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THE ENVIRONMENTAL IMPACT OF THE FERAL PIGEON (COLUMBA LIVIA F. DOMESTICA) IN THE HISTORICAL CITY CENTRE OF SOPRON

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ABSTRACT

The presence of different bird species in inhabited areas is becoming increasingly common. The problem with these species is that they are more likely to spread pathogens, contaminate public and private land with their droppings, cause economic damage or even frighten the public. One of the most notable conflict species causing environmental pressures in populated areas is the feral pigeon (*Columba livia f. domestica*), whose populations are increasing worldwide. Adequate practices and methods are available to reduce the problem. However, their applicability and effectiveness may vary from one locality to another due to the different characteristics of the localities and the various causes of the pigeons' presence. Therefore, it is essential to think in terms of town-specific solutions, the preparation of which requires, among other things, an assessment of the temporal and spatial pattern of occurrence of the species causing the conflict, an understanding of the extent of damage and an overview of the population's level of information. In our study, we investigated the environmental pressures of the feral pigeon in the historical city centre of Sopron, using a combination of the three elements mentioned above. For this purpose, we carried out a monthly visual population assessment combined with a photographic technique at sample points for one year. We conducted a field visit to the area to draw up a damage map of the study area and a spatial localisation of existing control methods. Questionnaire surveys complemented this to assess the public's awareness of the issue. In light of the results, we drew up a map of the pigeon conflict in the city centre of Sopron and identified possible solutions.

Keywords: human-wildlife conflicts, urbanisation, public space cleanliness, monitoring

1. INTRODUCTION

Today, the importance of human-wildlife conflict is growing in proportion to increasing urbanisation. Different animal species are becoming increasingly accustomed to human disturbance and urban artificial environments, and this is particularly true for some bird species. One of the most prominent urbanised bird species is the feral pigeon (C*olumba livia f. domestica*) [1]. Its habitat preference ranges over a broad spectrum. Its good adaptability has enabled it to adapt easily and quickly to urban environments [2], where it can find the necessary food, nesting, and roosting sites for most of the year [3]. Most of their food sources come directly from humans through targeted feeding. They also readily consume food scraps found in the garbage. In addition, they can find suitable natural food within the city [4][5]. Due to the favourable habitat conditions, feral pigeons can breed the whole year, even during winter [6][7]. The peak of their breeding is usually in spring and summer, declining in late autumn and winter [8]. The species is distributed worldwide, except in areas with extreme climatic conditions (arctic, tropical, and desert habitats) [9]. Regarding population distribution in Hungary, the feral pigeon is a regularly nesting year-round species [10]. The proliferation of feral pigeons in urban areas poses several problems, including human health conflicts. Pigeons can carry and spread many infective agents, especially in large flocks, which can also threaten humans. [9]. Infections spread by birds are mainly transmitted by inhalation with dry, dusty droppings or direct contact with animals [11]. A variety of diseases can be caused by viruses, fungi or bacteria that they spread [12][13][14]. In addition, feral pigeons cause significant pollution of public areas with their droppings, which are costly to clean up [15]. The birds' droppings are damaging not only to public spaces but also to high-value monuments. Besides leaving visible traces on contaminated surfaces, its acidic pH end-product corrodes various metals, especially copper, damaging the roofs of churches and religious

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buildings [16]. Adequate practices and methods are available to reduce the problem. However, their applicability and effectiveness may vary from one locality to another due to the different characteristics of the localities and the different causes of the pigeons' presence. Therefore, it is essential to think in terms of town-specific solutions, the preparation of which requires, among other things, an assessment of the temporal and spatial pattern of occurrence of the species causing the conflict, an understanding of the extent of damage and an overview of the population's level of information. The purpose of the study was twofold. On the one hand, it investigated the human-pigeon conflict in the historic city centre of Sopron. On the other hand, it evaluated the effectiveness of the methods used and their management.

2. MATERIALS AND METHODS

The investigation took place in Northwest Hungary, near the Austrian border, in the city of Sopron. The study focused on the historical city centre in the town, as this area has several historical assets and is highly frequented by residents and tourists. The study area covered approximately 22.9 hectares, including 6.14 kilometres of roads, five squares and more than 200 buildings. Fifteen monitoring points were established in the designated area (Figure 1.).

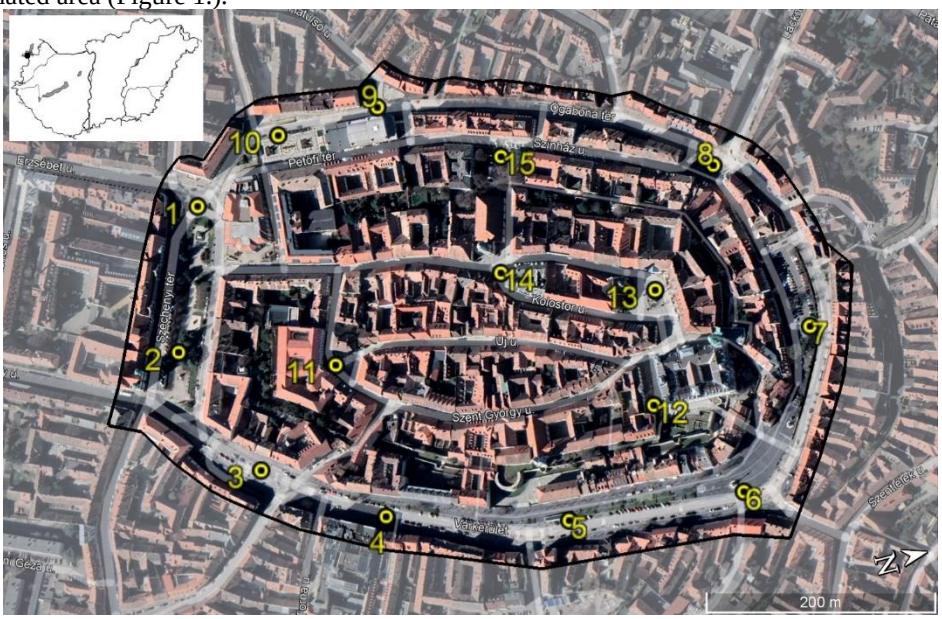

Figure 1. Research area with the monitoring points

The observations were carried out monthly from October 2021 to September 2022, on the third weekend of each month. The sample points were visited sequentially, each observed for 5 minutes. The maximum number of pigeons kept was recorded, with buildings as boundaries between points to avoid double counting. The number of pigeons in large groups was controlled by photographs. The images were taken with a Canon EOS 800D single-lens reflex (DSLR) camera using a Canon EF-S 55-250mm f/4-5.6 IS STM and Canon EF-S 18-55mm f/3,5-5,6 IS II telephoto lens. A habitat survey was also conducted for all streets and buildings in the study area. Verified nesting, hiding and roosting sites were recorded, and buildings were protected against pigeons (spikes, nets and wires). The contamination of public areas with droppings assessed environmental pollution. It was measured on a 4-point scale according to the degree of contamination: scattered, light, moderate, and heavy contamination (Figure 2.).

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Figure 2. Environmental impact classification based on faecal contamination (from left to right: scattered, light, moderate, and heavy contamination)

The habitat survey results were displayed on a map using Google Earth Pro Software [17]. A questionnaire accompanied the habitat survey to assess public awareness. The questionnaire covered public acceptance of pigeons, public health risks and the need for population control. The data were recorded in MS Excel, and statistical analyses (cluster analysis (Bray-Curtis dissimilarity index [18], Kruskal-Wallis test, Mann-Whitney pairwise test) were performed in PAST4 Software) [19].

3. RESULTS AND DISCUSSION

During the survey period (12 months), the monthly average number of pigeons was 381 for the whole area, taking into account the aggregated data of the sample points by a visual survey. Variations were observed between months (Table 1.)

Table 1. Trends in the number of pigeons over the research period

	October	*November*	*December*	*January*	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*
Total number of pigeons in the research area	434	269	287	150	280	347	281	483	302	364	412	963
The average number of pigeons on sample points	28.9	17.9	19.13	10	18.6	23.1	18.7	32.2	20.1	24.26	27.4	64.2
Min. - Max. number of pigeons on sample points	0-79	0-57	0-76	1-37	3-54	2-102	3-86	10-110	3-112	0-92	3-121	0-354

The lowest number of pigeons was observed in January (150) and the highest in September (963), which was confirmed by the Kruskal-Wallis test (H=22.46; p=0.0209). Spearman correlation (r=0.5314, p=0.0753) performed on the variation in the number of pigeons over the whole survey period showed no significant linear correlation with time. However, a linear increase in the number of pigeons from January (from minimum value) to September was observed (r=0.833, p=0.007). In addition to the temporal variation in the number of pigeons, spatial comparisons were made between sample points using cluster analysis and the Bray-Curtis dissimilarity index (Figure 3.).

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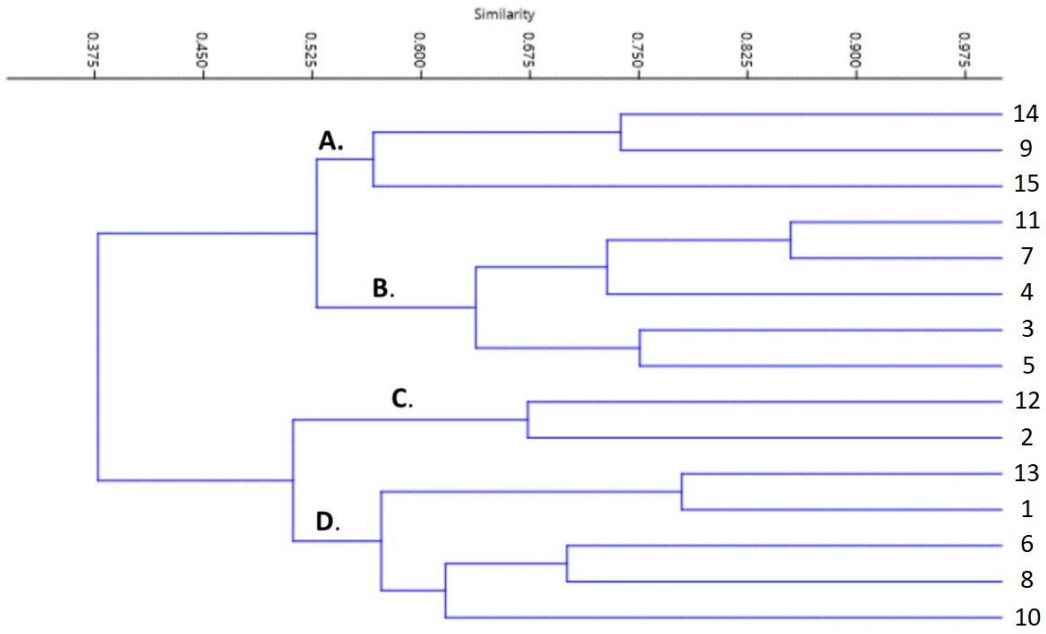

Figure 3. Classification of observation points by the number of pigeons

The cluster analysis allowed the separation of 4 groups that were verified to be dissimilar according to the number of pigeons observed per sample point (Kruskal-Wallis test, H=90.49; p<0.001). All groups were also different when compared pairwise (Mann-Whitney pairwise test) (Table 2).

Table 2. Comparison of numbers of pigeons per group

	The average number of pigeons		***A***	***B***	***C***	***D***
A	5.6	***A***		p<0.001	p<0.001	p<0.001
B	12.1	***B***	533.5		p<0.001	p<0.001
C	76.2	***C***	27	73		p<0.001
D	30.3	***D***	193.5	769	262	

Mann-Whitney U value below the diagonal
p value below the diagonal

These results show that the study area can be divided into four different categories according to the presence of pigeons. Intense presence affected 2 sample points (group C.), strong presence 5 sample points (group D.), and moderate presence was observed at 5 sample points (group B.), while rare occurrence affected 3 sample points (group A.). Based on the cluster analysis results, it was possible to construct a map showing the intensity of occurrence of the species (Figure 4.).

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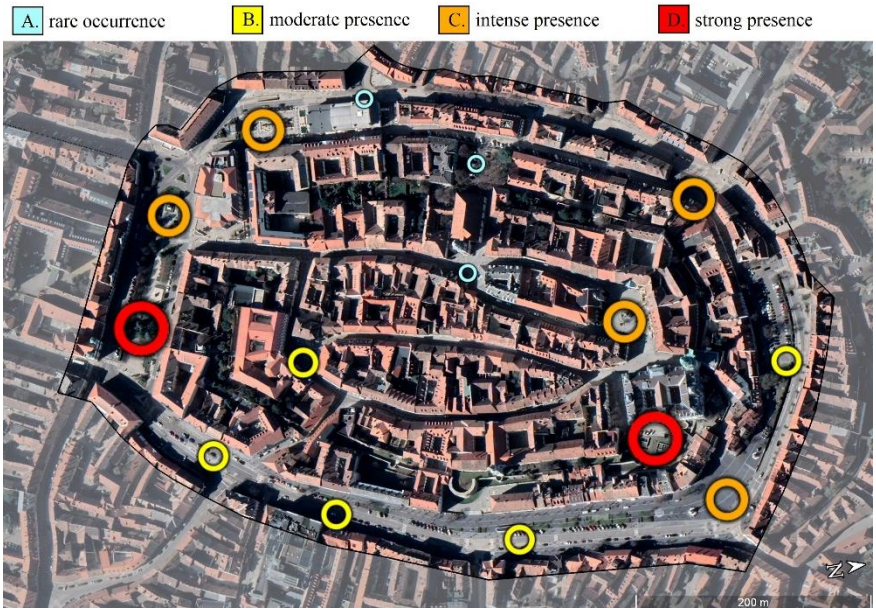

Figure 4. Pigeon abundance by groups

During the habitat survey of the study area, street sections contaminated with pigeon droppings, roosting and nesting sites and buildings with pigeon-proofing were recorded. The map shows that several public areas are affected, with 711.9 metres of the 6140 m road surveyed being contaminated by pigeons, representing 11.9% of the total road surveyed. Furthermore, out of 250 buildings surveyed, there were indications of nesting or hiding places. In addition, 52 buildings had some form of protection against pigeons. Overlap between buildings was also observed. Their spatial distribution is shown in Figure 5.

Figure 5. Results of the habitat survey

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During the survey, 65 people responded to the questionnaire, of which 41 were women (63.1%) and 24 were men (36.9%). It can be said that 96.9% of the respondents had regular encounters with pigeons in the study area. 15.6% of the respondents had fed pigeons in public places. Regarding the frequency of encounters with conflicts caused by pigeons, 28 respondents (43.1%) answered that they encountered polluted areas and nuisances daily. Twenty respondents (30.8%) responded that they only encountered nuisances monthly. At the same time, 17 respondents (26.2%) were affected rarely, 1-2 times a year. Of the nuisance effects, faecal pollution was the most frequently reported (92.6%), followed by intrusive behaviour (37%), while noise impact was only the third (11.1%). Regarding attitudes towards pigeons, 67.8% of respondents described the relationship as neutral, 6.9% were intimidated by the presence of the animals, and 15.4% of respondents strongly liked their presence. Respondents in the latter group fed the animals regularly. Public awareness of *E. coli* and *Salmonella* infections, which pigeons can spread, was surveyed, with 93.8% of respondents having heard of these diseases. However, most respondents (43.1%) thought that birds play only a minor role in spreading these pathogens. 30.7% of respondents thought pigeons could play a significant role in spreading dangerous infections. 18.5% of the respondents did not have precise information, while 7.7% thought pigeons do not spread pathogens. 60% of respondents did not consider it necessary to reduce the pigeon population in the study area.

4. DISCUSSION

Based on the results of the survey, it can be said that a significant number of feral pigeons are present in the historic city centre of Sopron, putting pressure on the built environment and the population. Based on one year's survey, the average monthly number of pigeons is close to 400. The highest count was 963 pigeons in September, which, given the size of the area surveyed, represents a maximum density of 42 pigeons per hectare. The population number showed a linear increase from January to September, which can be explained by the reproductive biology of the feral pigeon, whereby the breeding success increases from spring to summer and then decreases in winter [20]. The highest numbers in the study area in September may have been because nestlings from successful breeding in late summer reach the age of 5 weeks [21]. Regarding spatial distribution, the survey identified binding sites intensively affected by the presence of the species. These were generally clustered around large open areas and squares with little or no vegetation cover. In spaces where woody vegetation with significant canopy cover was present or closed, narrow streets, the presence of pigeons was possible. While the abundance of most species of birds in urban environments is positively influenced by the presence of woody vegetation [22], a few exceptions, including the homing pigeon, prefer mainly urban environments [23]. Extensive public areas and squares with resting benches are frequented by the population, where food from open rubbish bins, littering and direct feeding is an easily accessible food source. Consequently, the environmental pressure was also highest in these exposed areas. However, the conflict map showing the occurrence of faecal matter indicates that the problem is not generalised throughout the study area, but is specific to the aforementioned preferred areas. The problem is confirmed by the fact that the habitat survey also shows that the pigeons find suitable hiding and nesting sites in the public areas favoured by the pigeons. Even though, in many cases, these buildings are provided with some form of mechanical protection, the conflict map showed that in many cases, the protection is incomplete, mainly due to installation problems or lack of maintenance. This also indicates that installing mechanical protection requires expertise and fails to deliver, although the cost of removing access to nesting and hiding places is high [24]. This is why limiting access to food sources is essential and key to managing damage to pigeon habitat [25][26]. Public information is fundamental for this [27]. Even with a low number of items, the results of the questionnaire survey highlighted the importance of the latter, as almost 30% of the respondents were unaware of the diseases spread by pigeons, and those who liked the presence of the animals fed them regularly.

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5. CONCLUSIONS

Based on the study results, the methods used are suitable to assess the existing human-pigeon conflict in a given area. The method is ideal for determining the problem's spatial development and identifying the conflict locations. However, to accurately determine the number of pigeons, a condensation of the recording events is required, in the absence of which only the population trend can be traced. Identifying buildings requiring mechanical protection or revising existing protection is also possible. The questionnaire survey is an excellent way to show the population's awareness level, even with a few items.

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