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Distribution and Density of Common Woodpigeon (*Columba palumbus*) in Central Northern Bulgaria

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ABSTRACT

The breeding density of the Woodpigeon was determined in square LH75 in the period from March to May 2023. For this purpose, a point counting method was used, and in addition, some characteristics of the habitats were taken into account. The breeding density of Woodpigeon in the present study was 16.42, 12.75 and 14.44 pairs/100ha, in March, April and May 2023 year, respectively. Breeding density decreases from March to May. Anova analysis showed statistically significant differences in the mean number of song pigeons by habitat and cropland types (F=8.11, p=0.005). The number of song Woodpigeons was significantly greater in open habitats with single large trees or small groups of large trees among grassland and meadows than in other breeding habitat types. Their number is relatively high in Silver lime forests, coniferous plantations, and in the fringe strip of all forest habitats. The number of song pigeons is also relatively high in cases where we have a lack of arable land in the fixed radius or in the presence of wheat. Their number in the fixed radius increased with increasing average tree height. The number of singing pigeons is positively correlated with tree height (R=0.49, F=2.132, p<0.0001). The latest data on the breeding density of the Woodpigeon are from the end of the last century in Bulgaria. This study presents first results on the breeding distribution and density of the species in an information-poor area.

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1. Introduction

In the past few decades, the Woodpigeon has had an increasing distribution and a positive trend of breeding density. This trend for some European countries has been reported since 1970 [1-3]. The main breeding sites of the Woodpigeon are various types of forests, but of course the breeding density largely depends on the neighbouring cultivated lands [4]. The species can also be found breeding in many urban areas [5]. This trend has been observed since the beginning of the 19th century [6-10].

In the past, Woodpigeon was a widespread species in Bulgaria, being found up to 2000 meters a.s.l. [11]. This wide distribution was later confirmed as the species was recorded reaching up to 1200 meters a.s.l., forming flocks of 300 to 500 individuals in winter [12]. The species has also been established as a breeder on the outskirts of large cities [13]. According to recent ornithological studies in Bulgaria, the size of the breeding population is estimated between 15 and 35 thousand breeding pairs. Distribution and density are stable with increasing population trend [14].

The aim of this study is to present new data on the breeding density of the Woodpigeon in different breeding habitats in the LH 79 quadrant, 35T of Universal Transverse Mercator (UTM) of Bulgaria [15]. The species are more widely distributed in the mountainous and semi-mountainous parts of the country, absent or with single distribution on significant territories in the flat parts of Bulgaria, where there is a predominance of agricultural crops (Danubian Plain, Dobrudzha, Trakia and Burgas Plains etc.) [16]. The scope of the present study falls within a part of an area, where the distribution and breeding density of the Woodpigeon is poorly studied.

2. Material and Methods

2.1. Study Area

The study area is located in Central Northern Bulgaria, – quadrant LH 79, 35T of the UTM grid of Bulgaria [15] (N43 17; E25 28) (Fig. **1**). In this quadrant, the species was not reported to Iankov [16], but was reported as a species in suitable habitats in 2023 [17]. There are no accurate data on the breeding density of the species in the study until the present study.

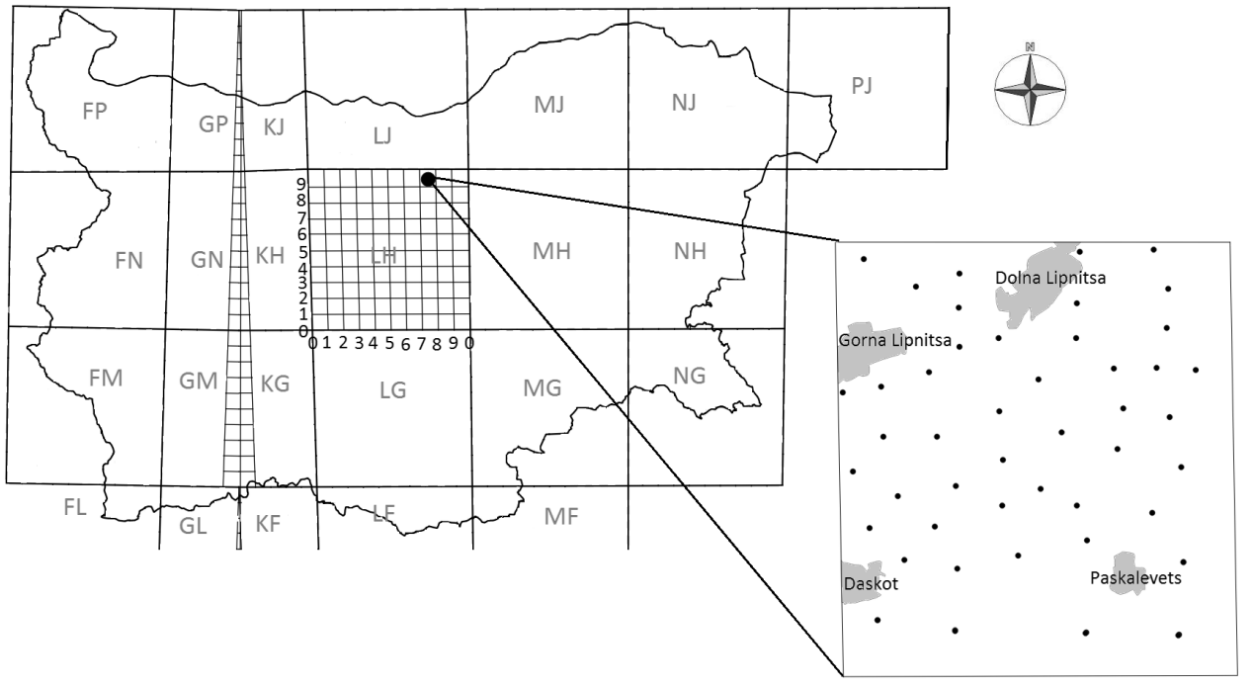

Figure 1: Study area and the count points distribution in LH 79 35 T UTM [10].

The terrain is mostly flat, mainly occupied by arable land. The average altitude of the terrain is 150 meters (100-200m). Main crops are maize, wheat, sunflower, and barley. In the study territory, 10 breeding habitats of the species were established in advance (Fig. **2**). Forest habitats are represented by small-scale lowland broad-leaved forests and small patches of coniferous plantations of Scots Pine (*Pinus silvestris* L.) and Acacia (*Robinia pseudoacacia* L.). Scots Pine plantations have an average height of 6 meters, with single bushes of 1.5 meters height located below the forest canopy. Acacia plantations have an average height of 6.8 meters, with single bushes of 1 meter below the forest canopy. Plain deciduous forests are represented by Turkey Oak (*Querqus cerris* L.), Hornbeam (*Carpinus orientalis* Mill.), and mixed with Manna Ash (*Fraxinus ornus* L.). These habitats are combined into deciduous forests (Fig. **2**) with an average height of 10.9 meters and 15% shrub cover below the forest canopy, with a height of 1.4 meters. Another type of broad-leaved forest characteristic of the region is the forest composed of Turkey oak and Virgilian Oak (*Quercus virgiliana* Ten.).These communities are united as oak forests with an average height of 6.5 meters and a 25% shrub floor under the forest canopy, with a height of 0.6 meters. Also found are mixed forests of Silver lime (Tilia tomentosa Moench.) and Common hornbeam (*Carpinus betulus* L.) or Silver lime mixed with Turkey oak, Dalechamps Oak (*Quercus dalechampii* Ten.), and Field Maple (*Acer campestre* L.). Because the participation of Silver lime in these forests was dominant (90%), and the other tree species had a single participation, these communities were classified as Silver lime forests. They have an average height of 11 meters without the presence of shrubs. A small part of the studied territory is occupied by pastures, which are xerothermic grass formations with a predominance of Dichantieta ischaemi Willemet, Poatea bulbosae L., Poatea concinae, Chrysopogoneta grylli Trin., and Ephemeret [18]. We designated these communities as grass/shrub. Other suitable breeding habitats for the Wood Pigeons are strips of trees and shrubs, separating the cultivated lands. In these habitats, the average height of trees is 6.4 meters, and of shrubs is 0.9 meters. Habitats with single large-sized trees (most often oaks or poplars) were classified separately. They are characterized by an average tree height of 10.9 meters and single shrubs with a height of 0.9 meters. Other suitable breeding sites are wetlands. They are fragmented and occupy a small area of the studied territory and are composed of poplars and willows. The average height of the trees is 8.7 meters, and of the shrubs 2.5 meters. The last type of nesting site is the forest ledge. These are strips of different broad-leaved trees, but oaks are dominant. The average height of tree is 7.5 meters, and there is also a well-defined shrub floor with a height of 0.9 meters. These strips were built in the past for field protection.

2.2. Field Methods

We used a point count method [19-21] to determine the distribution and breeding density of the Woodpigeon. In the LH 79 quadrant, we located 45 points with a minimum distance of 1 kilometer between them. The points were positioned, and we excluded the territories of villages and water mirrors, as well as large-scale agricultural land (over 200 acres), in which the birds only pass or visit them during feeding. The points were selected so that the entire diversity of pigeon breeding habitats in the study area was included. This allowed us to subsequently compare the number of songbirds in different habitats, using all the data collected to have a large enough sample. Projected points fall within all habitats in the study area, and this allowed us to determine both the breeding density and the pigeon presence index (number of singing birds inside the fixed radius) in individual habitats. In 2023, 3 reports were made in the period March – May. Every report was made between 04:30 and 07:30 am, when pigeons are most active. According to some authors, in the morning hours the birds are most active, and then we have a higher detectability [20, 22]. The data was collected in clear and quiet weather, with no rainfall. Sometimes birds may respond to the observer's presence [19, 23]. To avoid this effect, the number of birds singing at each point was counted for 5 minutes, having previously stood quietly for 2 minutes at the point to eliminate observer effects on birds' song intensity and for better detection probability [19, 20, 24]. We also counted the number of singing pigeons within a 100 meter radius around each point and beyond. Breeding density was determined by the formula: D = loge(n/n2)*(n/(m*(πr2))), where: D – breeding density; n – total number of recorded singing birds; n_1 – number of singing birds in the fixed radius; n_2 – number of singing birds outside of the fixed radius; r – fixed radius. To get the density per 100 hectares, we multiplied the density obtained by the formula by 1 million. Also during the reports, information was collected on the average height of trees and shrubs within a fixed radius of 100 meters around the each point. Tree height was determined as the mean value of the measured tree heights within the fixed radius. The height was determined using a SUUNTO PM-5/120 altimeter. The height of the shrubs was determined analogously. The type of agricultural crops was also recorded, again within the fixed radius. This allowed us to subsequently compare the number of singing pigeons in the fixed radius with these variables.

2.3. Statistical Methods

We used Anova main effects to test for a relationship between the mean number of Wood pigeons reported over the study period and the different types of breeding habitats and cropland within the fixed radius. We also used a multiple regression model to determine whether there was correlation between the number of pigeons recorded in fixed radius, and the tree and shrub height. In this model, the dependent variable was the number of song birds within the fixed radius, and the independent variables, the average height of trees, and shrubs again within the fixed radius. All statistical procedures were performed with Statistica 10 Software [25].

3. Results

The breeding density of Woodpigeon in present study was 16.42, 12.75 and 14.44 pairs/100ha, in March, April and May 2023 year, respectively. Breeding density decreases from March to May.

Anova analysis showed statistically significant differences in the mean number of song pigeons established by habitat, and cropland types within the fixed radius (Table **1**).

Table 1: Results from main effects Anova for mean distribution of singing wood pigeons bay habitat type and arable land inside of fixed radius of 100 meters over the every count point.

Effect	Sum of Squares	Degree of Freedom	Mean Squares	F Test of Equality of Means	p-value
Intercept	2,189	1	2,189	8,112	0,0051
Habitat	7,929	9	0,881	3,265	0,001
Arable Land	3,855	6	0,643	2,381	0,032
Error	32,113	119	0,270		

The number of song Woodpigeons was significantly greater in open habitats with single large trees or small groups of large trees among grassland and meadows than in other breeding habitat types (Fig. **2**).

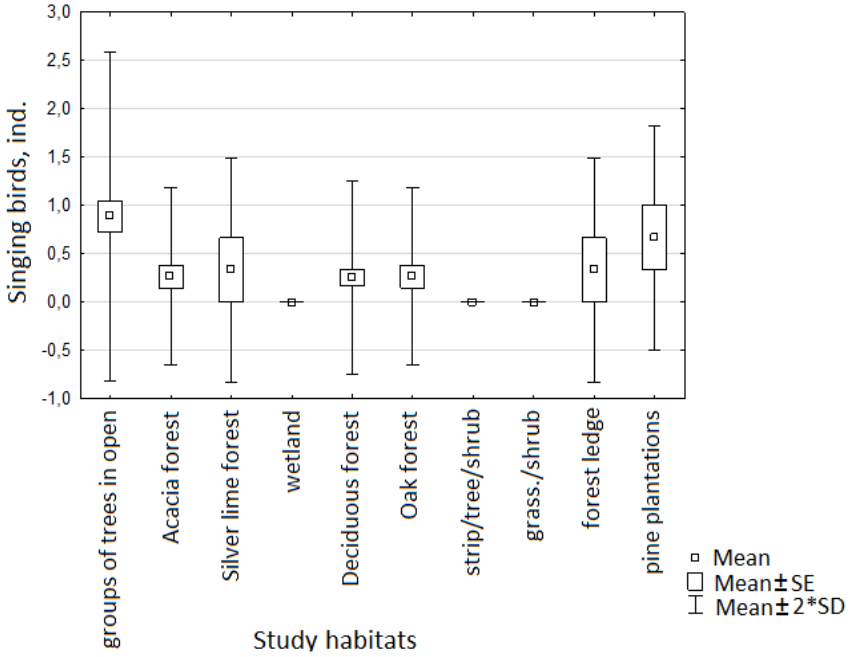

Figure 2: Number of singing Woodpigeons in different habitat type inside the fixed radius in study area. (singing bird, ind. is singing individuals inside the radius of 100 meters).

The number of pigeons is relatively high in Silver lime forests, coniferous plantations and in fringe strip of all forest habitats (Fig. **2**). The number of song pigeons is also relatively high in cases, where we have a lack of arable land in the fixed radius or the presence of wheat (Fig. **3**).

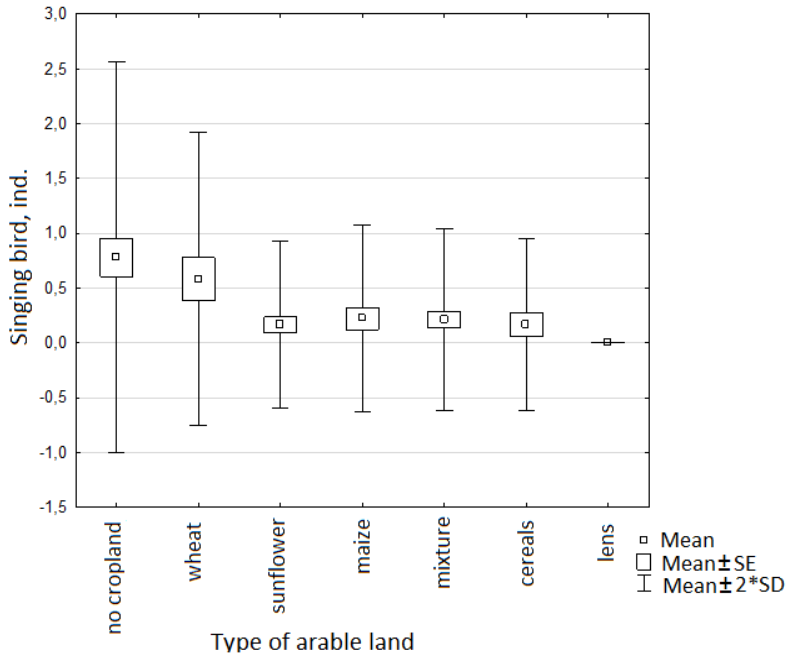

Figure 3: Mean singing Woodpigeon in different types of arable land inside the fixed radius of 100 meters in all point count.

The number of Woodpigeon in the fixed radius increased with increasing average tree height in the breeding habitats. Although, the pigeons also increased with an increase in the average height of the shrubs, the dependence was not statistically reliable (Table **2**).

Table 2: Summary for regression model for singing wood pigeons. (Where, the dependent variable was number of singing Wood pigeons inside the fixed radius of 100 meters, continuous predictors were tree and shrub height in meters also in fixed radius: R=0.492, R^2=0.242, Adjusted R^2=0.230, F=2.132, p<0.0001).

N=135	b*	Std.Err. of b*	b	Std.Err. of b	t(132)	p-value
Intercept			**-0,256**	**0,122**	**-2,103**	**0,037**
Tree height	**0,527**	**0,081**	**0,084**	**0,013**	**6,482**	**0,000**
Shrub Height	-0,157	0,081	-0,139	0,072	-1,928	0,056

Note: In bold are the values with statistical significant.

4. Discussion

The present study recorded Woodpigeon with confirmed breeding category for the first time in square LH 79. The species weren't reported in previous studies for Bulgaria in this area [16], but were reported in 2023 in the smart bird electronic platform [17] as a species in suitable habitat. In the last few decades, the species have an increasing breeding distribution and a positive trend in breeding density, which for some European countries has been established since 1970 [1-3]. The trends of distribution and abundance of the species in our country are also stable [26]. According to a 20-year monitoring of common bird species in Bulgaria, the Woodpigeon is classified as one of the birds with an increasing population trend [14]. The results of the present study are in agreement with the data on increasing distribution of Woodpigeon in Bulgaria. Breeding density in this study varied between 12 and 16 breeding pairs per square kilometer. Its density falls within the limits reported for the species in other parts of Woodpigeon range. In Poland, densities in urbanized areas between 7.4 and 96.5 pairs/100ha were found

[27], in Algeria, densities of 57 pairs /10ha were found [19]. In urbanized areas of Belarus, breeding density varies from 0.1 to 0.92 birds/ha [20]. In Bulgaria, there's a lack of specific data on the breeding density of the Woodpigeon. In the past the species were indicated as common and widespread, but there is no data on the density [13, 12, 26]. Density of 76 ind./100ha for beech forests, 30 ind./100ha for Bosnian pine (*Pinus heldreichii* H. Christ.) communities, 28 ind./100ha in Austrian pine (*Pinus nigra* J.F. Arnold) plantations, 19 ind./100ha in Scots pine (*Pinus silvestris* L.) forests was reported by Simeonov [30] in Western Pirin Mountain in the past. The present study was conducted in flat breeding habitats, unlike most studies for Bulgaria since the end of the last century. This makes density results largely incomparable, due to habitat differences.

This study also found differences in species densities across habitat types. Some of the highest densities in the study area are in the groups of trees in open areas, linden forests and Scots pine plantations. Nest building preferences in linden trees have also been found in other studies of the species, but for urbanized areas [31, 28, 29]. The latest authors found that out of 19 plant species, the Woodpigeon prefers linden (*Tilia cordata*) in 68% of cases for nest building in Belarus. Thirty two percent of the total numbers of nest analyzed in the UK were built on tree species of the Tilia genius [31]. Woodpigeon was recorded with a certain density in Scots pine forests in Western Pirin Mountain [30]. The author reported a density of 19 ind./100ha for these habitats. In our study, Scots pine plantations are one of the habitats with relatively high breeding density. This study also found differences in the number of Woodpigeons within a 100 meters radius around each point count, and the type of crops in the open habitats within that radius. The highest number of pigeons were recorded where we have no cultivated areas in the fixed radius and the ground cover is occupied by grass or shrub vegetation. The Woodpigeon is a fairly mobile species that can travel different distances in search of food, and it is unlikely that the type of arable land on such a small scale (100 meters around the counting point) as we used can affect the distribution of birds. Sometimes the Woodpigeon can travel at least 6 kilometers to feeding sites [31]. Some authors [32, 33] report the appearance of damage to various crops, most often in oilseed rap, with the damage being the highest in the January-March period. During the present study, we didn't record large food aggregations of the pigeon, and no damage to agricultural crops. Therefore, in the future, large-scale habitat associations need to be investigated to determine how the species are related to the food supply.

The final analysis in the current study showed a relationship between tree height and the number of recorded singing pigeons. As the height of the trees increases, so does the number of recorded Woodpigeons increased (Table **2**). Similar results were obtained in other studies, where the authors found a preference for building nests in higher trees [31, 34, 35]. The Woodpigeon is plastic species that can breed in many different and varied habitats, including urban areas [1-3, 28].

Different authors provide diverse information about the characteristics of nesting sites. In Belarus, in urban areas, birds prefer to build nests in old trees, but the height at which they are located dependents to some extent on the type of territory [31]. A survey in North - West England indicated the greatest number of established nests at heights of 5 to 15 meters [31]. Studies in the United Kingdom have found similar associations with differences in nesting heights [36]. In some places, the main factor affecting nest site selection of the Woodpigeon in urban habitats is predation of Corvidae [31, 37, 38]. Possible reason why birds prefer higher trees in our study is better protection from predators or differences in forest management, which may provide suitable nesting sites in different height.

The distribution and density of the Woodpigeon probably also depends on the species' interaction with other forest-nesting birds. The habitat overlap of different Columbidae species has been demonstrated in previous studies [39]. There are even known cases of closely located nest and occupying the same habitats [35, 40]. The Woodpigeon is increasing it's distribution throughout Europe [1-3, 41-43]. However, some authors report that the colonization of new habitats started later in Eastern Europe and it's effects are likely to be felt a later stage [39, 44]. Further studies are needed to establish breeding density on a wider scale, and also to identify important breeding and feeding habitats for the species. In addition, additional data are needed on the breeding phenology of pigeons, which have not been specifically studied in Bulgaria for more than 15 years. All this would help to better understand and take the right measures to manage the species, which would avoid the scenario with the European Turtle Dove (*Streptopelia turtur*), Common Quail (*Coturnix coturnix*) and the birds of open habitats in Bulgaria.

5. Conclusion

The Woodpigeon is a widespread species throughout it's European range, with increasing distribution and numbers. However, there is not much data on these population parameters in Bulgaria. This study established, albeit on a smaller scale, the breeding distribution, and density of the species in a particular region of the country. In addition, some relationships were found between the number of singing Woodpigeons, the type of nesting habitats, the open areas in the neighborhood and the height of the trees. This is the initial data that may help in future studies to better understand the breeding biology of the species in Bulgaria.

Conflict of Interest

The author declares that there is no conflict of interest.

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