. Food Items, Communal Roosts, and Outdoor Dogs*

We were able to identify the food item in a total of 51 instances for 84 individuals (Table 3). The most common food was pet food, accounting for 30 individuals on 18 occasions (36% of the total). For 12 individuals on seven occasions, the food was unknown but was foraged from a garden feeder. Other anthropogenic items included human food, such as bread, cooked rice, and sweets, food waste, and livestock feed spilled from a feed factory or a transport truck. In total, 64 individuals (76%) on 40 occasions were observed utilizing anthropogenic food resources. Apart from anthropogenic food, sunflower seeds planted in gardens or along roadsides, fruits of *Moraceae* sp. and *Araliaceae* sp., *Earthworm* sp., and insects in flight were observed.

**Table 3.** Numbers of Oriental Magpies and observations in parentheses with respect to the season and food items identified during the field surveys.

| Food Type | May | Jul. | Sep. | Nov. | Jan. | Mar. | Total |
|---|---|---|---|---|---|---|---|
| Pet food | | | 6 (4) | 13 (5) | 10 (8) | 1 (1) | 30 (18) |
| Garden feeder | | | 7 (3) | 1 (1) | 4 (3) | | 12 (7) |
| Human food | 3 (2) | | 2 (2) | 4 (3) | 1 (1) | 1 (1) | 11 (9) |
| Garbage | | 1 (1) | 1 (1) | 2 (2) | | | 4 (4) |
| Livestock feed | | | 5 (1) | | 2 (1) | | 7 (2) |
| Sunflower seed | | | 4 (3) | | | | 4 (3) |
| Berry | | 3 (1) | 3 (1) | | 3 (1) | | 9 (3) |
| Earthworm | | | | 6 (4) | | | 6 (4) |
| Insect | | 1 (1) | | | | | 1 (1) |
| Total | 3 (2) | 5 (3) | 28 (15) | 26 (15) | 20 (14) | 2 (2) | 84 (51) |

A total of nine roosts were identified in September 2012 and January 2013 (Figure 1, Table S2). The five of these roosts confirmed in September were in small patches of deciduous broad-leaved forest, three of which were in the residential zone, one on a public facility (art museum) in the commercial zone, and the remaining one in a forest adjacent to the West-residential block. A total of 6 to 44 magpies were identified as roosting in each roost in September. None of these roosts in the deciduous broad-leaved forest were in use in January, and instead, 2 to 40 magpies were identified roosting in four locations: inside a factory building, in trees surrounded by school buildings or in a private garden, and on the exterior walls of a residential house. All of these locations provided protection from the winter monsoons. The total numbers of roosting birds confirmed in September and January were 88 and 69, respectively, which were 35.5% and 29.6% of those found in each search survey.

The number of dogs kept outside was 211 in total, with 128 in May and 83 in September (there was some overlap between the records in May and September). Of these, only 2 were found in the West-industrial block, with the other 209 found in the residential zone. Within the residential blocks, the average number of dogs per square kilometer was, in descending order, 6.4 in the Yufutsu, 3.2 in the Utonai, 2.5 in West, and 2.2 in Central (Table 1).

## 4. Discussion

We found 181 to 248 magpies and 46 active nests in our surveys across the study area. Most magpies and their nests were found in residential districts except in central area of the city; few magpies lived in commercial and industrial areas. This distribution pattern did not change year round, but the magpies changed their main feeding habitats from grasslands in summer to house gardens in winter. More than 70% of magpie food items we identified were anthropogenic.

### *4.1. Food Resources as the Determinant of Distribution*

Sol et al. [4] showed that non-native bird species in urban environments tend to be dependent on anthropogenic food resources that have not been fully exploited by native species in Australia. The same pattern can be found in native birds that have recently invaded urban environments, especially in corvids [22,27,36,37]. Benmazouz et al. [38] reviewed the literature on urban crows and found that most of the studies showed that urbanization has a positive effect on crows and the accessibility of anthropogenic food resources is the most important factor (but see [39]). Borray-Escalante et al. [40] revealed that the Monk Parakeet (*Myiopsitta monachus*) and the Rose-ringed Parakeet (*Psittacula krameri*), two introduced species of parakeets that are established in Barcelona, Spain, heavily rely on food resources mainly provided by local people, on the basis of stable isotope ratios in feathers. In this study, more than 70% of the food resources that could be visually confirmed were anthropogenic, with pet food being the most often observed. By using stable isotope analysis, Oyake et al. [24] estimated that approximately 44.6% of magpie diets in the egg-laying period comprise pet food in the same population as our study. Statistical analysis that carefully excluded the possibility of other factors revealed that a rapid increase in the number of bird feeders and the variety of food in recent years has led to national-level population increases in many species, including the Eurasian Magpie (*Pica pica*) [41]. Further studies on the usage of anthropogenic food resources by invasive bird species, which often occurs as in the above examples, could make a significant contribution to urban ecology and invasion biology, especially to understanding the limiting factors in terms of the number and distribution range of invasive birds.

The spatial distribution of urban birds may also be related to anthropogenic food resources. In areas where magpie species have invaded urban areas, the density is generally very high in the city center and decreases farther away ([22] and references therein). However, in this study, the densities of nests and magpie individuals were much lower in the city center than surrounding residential areas, being consistent with Nakahara et al.'s [29] study conducted in the previous year, and the magpie density was inversely correlated with the human population density in residential areas of Tomakomai. Furthermore, the magpie density was consistent with that of outdoor dogs, which we recorded as an index of the availability of pet food. Higher nest densities in residential areas than in city centers have also been reported in medium-sized cities in southwestern Finland and northern Poland [21,42]. These studies suggest that magpie species gather more densely in urban areas than in rural areas but that the densities can decrease in city centers, such as business and commercial districts, where anthropogenic food may be less available. For the Kyushu population of the Oriental Magpie in Japan, Eguchi [43] suggested that the decline in the 1990s was due to deterioration of urban foraging environments.

This study shows that Oriental Magpies in Tomakomai shifted their feeding habitat from grasslands to houses with gardens from summer to winter. In Tomakomai, there are about 20 days of snowfall in every winter month, with the average snow depth exceeding

20 cm in February. Nonetheless, the time spent on feeding decreased in winter, which may also suggest magpies' successful use of anthropogenic food resources, especially pet food. In rural areas of western Poland, food given to outdoor dogs was recorded as often being stolen by wild animals such as House Sparrows (*Passer domestics*) and Eurasian Magpies [44]. The range of a large terrestrial bird, the Red-legged Seriema (*Cariama cristata*) on a university campus in southeastern Brazil coincided with cat food feeding points [45]. For magpie species, stealing pet food may be more efficient than feeding at garbage bins, where much larger birds such as gulls and other corvids often explore the food [46]. Magpie species, like other corvids, can store food temporarily in their throat pouches and then carry it for temporary storage. Food storage behavior increased dramatically from autumn to winter in Sheffield, UK, and anthropogenic food resources such as garbage and feed for animals accounted for more than 70% of the stored food resources [47]. The magpies in Tomakomai may also be able to secure more pet food than they can eat directly by storing food [24].

### *4.2. Crows and Nest Sites*

Magpies in Tomakomai compete with crows for nest sites and food. Although there are no quantitative data, we observed nest takeovers and attacks on magpie fledglings by the two species of crows, and it is likely that the main cause of magpie breeding failure is breeding interference and predation of eggs and chicks by these crows. In Europe, crows are often the main predators of magpie eggs and chicks [22,23]. However, crows are widespread throughout our study area and were unlikely to have been responsible for the observed pattern of the magpie distribution.

Nakahara et al. [29] showed that magpies chose nesting sites in urban land use with many tall trees in Tomakomai. Some reports suggested that the use of evergreen coniferous trees, in addition to deciduous broad-leaved trees, as nesting trees by the European Eurasian Magpie has promoted its expansion into European cities [10,48]. Similarly, some reports have suggested that nesting on artificial structures reduces predation and human interference [49–52]. In this study, magpies nested most frequently in tall deciduous broad-leaved trees but also in evergreen coniferous trees and on artificial structures. This tendency is common among magpie species in urban areas [22,53–55]. However, none of these studies on nesting site preference have shown a shortage of nesting sites or a spatial bias in suitable nesting sites within their study area. In our study area, there were sufficient tall trees and man-made structures available for nesting, even in areas where there were few magpies, so it is unlikely that the number of nesting sites had a significant effect on the number of nests or the distribution of the population.

### *4.3. General Biology*

The magpies in Tomakomai did not shift their distribution seasonally, often used short grasslands as feeding habitats, were most often seen in pairs, and formed communal roosts, all being similar to other magpies species [20,28,33,56–59].

The spatial structure of magpie species varies widely from region to region. The Eurasian Magpie in central and northern Europe engages in territorial defense throughout the year [20,60]. In North America, the territorial defense of the Black-billed Magpie (*Pica hudsonia*) is limited to a small area around the nest [61]. In Tomakomai, the magpies did not show any territorial defense behavior during our surveys. Short-distance chasing was observed on only six occasions in 22 birds out of 1134 recorded behaviors, and all of them were away from any active nest. Furthermore, the magpies in Tomakomai were often observed feeding in groups consisting of multiple pairs and families. Therefore, unlike many Eurasian Magpie populations, Oriental Magpies in Tomakomai probably only defend the small area around their nests, and they share feeding areas with other individuals, as is the case in Kyushu [28].

### *4.4. Estimate of Population Size*

Magpies are highly conspicuous in terms of their plumage color pattern, calls, and nests, so we believe that we were able to find almost all the individuals and nests in Tomakomai City during the three survey periods (May, September, and January), when the entire area was surveyed. However, some oversights were inevitable, such as when the magpies were behind buildings or houses. Since this population was not banded, we cannot know the exact oversight rate, but if we assume it to be 10%, the number of mature birds living in Tomakomai around 2012–2013 is estimated to be approximately 201, based on the 181 birds recorded in May. The number of 46 nests is small relative to the 181 birds in the same survey period, suggesting a considerable underestimation of the nest numbers or the existence of several non-breeding birds. This speculation may also be supported by a small increase (37%) in the number of magpies from May (181 birds) to September (248 birds), though breeding performance was not investigated in this study

### *4.5. Study Limitations*

In this study, the survey effort index was low in the industrial zone, where magpies were few, but there was no difference in the survey effort between the residential zone, where magpies were many, and the commercial zone, where magpies were fewest. Additionally, there was no difference in the survey effort among the four residential blocks, where the density of the magpies varied. Therefore, it is unlikely that the survey effort had a significant impact on the bias in the estimate of the magpie population and distribution.

We did not evaluate the nest site availability, which has been suggested as an important determinant of the population increase of magpie species in urban environments [10,48–52]. Also, we did not quantify predation by crows and competition for food and nest sites with crows, which could affect the magpie population [21,22]. Therefore, the observed spatial pattern of the magpie distribution and magpie numbers in Tomakomai City might have been affected not only by food availability but also by these non-food factors. In addition, our one-year survey, limited to Tomakomai City, cannot determine whether the magpie population and distribution range in Hokkaido is stable. These shortcomings should be addressed by further studies of this population.

## 5. Conclusions

The number of mature Oriental Magpies in Tomakomai City was estimated to be about 201 birds as of May 2012. The magpies in Tomakomai preferred residential areas to central business and commercial areas of the city, and the better availability of anthropogenic food was likely to make residential areas more attractive to magpies. Apart from one case where roosting magpies inside a factory building caused damage by soiling products stored underneath, we have not heard of any negative impacts of magpies in Tomakomai on human activities or other birds. Magpies are not persecuted in Hokkaido so far. However, several studies have suggested that magpie invasion into urban areas reduces the reproductive output of songbird populations there [62–64] (but see [65]). Therefore, extensive and long-term monitoring is needed to predict or to control, if necessary, the further spread of magpies in Hokkaido. Magpie nests are easy to find, and audio playback can greatly increase the efficiency of finding magpie individuals (personal observations) in monitoring surveys. Such monitoring of urban-invaded non-native populations will bring further knowledge of the factors that limit the number and range of invasive birds in general

**Supplementary Materials:** The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/birds5040045/s1, Table S1: The features of the active nests of Oriental Magpies and nest sites. Table S2: Communal roosts of Oriental Magpies found in September 2012 and January 2013. Figure S1: Correlations between (**a**) human population density and magpie nest density, and (**b**) human population density and magpie individual density found in each study block. Figure S2: Seasonal change in the flock composition of Oriental Magpies in Tomakomai City. Figure S3: Seasonal change in the behavior of Oriental Magpies in Tomakomai City. Spread sheet

S1: An Excel file that contains the raw data used for the analyses in this paper. The "nest", "indvs", and "roost" sheets are the lists of nests, individuals, and roosts found in the study. The "srvys" sheet is the list of our field surveys, and the "notes" sheet explains the abbreviations in the other sheets. Note that some remarks recorded in Japanese have been removed. GIS file S1: Compressed Keyhole Makeup Language (kml) files that contain all the location data analyzed with QGIS in this study.

**Author Contributions:** Conceptualization, M.F. and H.M.; methodology, M.F. and H.M.; formal analysis, M.F. and H.M.; investigation, M.F. and H.M.; resources, M.F.; writing—original draft preparation, M.F.; writing—review and editing, M.F. and H.M.; supervision, M.F.; project administration, M.F. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** The raw data supporting our findings have been uploaded as Supplementary Materials (Excel file S1; Zip file consisting of kml files S2).

**Acknowledgments:** We are grateful to several residents of Hokkaido—Osamu Hasegawa, Yuko Hayashi, Sayaka Mori, and Miho Suzuki—for their help with the field survey. We thank Toru Morita and Youta Fujioka, who cooperated with the storage and management of the survey gear. We also express our gratitude to several factories, including Nippon Paper Industries and Nippon Hume, for their kind permission to conduct surveys on their premises, and to Eguchi Kazuhiro for giving us the opportunity to undertake this research through information exchanges at academic conferences. We also thank the three reviewers and the editor-in-chief for their valuable comments and literature information for the manuscript.

**Conflicts of Interest:** The authors declare no conflicts of interest.

## References

1. Eguchi, K.; Amano, H.E. Spread of exotic birds in Japan. *Ornithol. Sci.* **2004**, *3*, 3–11. [CrossRef]
2. Williamson, M.; Fitter, A. The varying success of invaders. *Ecology* **1996**, *77*, 1661–1666. [CrossRef]
3. Lockwood, J.L.; Cassey, P.; Blackburn, T. The role of propagule pressure in explaining species invasions. *Trends Ecol. Evol.* **2005**, *20*, 223–228. [CrossRef] [PubMed]
4. Sol, D.; Bartomeus, I.; Griffin, A.S. The paradox of invasion in birds: Competitive superiority or ecological opportunism? *Oecologia* **2012**, *169*, 553–564. [CrossRef] [PubMed]
5. Redding, D.W.; Pigot, A.L.; Dyer, E.E.; Şekercioğlu, Ç.H.; Kark, S.; Blackburn, T.M. Location-level processes drive the establishment of alien bird populations worldwide. *Nature* **2019**, *571*, 103–106. [CrossRef]
6. Clergeau, P.; Croci, S.; Jokimäki, J. How useful are urban island ecosystems for defining invader patterns? *Environ. Conserv.* **2004**, *31*, 181–184. [CrossRef]
7. Vuorisalo, T.; Andersson, H.; Hugg, T.; Lahtinen, R.; Laaksonen, H.; Lehikoinen, E. Urban development from an avian perspective: Causes of hooded crow (*Corvus corone cornix)* urbanisation in two Finnish cities. *Landsc. Urban Plann.* **2003**, *62*, 69–87. [CrossRef]
8. Fey, K.; Vuorisalo, T.; Lehikoinen, A.; Selonen, V. Urbanisation of the wood pigeon (*Columba palumbus*) in Finland. *Landsc. Urban Plann.* **2015**, *134*, 188–194. [CrossRef]
9. Kövér, L.; Gyüre, P.; Balogh, P.; Huettmann, F.; Lengyel, S.; Juhász, L. Recent colonization and nest site selection of the Hooded Crow (*Corvus corone cornix* L.) in an urban environment. *Landsc. Urban Plann.* **2015**, *133*, 78–86. [CrossRef]
10. Jokimäki, J.; Suhonen, J.; Vuorisalo, T.; Kövér, L.; Kaisanlahti-Jokimäki, M.-L. Urbanization and nest-site selection of the Black-billed Magpie (*Pica pica*) populations in two Finnish cities: From a persecuted species to an urban exploiter. *Landscape Urban Plan.* **2017**, *157*, 577–585. [CrossRef]
11. Hernández-Brito, D.; Carrete, M.; Tella, J.L. Annual censuses and citizen science data show rapid population increases and range expansion of invasive Rose-ringed and Monk Parakeets in Seville, Spain. *Animals* **2022**, *12*, 677. [CrossRef] [PubMed]
12. López-Ramírez, S.; Muñoz, A.-R. A Local approach to better understand the spread and population growth of the Monk Parakeet as an invasive species. *Birds* **2022**, *3*, 277–284. [CrossRef]
13. Gill, F.; Donsker, D.; Rasmussen, P. IOC World Bird List (V14.1). 2024. Available online: https://www.worldbirdnames.org/new/ (accessed on 18 August 2024). [CrossRef]
14. Eguchi, K.; Kubo, H. The origin of the magpie *Pica pica sericea* in Japan: An investigation of historical records. *J. Yamashina Inst. Ornithol.* **1992**, *24*, 32–39, (In Japanese with an English summary). [CrossRef]
15. The Ornithological Society of Japan. *Check-List of Japanese Birds*, 7th ed.; Ornithological Society of Japan: Sanda, Japan, 2012.
16. Horimoto, T. Records of Magpie *Pica pica* in Iburi District, south-western Hokkaido. *J. Yamashina Inst. Ornithol.* **2004**, *36*, 87–90. (In Japanese with an English summary) [CrossRef]

17. Kurosawa, R.; Horimoto, T. Changes of distribution of the Eurasian Magpie *Pica pica* in the Iburi Region of southern Hokkaido. *J. Yamashina Inst. Ornithol.* **2015**, *46*, 83–88. (In Japanese with an English summary) [CrossRef]
18. Hasegawa, O. Have magpies visited your neighborhood? *Hokkaido Nat. Magaz. MALLY* **2013**, *31*, 38–41. (In Japanese)
19. Kryukov, A.P.; Spiridonova, L.N.; Mori, S.; Arkhipov, V.Y.; Red'kin, Y.A.; Goroshko, O.A.; Lobkov, E.G.; Haring, E. Deep phylogeographic breaks in Magpie *Pica pica* across the Holarctic: Concordance with bioacoustics and phenotypes. *Zool. Sci.* **2017**, *34*, 185–200. [CrossRef]
20. Birkhead, T.R. *The Magpies*; T & AD Poyser: London, UK, 1991.
21. Górski, W.; Kotlarz, B. Changes and breeding ecology in an urban population of the Magpie *Pica pica* in Slupsk, NW Poland. *Acta Ornithol.* **1997**, *32*, 61–67.
22. Jerzak, L. Synurbanization of the Magpie in the Palearctic. In *Avian Ecology and Conservation in an Urbanizing World*; Marzluff, J.M., Bowman, R., Donnelly, R., Eds.; Springer: Boston, MA, USA, 2001; pp. 403–425. [CrossRef]
23. Antonov, A.; Atanasova, D. Small-scale differences in the breeding ecology of urban and rural Magpies *Pica pica*. *Ornis Fennica* **2003**, *80*, 21–30.
24. Oyake, N.; Fujioka, M.; Nakashita, R.; Mori, S. Stable isotope analysis reveals intensive exploitation of pet food by the newly established Oriental Magpie *Pica serica* population in Hokkaido, Japan. *Ornithol. Sci.* **2024**, *23*, 77–89. [CrossRef]
25. Marzluff, J.M.; Neatherlin, E. Corvid response to human settlements and campgrounds: Causes, consequences, and challenges for conservation. *Biol. Conserv.* **2006**, *130*, 301–314. [CrossRef]
26. Baltensperger, A.P.; Mullet, T.C.; Schmid, M.S.; Humphries, G.R.W.; Kövér, L.; Huettmann, F. Seasonal observations and machine-learning-based spatial model predictions for the common raven (*Corvus corax*) in the urban, sub-arctic environment of Fairbanks, Alaska. *Polar Biol.* **2013**, *36*, 1587–1599. [CrossRef]
27. Kövér, L.; Lengyel, S.; Takenaka, M.; Kirchmeir, A.; Uhl, F.; Miller, R.; Schwab, C. Why do zoos attract crows? A comparative study from Europe and Asia. *Ecol. Evol.* **2019**, *9*, 14465–14475. [CrossRef] [PubMed]
28. Takeishi, M. A study on the ecological factors in the population dynamics and distribution of the Black-billed Magpie *Pica pica sericea* in Japan. *Bull. Kitakyushu Mus. Nat. Hist.* **1995**, *14*, 55–97. [CrossRef]
29. Nakahara, T.; Kuroe, M.; Hasegawa, O.; Hayashi, Y.; Mori, S.; Eguchi, K. Nest site characteristics of the newly established Eurasian Magpie *Pica pica* population in Hokkaido, Japan. *Ornithol. Sci.* **2015**, *14*, 99–109. [CrossRef]
30. GSI Maps. Available online: https://maps.gsi.go.jp (accessed on 18 August 2024). (In Japanese).
31. Tomakomai City Urban Planning. Available online: https://www.city.tomakomai.hokkaido.jp/shisei/toshikeikaku/ (accessed on 18 August 2024). (In Japanese).
32. e-Stat, a Portal Site for Japanese Government Statistics. Available online: https://www.e-stat.go.jp/gis (accessed on 26 September 2024). (In Japanese).
33. Czechowski, P.; Jerzak, L. Magpie *Pica pica* communal roosting in an urban environment (Zielona Góra, W Poland). In *Corvids of Poland*; Jerzak, L., Kavanagh, B.P., Tryjanowski, P., Eds.; Bogucki Wydawnictwo Naukowe: Poznań, Poland, 2005.
34. R Core Team. *R: A Language and Environment for Statistical Computing*; R. Foundation for Statistical Computing: Vienna, Austria, 2024. Available online: https://www.r-project.org/ (accessed on 18 August 2024).
35. Ivlev, V.S. *Experimental Ecology of the Feeding of Fishes*; Yale University Press: New Haven, CT, USA, 1961.
36. Eden, S.F. The social organization of non-breeding Magpie *Pica pica*. *Ibis* **1989**, *131*, 141–153. [CrossRef]
37. Preininger, D.; Schoas, B.; Kramer, D.; Boeckle, M. Waste disposal sites as all-you-can eat buffets for Carrion Crows (*Corvus Corone*). *Animals* **2019**, *9*, 215. [CrossRef] [PubMed]
38. Benmazouz, I.; Jokimäki, J.; Lengyel, S.; Juhász, L.; Kaisanlahti-Jokimäki, M.-L.; Kardos, G.; Paládi, P.; Kövér, L. Corvids in urban environments: A systematic global literature review. *Animals* **2021**, *11*, 3226. [CrossRef]
39. Jokimäki, J.; Kaisanlahti-Jokimäki, M.-L.; Suhonen, J. Long-term winter population trends of Corvids in relation to urbanization and climate at northern latitudes. *Animals* **2022**, *12*, 1820. [CrossRef]
40. Borray-Escalante, N.A.; Mazzoni, D.; Ortega-Segalerva, A.; Arroyo, L.; Morera-Pujol, V.; González-Solís, J.; Senar, J.C. Diet assessments as a tool to control invasive species: Comparison between Monk and Rose-ringed Parakeets with stable isotopes. *J. Urban Ecol.* **2020**, *6*, juaa005. [CrossRef]
41. Plummer, K.E.; Risely, K.; Toms, M.P.; Siriwardena, G.M. The composition of British bird communities is associated with long-term garden bird feeding. *Nat. Commun.* **2019**, *10*, 2088. [CrossRef] [PubMed]
42. Vuorisalo, T.; Hugg, T.; Kaitaniemi, P.; Lappalainen, J.; Vesanto, S. Habitat selection and nest sites of the Magpie *Pica pica* in the city of Turku, SW Finland. *Ornis Fennica* **1992**, *69*, 29–33.
43. Eguchi, K. The Eurasian Magpie. *Jpn. J. Ornithol.* **2016**, *65*, 5–30. (In Japanese with an English summary) [CrossRef]
44. Andrzejczak, R.; Dylewski, Ł.; Jerzak, L.; Pet'ko, B.; Myczko, Ł. Does traditional feeding of outdoor guard dogs provide a food resource for wild mammals and birds? *Animals* **2021**, *11*, 1198. [CrossRef] [PubMed]
45. Alexandrino, E.R.; Bogoni, J.A.; Navarro, A.B.; Bovo, A.A.A.; Gonçalves, R.M.; Charters, J.D.; Domini, J.A.; Ferraz, K.M.P.M.B. Large terrestrial bird adapting behavior in an urbanized zone. *Animals* **2019**, *9*, 351. [CrossRef] [PubMed]
46. García-Arroyo, M.; Gómez-Martínez, M.A.; MacGregor-Fors, I. Litter buffet: On the use of trash bins by birds in six boreal urban settlements. *Avian Res.* **2023**, *14*, 100094. [CrossRef]
47. Clarkson, K. The breeding and feeding ecology of the Magpie *Pica pica*. Ph.D. Thesis, University of Sheffield, Sheffield, UK, 1984. Unpublished.

48. Ciebiera, O.; Czechowski, P.; Morelli, F.; Piekarski, R.; Bocheński, R.; Chachulska-Serweta, J.; Jerzak, L. Selection of urbanized areas by Magpie *Pica pica* in a medium size city in Poland. *Animals* **2021**, *11*, 1738. [CrossRef]
49. Eguchi, K. Recent increase of nesting on utility poles by the Black-billed Magpie *Pica pica sericea*. *Jpn. J. Ornithol.* **1996**, *45*, 101–107. [CrossRef]
50. Wang, Z.; Wang, Y.; Jerzak, L.; Zhang, Z. Nest site selection of the Magpie *Pica pica sericea* in Beijin of China. *Studia Biologica* **2010**, *4*, 71–82. [CrossRef]
51. Šálek, M.; Grill, S.; Riegert, J. Nest-site selection of an avian urban exploiter, the Eurasian Magpie *Pica pica*, across the urban-rural gradient. *J. Vertebr. Biol.* **2020**, *70*, 20086. [CrossRef]
52. Xu, Y.; Cao, Z.; Wang, B. Effect of urbanization intensity on nest-site selection by Eurasian Magpies (*Pica pica*). *Urban Ecosystems* **2020**, *23*, 1099–1105. [CrossRef]
53. Mérő, T.O.; Žuljević, A.; Varga, K. Nest-site characteristics and breeding density of Magpie *Pica pica* in Sombor (NW Serbia). *Acrocephalus* **2010**, *31*, 93–99. [CrossRef]
54. Takeishi, M.; Eguchi, K. Nest-site characteristics in the Black-billed Magpies *Pica pica sericea*. *Jpn. J. Ornithol.* **1994**, *42*, 53–59. [CrossRef]
55. Antonov, A.; Atanasova, D. Nest-site selection in the Magpie *Pica pica* in a high-density urban population of Sofia (Bulgaria). *Acta Ornithol.* **2002**, *37*, 55–66. [CrossRef]
56. Møller, A.P. Habitat selection and feeding activity in the Magpie *Pica pica*. *J. Ornithol.* **1983**, *124*, 147–161. [CrossRef]
57. Kryštokofvá, M.; Fousová, P.; Exnerová, A. Nestling diet of the Common Magpie (*Pica pica*) in urban and agricultural habitats. *Ornis Fennica* **2011**, *88*, 138–146. [CrossRef]
58. Vogrin, M. Density and flock size of the Magpie *Pica pica* on the agricultural landscape during winter period. *Ornis Svecica* **1998**, *8*, 167–170. [CrossRef]
59. Reebs, S.G. Roost characteristics and roosting behaviour of Black-billed Magpies, *Pica pica*, in Edmonton, Alberta. *Can. Field Nat.* **1987**, *101*, 519–525. [CrossRef]
60. Birkhead, T.R.; Eden, S.F.; Clarkson, K.; Goodburn, S.F.; Pellatt, J. Social organisation of a population of Magpies *Pica pica*. *Ardea* **1986**, *74*, 59–68.
61. Reese, K.P.; Kadlec, J.A. Influence of high density and parental age on the habitat selection and reproduction of Black-billed Magpies. *Condor* **1985**, *87*, 96–105. [CrossRef]
62. Jokimäki, J.; Huhta, E. Artificial Nest predation and abundance of birds along an urban gradient. *Condor* **2000**, *102*, 838–847. [CrossRef]
63. Jokimäki, J.; Kaisanlahti-Jokimäki, M.-L.; Sorace, A.; Fernández-Juricic, E.; Rodriguez-Prieto, I.; Jimenez, M.D. Evaluation of the "safe nesting zone" hypothesis across an urban gradient: A multi-scale study. *Ecography* **2005**, *28*, 59–70. [CrossRef]
64. Madden, C.; Arroyo, B.; Amar, A. A review of the impacts of corvids on bird productivity and abundance. *Ibis* **2015**, *157*, 1–16. [CrossRef]
65. Chiron, F.; Julliard, R. Responses of songbirds to magpie reduction in an urban habitat. *J. Wildl. Manag.* **2007**, *71*, 2624–2631. [CrossRef]


**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.