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Turtle Dove (Streptopelia turtur Linnaeus, 1758) Distribution Dependence of Habitat Variables in Central South Bulgaria

Gradimir V. Gruychev[*]

University of Forestry, Faculty of Forestry, Department of Wildlife Management,
10 Kliment Ohridski Blvd., 1756 Sofia, BULGARIA
[*]Corresponding author: gradi.val@gmail.com

Abstract. In the period 2016–2019, we monitored the presence of Turtle Doves in 153 census points within a study plot in Central South Bulgaria. The presence of singing males varied slightly throughout the study period and there was no significant difference between years. The riparian and oak forests are characterised by a greater presence of Turtle Doves than other habitat types. The Multiple regression model showed a relation between the presence index, the height of trees and the distance to water resources.

Key words: breeding habitats, habitat preference, presence index, tree height, water sources.

Introduction

Avian populations are one of the important indicators of biodiversity applied worldwide (Burchard et al., 2010; Gregory et al., 2005; Gamero et al., 2017). Agricultural intensification is considered to be one of the main reasons for the decline of farmland birds (Donald et al., 2006; Emmerson et al., 2016; Rief & Vermouzek, 2018; Traba & Morales, 2019). One of the species affected by the Pan-European agricultural practices is the Turtle Dove (*Streptopelia turtur*). Its breeding population is declining which is why it falls under the category of vulnerable species (IUCN, 2019). Threats in Europe include fragmentation and reduction of nesting habitats (Browne et al., 2004; Dunn & Morris, 2012; Kleeman & Quillfeld, 2014), as well as changes in agricultural practices leading to a decrease in food availability (Browne & Aebisher, 2003, 2004; Baptista et al., 2015). Other factors that contribute to the Turtle Dove's decline are associated with wintering grounds and migration routes (Browne & Aebisher, 2001).

Although the main food resources for the Turtle Dove are seeds in open areas (Browne & Aebisher, 2001, 2003), breeding habitats are forests close to the feeding areas (Browne & Aebisher, 2003; Browne et al., 2004). Within nesting sites, Turtle Doves are influenced by forest type, forest characteristics, and the type of adjacent open areas offering food resources (Bakaloudis et al., 2009; Dias & Fontoura, 1996; Dias et al., 2013; Rocha & Hidalgo, 2002). This defines the complex interrelationships between the environmental factors that determine the spread and the preferences of the Turtle Doves, which are sometimes difficult to understand. There are few studies on breeding habitat variables and the Turtle

Dove's presence (Bakaloudis et al., 2009; Dias et al., 2013), and differences in landscape structure in various nesting habitats that determine different preferences for nesting habitats.

The purpose of this study is to determine the preferences of the Turtle Dove to certain breeding habitats in the study area. It also analyses the impact of some habitat characteristics affecting the distribution of breeding birds.

Material and Methods

Study area. The study area falls in Central Southern Bulgaria and occupies parts of the Sakar Mountain and the Upper Thracian Plain (Fig. 1).

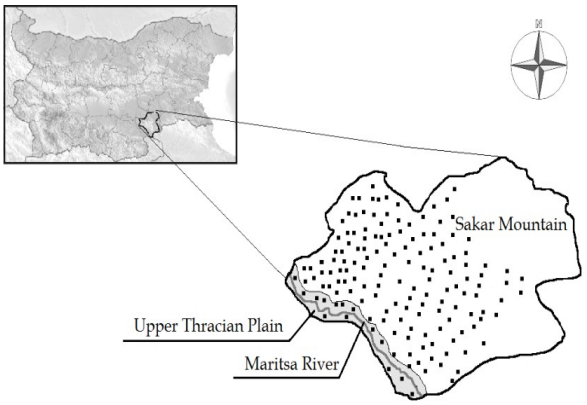

Fig. 1. Study area and distribution of points.

The study area covers an area of 1019 km^2 and includes several Natura zones: Sakar (BG 0000212; BG 0002021), Radinchevo (BG 0002020) and Maritsa River (BG 000578).

The forest flora is represented by *Quercus fraineto* (Ten.), *Quercus pubescens* (Willd.) and *Quercus virgiliana* ((Ten.) Ten.)). The main species at the shrub floor are: *Crataegus monogina* (Jacq.), *Rosa canina* (L.), *Rosa gallica* (L.), *Paliurus spina-christi* (Mill.), *Prunus*, *Cornus* etc. In wetlands, other groves can also be seen in patches: *Salix alba* (L.), *Salix fragilis* (L.), *Populus,Fraxinus Acer*, etc. (Bondev, 1991). Part of the territory is occupied by coniferous cultures: *Pinus nigra* (Arnold) and *Cedrus*. Open habitats are cultivated lands – mainly wheat and rapeseed. These are divided by narrow strips of deciduous trees and shrubs.

Field methods. In the period 2016–2019, we monitored the presence of Turtle Doves in 153 census points in the studied area. The number of singing male birds within 100 meters of the centre of each point was recorded from May 1 to July 20 two times per year. The data were collected in clear and quiet weather, with no rainfall, between 5:00a.m. and 8:30a.m.. The number of singing Turtle-Doves was determined from duration of 10 minutes, after a two-minute wait on the part of the observer before the onset of the measurement of each point. Several types of nesting habitats were distinguished in the study area and points were distributed to all of them (Table 1).

Table 1. Number of points count by habitat type.

Habitat type	Number of points
Coniferous cultures	24
Oak forest (*Quercus pubescens, Q. fraineto, Q. virgiliana*)	22
Deciduous forests dominated by Oaks	22
Riparian forests	22
Shrubs predominated by *Paliurus spina-christi*	24
Strips of trees and shrubs amid vineyards	19
Strips of trees and shrubs amid arable land	20

Coniferous cultures are composed mainly of Black Pine (*Pinus nigra* Arnold) and there is no shrubby floor. Single spots consist of *Cedrus*. The Oak forests are represented by Hungarian Oak (*Querqus frainetto* Tenn.), Austrian oak (*Querqus cerris* L.), and Downy oak (*Querqus pubescens* Willd.). They have an average height of 10 meters and no shrubby floor. The Deciduous forests have a mixed composition of Narrow- leafed ash (*Fraxinus ornus* L.), Oriental hornbeam (*Carpinus orientalis* Mill.) and Downy oak (*Quercus pubescens* Willd.). They are characterized by a shrub floor of Common

hawthorn (*Crataegus monogina* Jacq.), Dog rose (*Rosa canina* L.), Provence rose (*Rosa gallica* L.), Jerusalem thorn (*Paliurus spina-christi* Mill.), Cornelian cherry (*Cornus mas* L.) and average height of 8meters. The riparian forests are representing of poplars, willows and ash trees. They are up to 20 meters in height and single shrubs. Jerusalem thorn communities are the lowest (3.2 m height). Among the shrubs there are single pears and oaks. The stripes of trees and shrub amid vineyard and arable lands are represented by oaks, pears and ash trees. They have a shrub floor of Blackthorn (*Prunus spinosa* L.), Hawthorn (*Crataegus*) and Jerusalem thorn with an average height of 4 meters.

We calculated the Turtle Dove's abundance index as the average number of singing birds in each point by year (total number of singing birds in each point/number of observations per year). In addition, we used data from the study of the Turtle Dove in 2014–2016 at MG 14 (UTM) (Gruychev & Mihaylov, 2019). In 2014–2016, data was used only for reports in the period May 1 –July 20, so that there are no time distortions.

Flora characteristics were determined at each point within the 100-metre radius around it: 1) cover of a dominant tree species (%); cover of a dominant shrub species (%); tree density (number of trees in a spot of ten by ten metres) (number); average vegetation coverage (%); grass height (metres); tree height (metres); shrub height (metres); deciduous coverage (%); total shrub coverage (%); grass coverage (%) (Bibby et al., 1992). Next, we characterised the flora in each separate type of habitat by averaging the values measured at each point. This allowed us to compare the Turtle Dove's abundance in each separate type of nesting habitat with the characteristics of the vegetation therein. We measured the shortest distances from each point to open areas and to water sources. The distances were measured with QGIS (QGIS, 2019). These variables were included in a model to look up the relations between the Turtle Dove's presence and the habitat variables.

Statistical methods. We used one-way ANOVA to compare the abundance of Turtle Doves in different years and habitats and ANOVA main effect to compare the abundance of birds in different crops in the neighbourhood. In this case, the dependent variable was the Turtle Dove's presence and the independent variable was habitat type and crops in the neighbourhood. A multiple regression model was used to determinate the relations between habitat variables and the Turtle Dove's presence. The presence of Turtle Doves was a dependent variable and the habitat characteristic was an independent variable (Dytham, 2011).

The habitat selection by Turtle Doves was assessed comparing the bird's abundance index in each habitat to its availability in the whole study area by using the Jacobs' index of selection J (Jacobs, 1974):

$$J = (H1/H2-A1/A2) / (H1/H2+A1/A2),$$

where: H1 – Turtle Doves abundance in habitat 1; H2 – Turtle Doves abundance in all habitats; A1 – area of all study plots in habitat 1 (coniferous, oak etc.); A2 – area of all study plots in all habitats (Jacobs, 1974).

All statistical analyses were performed using Statistica 8.0 StatSoft, Inc (Hill & Lewicki, 2006).

Results

The presence of singing males varied slightly throughout the study period (Fig. 2), and there was no significant difference between years (F = 1,47; p = 0,199; df = 290).

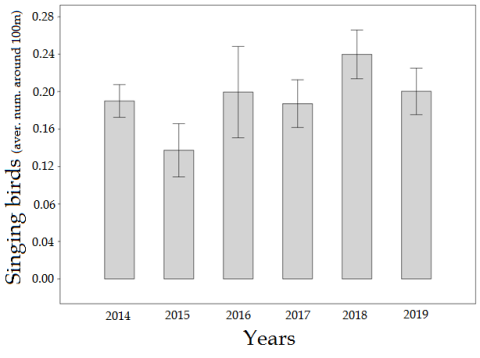

Fig. 2. Average number of singing Turtle Doves (*Streptopelia turtur*) by year around 100 meters (average, min.-max., st. err.).

The riparian and oak forests are characterised by a greater presence of Turtle Doves than other habitat types ($F = 4.43$; $p < 0.0001$; $df = 6$), (Fig. 3).

The Jacobs' index has the highest positive values for riparian and oak forests and negative ones for coniferous cultures and strips of trees and shrubs amid vineyards and arable land (Fig. 4).

The Multiple regression model showed a relation between the Turtle Dove's presence and height of trees and distance to water sources, but the general model is not significant (Table 2).

Although the presence of Turtle Doves is higher (Fig. 5) in the habitats with meadows our model does not recognise any significant differences (Table 3). The ANOVA main effect model is significant but does not show any differences in Turtle Dove's presence in addition by crop neighbourhood (Table 3).

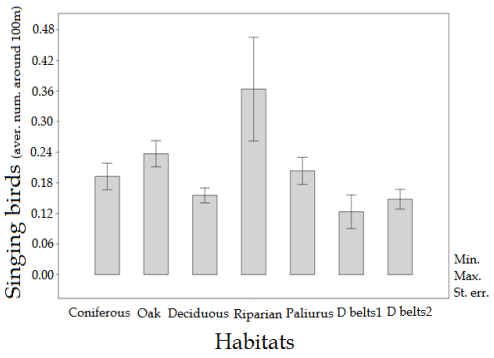

Fig. 3. Number of singing birds around 100 meters in different habitats of study area. (D belts 1 - strips of trees and shrubs amid vineyards; D belts 2 - strips of trees and shrubs amid arable land).

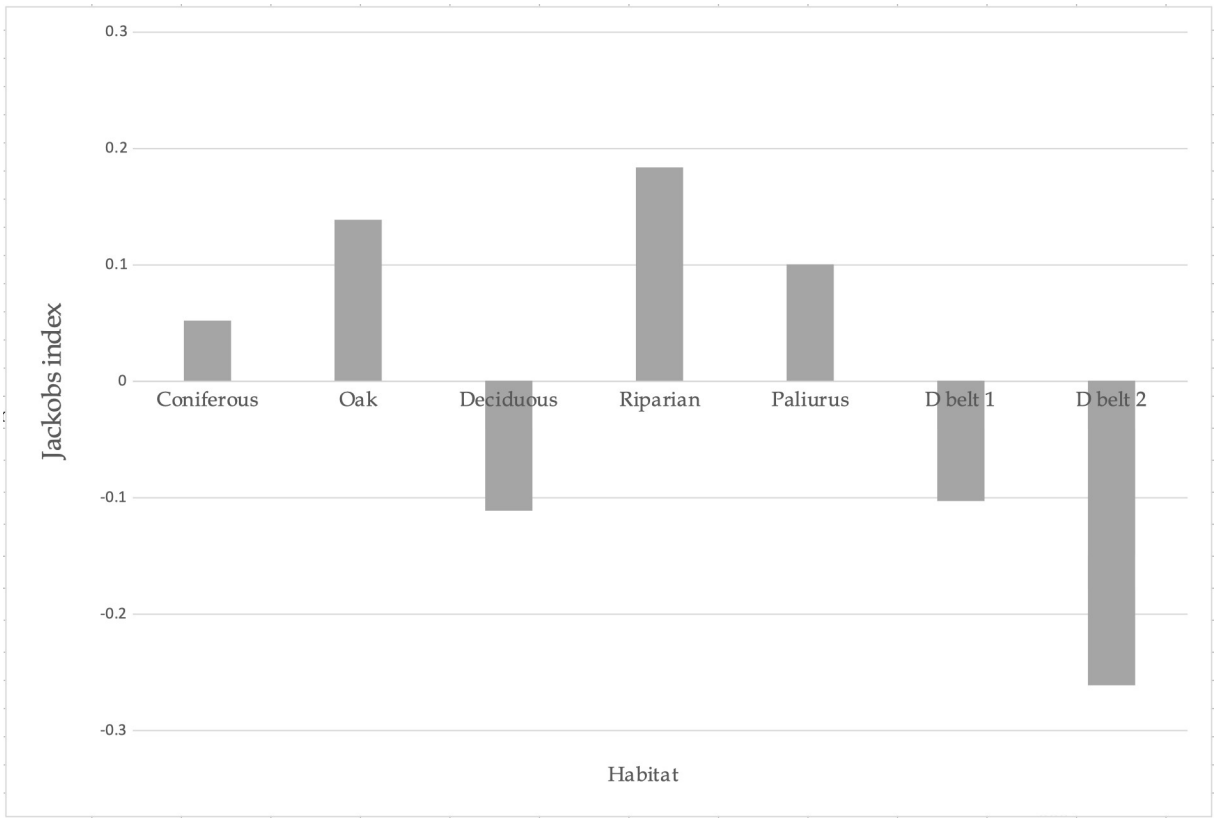

Fig. 4. Jacob's index by habitats. (D belts 1 - strips of trees and shrubs amid vineyards; D belts 2 - strips of trees and shrubs amid arable land).

Table 2. Results from multiple regression model for Turtle Dove's presence and habitat variables. Legend: in bold font are the results with p<0.05.

Regression Summary for Dependent Variable: Turtle Dove presence R= ,23344816 RI= ,05449804 Adjusted RI= ,03211930 F(12,507)=2,4353 p<,00438 Std.Error of estimate: ,32657						
	b*	Std.Err.	b	Std.Err.	t(507)	p-value
Intercept			-0.331731	1.391095	-0.23847	0.811615
Cover of a dominant tree species	-0.36656	1.111859	-0.003900	0.011830	-0.32968	0.741777
Cover of a dominant shrub species	0.20078	0.416050	0.005220	0.010816	0.48258	0.629601
Tree density	-1.42350	1.289121	-0.012616	0.011425	-1.10424	0.270012
Average vegetation cover	-0.44411	1.207920	-0.003838	0.010438	-0.36767	0.713273
Grass height	1.82990	1.480129	0.158592	0.128278	1.23631	0.216916
Tree height	**0.36096**	**0.161182**	**0.035462**	**0.015835**	**2.23943**	**0.025561**
Shrub height	-0.03551	0.212853	-0.000499	0.002991	-0.16681	0.867587
Deciduous coverage	1.07495	1.036068	0.010317	0.009944	1.03753	0.299985
Total shrub coverage	-0.18301	0.232824	-0.005093	0.006479	-0.78605	0.432206
Grass coverage	0.55540	0.537269	0.006874	0.006650	1.03374	0.301751
Distance to open areas	0.10052	0.055043	0.000672	0.000368	1.82623	0.068404
Distance to water areas	**-0.10891**	**0.050475**	**-0.000102**	**0.000047**	**-2.15775**	**0.031416**

Discussion

We did not find significant differences in the Turtle Dove's presence indices over the years. In a previous study, differences in species density by year (Gruychev & Myhailov, 2019) and a decrease in breeding density over previous periods (Simeonov & Petrov, 1978) were found in a part of the Sakar Mountains.

The riparian and oak forests are characterised by a higher abundance index than other breeding habitats. These results are confirmed for similar but smaller areas of Sakar Mountain (Gruychev & Myhailov, 2019) and other parts of Bulgaria (Nankinov, 1994; Simeonov et al., 1990;). Appropriate forest habitats can maintain 6.5 times higher density than open areas (Browne et al., 2004). The riparian forests are preferred by Turtle Doves in other parts of its range (Saenz de Buruaga et al., 2012). The Jacobs' index has the highest values for the last two habitat types. There are various studies on the Turtle Doves' breeding range in Europe which, to some extent, highlight dependencies between density and different habitats. In some parts of the Iberian Peninsula, the species prefers forested and agricultural landscapes with single trees (Dias et al., 2013). The Jacobs' negative index of trees and shrubs among arable land and vineyards in this study is probably due to a mechanized spraying in these areas, often with aviation creating anxiety during the breeding season. The Jacobs' negative index for deciduous forests remained interesting. The probable reason is the shrub floor in these habitats and reduced visibility, which is reported as a negative factor by other similar studies (Bakaloudis et al., 2009; Camprodon & Brotonos, 2006; Dias et al., 2013; Santos et al., 2002; Saenz de Buruaga et al., 2012). Coniferous cultures and shrub communities also have a positive Jacobs' index. In a number of studies, such habitat types have been reported to be positively related to breeding density of Turtle Doves

(Bakaloudis et al., 2009; Browne & Aebisher, 2004; Dias et al., 2013; Dunn & Morris, 2012). In the study area, the last two habitat types have lower presence index. A probable reason might be the preference of the Turtle Dove to riparian and oak forests.

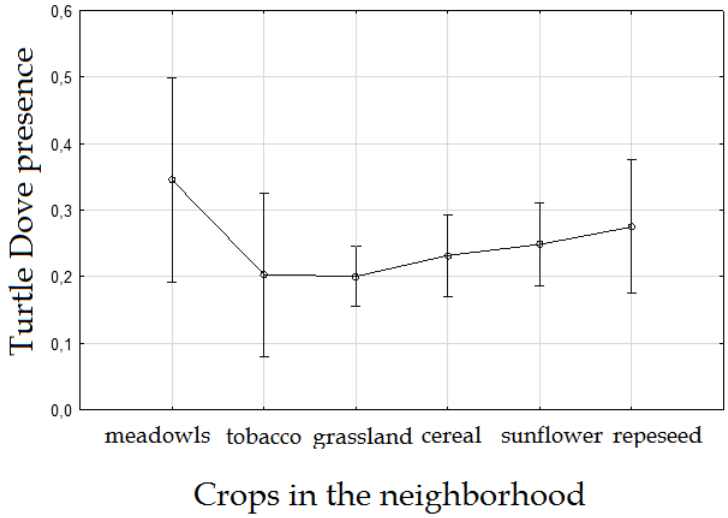

Fig. 5. Turtle Dove (*Streptopelia turtur*) presence by different crop in neighbourhood. (current effect F (5,519)=0.988; p=0.42, effective hypothesis decomposition, vertical bars denote 0.95 confidence intervals)

Table 3. The result of ANOVA main effect model by habitat type and crop neighborhood. Legend: in bold font are the results with significance.

	SS	Degree of freedom	MS	F	p
Intercept	**14.32005**	**1**	**14.32005**	**134.4404**	**0.00000**
Crop neighborhood	0.52608	5	0.10522	0.9878	0.424508
Habitat	**2.14193**	**5**	**0.42839**	**4.0218**	**0.001371**
Error	55.28181	519	0.10652		

The Multiple regression model showed a relation between the presence index, the height of trees and the distance to water resources, but the overall model is not significant. However, a similar relation has been established for another part of the Turtle Dove's range (Kafi et al., 2015). Recent authors have found that the number of hatchlings increases with the height of the trees up to about 1.6 m and then sharply decreases. In this study, we have a height restriction on trees, because we do not have many counting points in habitats with tree heights over 20 meters. Therefore, we do not know what height is optimal. There is a slight negative correlation between the

presence index and the distance to water resources. The presence decreases gradually with the increasing distance to water resources. The presence of permanent water sources can largely determine the distribution of some more sedentary bird species in dry areas, such as some Galliformes (Borralho et al., 1998; Larsen et al., 2010; Lee et al., 2003). But Turtle Doves are quite mobile species that can travel considerable distances and water should not be a limiting factor. There are studies which do not identify the impact of water resources on breeding density (Gutierrez-Galan et al., 2018; Kleeman & Quillfeld, 2012) and those that claim a relation (Dunn & Morris, 2012; Saenz de Buruaga et al., 2012). The mean distance to permanent water sources in this study is 486 ± 354 (27–1970 m) and although very close to other similar studies (Gutierez-Galan et al., 2018), there is a slight correlation here with the presence of the Turtle Dove. The probable reasons are the points with greater distances to the water. In addition, the habitats in the study area where we reported the highest presence indices are located near different water sources. Our results did not find a significant relationship between Turtle Dove's presence and other habitat characteristics. The analysis of variance did not consider a significant relationship between the presence of the Turtle Doves and the type of arable land in the neighbourhood. However, the presence is highest when there is a combination of forest habitats with meadows, followed by crops such as rapeseed, sunflower and cereals. The Turtle Dove's feeding areas consist of areas occupied by low grassland and arable land (Browne & Aebisher, 2003). Thus, wild and cultivated seeds are the main nutritional components for Turtle Doves (Dias & Fontoura, 1996; Gutierrez-Galan et al., 2018; Jimenez et al., 1994;). In the study area, the meadow probably offers the best food for the species in May and June. At the same time, they have lower degree of chemisation than the other feeding sites. Positive effects of grassland places have also been reported in other studies (Kleeman & Quillfeld, 2014). Although cereals and oilseeds are the preferred food for the species, they are only available in the study area in July and August. The presence of Turtle Doves is greater in habitats close to cereals and such offering wild seeds included in the local diet of the species (Gutierez-Galan et al., 2018; Mansouri et al., 2019). The reason for the lack of relationship between the Turtle Dove's presence and crops in neighbourhood within the present study area is likely due to its heterogeneity. It is a combination of many different habitats close to each other, and the mosaic of agricultural lands ensures a good food supply in the whole area. The study area includes habitats similar to those that are known to be preferred by Turtle Doves in other parts of the breeding range. The results confirm similar outcomes from other studies of the species (Barbaro et al., 2007; Browne & Aebisher, 2004; Dias et al., 2013).

Conclusions

In this study, no difference was found in the presence of Turtle Doves during the study period. We found that the riparian and oak forests have a higher presence index and a positive Jacobs' index. Of the habitat characteristics, the height of the trees and the distance to water resources are important for the presence of the species during the breeding season. These results must be taken into account when planning activities in the habitats concerned. Often, forestry activities, such as logging during the breeding season, can lead to significant losses of broods. The nesting habitats of the Turtle Doves must be managed through a comprehension of the breeding season of the species in order to avoid loss of biodiversity.

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