Distribution and habitat preference of roe deer (*Capreolus capreolus* L.) in Düzce Province (Turkey)

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Abstract: The roe deer is an important game animal in Turkey. The aim of the current study was to determine the likely distribution area and habitat preferences of roe deer (*Capreolus capreolus* (L., 1758)) in Duzce Province. The species was observed by wildlife camera traps and direct or indirect observation methods in different habitats in a total of 75 sampling sites during the period between 2013 and 2015. Roe deer avoid human contact. The species are found mostly (79%) in fir and beech forests, preferably those with a closed canopy cover but without dense understory. The numbers of individual of male are higher than the female. They are most often (74%) observed during feeding, with activity peaking at dawn and dusk. The roe deer has a wide distribution range in Turkey and has great potential as a game animal. However, its prevalence is not sufficient in all regions.

Keywords: Wildlife camera trap, stand, humans

Karaca (Capreolus capreolus L.)'nın Düzce'de yayılışı ve habitat tercihi

Özet: Karaca önemli av hayvanlarımızdan birisidir. Bu çalışma ile Düzce ilinde Karaca (*Capreolus capreolus* L.)'nın muhtemel yayılış alanlarını ve habitat tercihlerini belirlenmesi amaçlanmıştır. Bunun için tür 2013 ve 2015 yıllarında farklı habitatlarda fotokapan ve doğrudan ve dolaylı gözlenmiştir. Tür insan etkisinden mümkün olduğunca kaçınmaktadır. Çoğunlukla göknar ve kayın ormanlarını ve tercihen kapalı alanları kullanmaktadır. Ancak çok sık alt tabakayı tercih etmemektedir. Erkek birey dişilere göre daha fazla tespit edilmiştir. Alanda daha çok beslenme aktivitesi gösteren tür sabah ve akşam saatlerinde aktiftir. Ülkemiz av hayvanları arasında potansiyeli yüksek olan türün Düzce ilinde geniş yayılışı bulunmakta ancak görünme sıklığı her alanda yeterli seviyede bulunmamaktadır.

Anahtar Kelimeler: Fotokapan, meşcere, insan

1. INTRODUCTION

The roe deer, Capreolus capreolus (Linnaeus, 1758), is the smallest species in the Cervidae (deer) family in Europe and Turkey (Beskardes et al., 2008). Roe deer live 7-10 years, mate in July, and bear young between mid-April and early June. Unlike other ungulate species, in the roe deer, embryonic development is arrested for a period of 4-5 months. Thus, the mating and the birthing seasons both occur during a time when food is plentiful. The roe deer is territorial (Danilkin, 1996; Canakcioglu and Mol, 1996).The roe deer has a wide distribution in Europe and Asia. In Turkey, they are mostly found in northern Anatolia, with small numbers in the Aegean, Mediterranean and Eastern Anatolian regions (Hus, 1974; Demirsoy, 1995; Baskaya and Bilgili, 2002; Arslangundogdu, 2005; Evcin, 2013). The habitat of the species is determined primarily by the accessibility of food and cover. Although the diet of the roe deer consists of many diverse plant species, the regional plant species they feed on vary according to season and type of habitat. This diversity makes it easy for the roe deer to adapt to many different habitat types. The daily

water requirement of the roe deer is 2.5-3 liters. As they can obtain sufficient moisture and water from fresh leaves, roe deer can be found at quite far distances from sources of water. In order to ensure proper development, milk production and antler growth, roe deer meet their mineral requirements by eating soil and drinking mineral waters. Mineral deficiencies in roe deer are manifested by weight loss and physical defects such as development of small, weak antlers (Danilkin, 1996). The extent of the roe deer's territory does not depend on body size or age, but decreases when abundant food is available (Said et al., 2005). In Turkey, it is estimated that there are nearly 10 million hectares (Baskaya, 1998) of habitat populated by at least 50 thousand roe deer with great potential as a game species (Beskardes et al., 2013). In order to manage game animal populations like deer and roe deer, it is necessary to know the sex ratio (Kumbasli, 2006). However, to date, there have been no studies to determine roe deer territory and habitat preferences in Düzce Province.

The present study establishes the natural territorial range of the roe deer in Düzce Province and identifies their habitat use and preference.

2. MATERIALS AND METHODS

2.1 Study Area

Düzce Province lies on the western border of the Western Black Sea Region of Turkey (Figure 1). Although according to Düzce Governorship data, figures vary (241 000 - 364 000 ha) regarding the total surface area, according to the Bolu Forest Regional Directorship data, forest covers 123 814 ha (51 %) of the area. Deciduous (beech, hornbeam, oak, chestnut, linden) forests, coniferous (fir, yellow pine, black pine) forests, and a mixture of these are all under the influence of the Black Sea climate. Forest areas are found in regions where groups of high slopes rise to 1830 m a.s.l. (Kardüz Yaylası). The average temperature is 13.3 °C and the average rainfall is 816 mm (1950-2014). The climate (according to Thornthwaite) is classified as moist, with mesothermal water moderately deficient in the summer and a summer evaporation rate of 51 % (B1,B'2,s,b'4) (Anonymous, 2016).

Figure 1. The study area, Düzce Province
Şekil 1. Çalışma alanı (Düzce)

2.2 Data collection

For this study, determinations were made using a total of 75 locations (29 sites in 2013 and 46 sites in 2015) as a result of direct observation (1 site), indirect observation, including tracks, feces, feeding trail, antler, etc., (9 sites) and camera trap work (65 sites). Different habitat types were evaluated and camera traps were put in place to remain for at least 15 days in the areas where the species might possibly be found. In recent years, camera traps have been used in relevant field work with terrestrial mammalian species and they are said to be as effective as other methods (Roberts, 2011). Successful results have been achieved using camera traps to identify habitat preferences of ungulate species (Li et al., 2014). Sites where the species were observed via camera trap were identified and processed on a digital map. The habitat data of the sites established by camera trap in 2015 included the slope, aspect, stand type, number of tree and mean diameter

at breast height (DBH), canopy cover, shrub cover and dominant shrub height, and weed cover and average weed height, all measured within a 15-m radius of the area covered by the camera trap. Distances to the nearest road, nearest water source, and nearest settlement were measured from these sites, the shorter distances terrestrially and the greater ones via the map. From the resulting camera trap display, the sex and behavior (feeding, passing by, resting, etc.) of the species were noted, along with the date and time.

2.3 Data analysis

The current stand types were identified for sites where the species were detected, and abundance values were determined according to the stand type. Since the number of individuals of the species, gender, behavior and temporal information cannot be obtained from indirect observations, analysis can only be derived from images obtained with camera traps. In the sampling, the camera trap working times were not equal; therefore, the data was converted for a fixed period of 100 days. In order to do this, the following formula was used:

100 × number of roe deer sightings / number of camera trap working days (Kinnaird and O'brien, 2012).

Linear discriminant analysis (LDA) was conducted with the habitat values and the values for 100 camera trap days for the sampling sites. Using these values, the frequently observed roe deer habitat threshholds were then identified using the cluster and regression tree (CART) method. From the camera trap observations, the times of species activity were determined and land use patterns of behavior were noted. Furthermore, the sex ratio was determined through identification from the photographs. All analyses were carried out using the software package RGui version 3.0.2 (R Development Core Team, 2015).

3. RESULTS

In the two years covered by the study, roe deer were identified in the 75 locations (Fig. 2) by direct observation (1 site) and indirect observation (9 sites). Camera trap sightings for the year 2013 occurred in a total of 29 sites, while in 2015, sightings were recorded in 39 of the sites, with a total of 263 individuals detected by the camera traps. For all the sites, the frequency of species sightings in 100 days was 13.34 ± 2.2 (SE). Three fawns and seven individuals of undetermined sex were observed. From the 253 adult individuals whose sex was certain, the sex ratio of 1: 0.83 (male: female) was calculated. The species used the sampling areas mostly for feeding (74 %) and passage (26 %), but rarely for resting (< 1 %). Of all hours in the day, the species was observed to be most active in the mornings and evenings (Figure 3). Of the various stand types, more sightings were made in forests where fir and beech were found together (Figure 4).
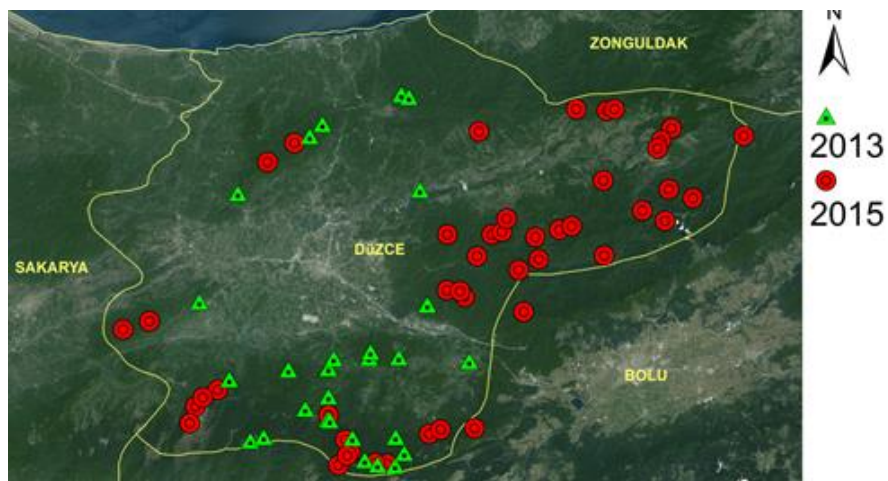

Figure 2. Determined roe deer plots in 2013 and 2015
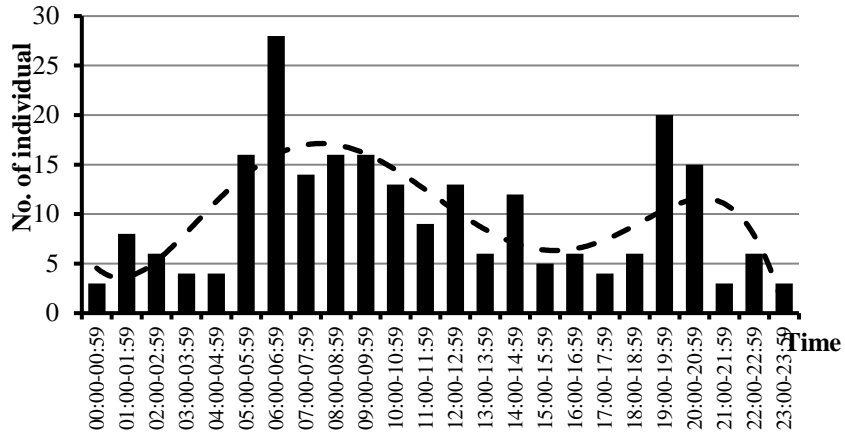Şekil 2. Belirlenmiş karaca alanları 2013-2015

Figure 3. Distribution of individual sightings determined by camera trap throughout the day
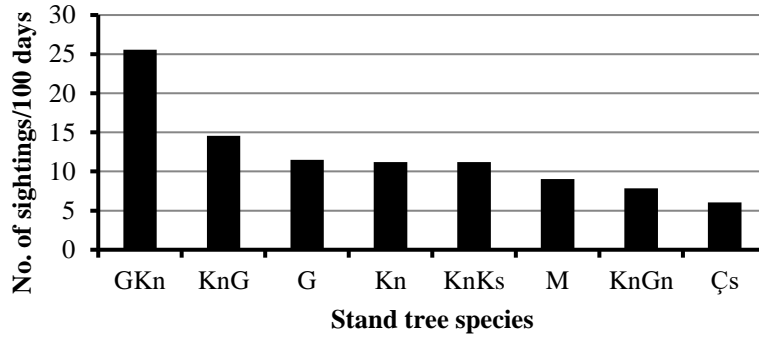Şekil 3. Gün boyu fotokanlardan belirlenen birey sayısı dağılımı

Figure 4. Distribution of roe deer camera sightings for 100 days according to stand tree species (G: Fir, Kn: Beech, Ks: Chestnut, M: Oak, Gn: Hornbeam, Çs: Scots Pine)
Şekil 4.100 gün boyunca meşcere tipine göre karaca görünme oranları

The linear discriminant analysis found a difference ($F_{1;37}$ = 9.463; P = 0.004) between the habitat characteristics and the number of roe deer sightings and found there was a relationship, albeit weak (R^2 = 0.204). In the analysis, in the first axis, the relationship of roe deer with habitat characteristics was 96%, and in the second axis, it was 3%. The percentages were very low in the third and fourth axis, so they were subsequently disregarded. The evaluation was made according to the first axis, as the relationship was quite strong. The species was seen to be affected by (in respective order) canopy cover, open ground, DBH, number of trees per hectare and proximity to settlements, these being directly proportional to herb height, degree of shrub cover, slope, degree of herb cover, shrub height and proximity to water source, while inversely proportional to altitude (Table 1).

Statistically, the primary threshold value for frequent roe deer sightings was a minimum distance of 6.1 km away from residential areas. The incidence of species sightings for 100 days in areas more remote than the threshold was a minimum of 13.34. Another threshold was the presence of more than 145 trees per hectare. In stands with fewer trees than this, the number of species sightings in 100 days was below 10.84 (Figure 5).

Table 1. Linear Discriminant Analyses of roe deer sightings according to habitat characteristics
(□: Averages; SD: Standard Deviation)
Tablo 1. Habitat karakteristiğine göre karaca görünümün doğrusal farklılık analizi

| Habitat parameters	LD1 (0.96)	LD2 (0.03)	□±SD
Altitude (m)	-0.00161	-0.00067	1091.95±377
Slope (%)	-0.04225	-0.00724	55.13±38
No. of tree ha⁻¹	0.01330	0.00143	216.29±207
DBH (cm)	0.02021	0.02208	37.08±13
Canopy cover (%)	0.56054	0.01161	76.79±22
Shrub cover (%)	-0.04327	0.00574	52.69±29
Shrub height (cm)	-0.02118	-0.00235	148.21±83
Weed cover (%)	-0.03342	0.01487	40.13±29
Weed height (cm)	-0.15470	0.06277	52.69±30
Open area (%)	0.05916	0.00860	16.13±16
Proximity to roads (m)	-0.00515	0.00881	136.28±171
Proximity to water (m)	-0.01206	-0.00080	165.59±130
Proximity to settlements (m)	0.00050	-0.00006	3480.13±2483
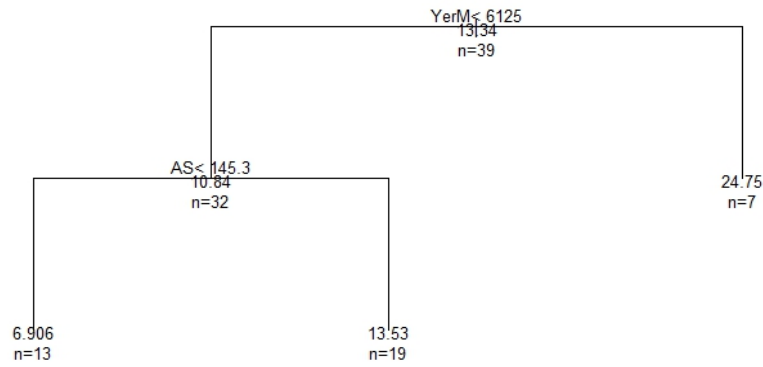
Figure 5. Cluster and Regression Tree (CART) of roe deer camera sightings for 100 days according to habitat characteristics (YerM = proximity to settlement; AS = No. of trees)
Şekil 5. Habitat karakteristiğine göre karacanın 100 günlük Cluster ve regresyon analizi ağacı

4. DISCUSSIONS AND CONCLUSION

The roe deer have a higher preference for closed and dense stands, while it is less likely to choose stands with little understory. Crown closure is important as a temperature regulator, while underlying shrubs and tall grassy plants serve as cover for the species (Mancinelli et al, 2015). In Northern Europe, roe deer preferred closed forests before they were forced out in later times by development of the stands (Staines and Welch, 1984; Latham et al., 1996; Hemami et al., 2005). Similarly, in Poland, the incidence of ungulate species and closed forest were found to be inversely proportional (Kuijper et al., 2009). However, closed forest is important for protection of the species from the southern European hot summer found in Turkey. In Düzce, the species have a positive relationship with tree diameter and closed forests and more often prefer dense stands, whereas slope, aspect and altitude are not important effective factors in roe deer habitat selection (Mancinelli et al, 2015).

The species has a natural sex ratio of 1:1, while this study determined that the number of male individuals was greater than the females. There can be several reasons for this. Firstly, there is an inverse relationship between body weight of female roe deer with the birth rate of male offspring (Hewison and Gaillard, 1996). In Düzce Province, ecologically speaking, the inability of the females to find food resources may be responsible for failure to attain the desired body size. High incidence of predation may also have an impact on body size. Secondly, the male roe deer has bigger home range than the female (Lamberti et al, 2006). This may be the reason male individuals circulate in a wider area and hence, the camera traps had a higher rate of recording them.

The geographical distribution of roe deer has been determined in varied habitat types including deciduous and coniferous forests and agricultural areas, indicating that there seems to be no particular preference. This herbivore species has an extensive diet that varies according to the season and includes herb, leaves, pine needles, fruit, shrubs, seeds, mushrooms, etc. (Tixier and Duncan, 1996). In this study, the species was more frequently detected in forests of fir, beech, and a mixture of the two types. Roe deer have been determined in larger numbers in areas of mixed pine, fir, beech and oak in the region of Kastamonu (Evcin, 2013), located next to Düzce. In Düzce, the roe deer has a wide distribution; however, sighting incidences in some areas, especially those near settlements, is low. Here, the important habitat preference of the species avoiding human influence is upheld (Evcin, 2013). Large herbivorous species are protected from human activities, especially from hunting. This information supports the association of roe deer sightings with the high threshhold of proximity to settlements. Although roe deer prefer the sheltered forest areas in the daytime, at night, they prefer the rich open areas for feeding (Bonnot et al., 2013).

In this study, roe deer were observed most often while feeding in the morning and evening hours. The species has a great potential as a game animal in Turkey (Baskaya, 1998; Beskardes et al., 2008; Evcin, 2013). In Düzce Province there is a wide distribution, but the frequency of sightings in all areas is not at a sufficient level. In particular, the prevention of uncontrolled human entry and illegal hunting along with the reduction of stray dogs in forest areas (Beskardes et al., 2013) will reduce the stress on the species in the forest. Furthermore, preservation of the forest canopy and the creation of suitable spaces in the forest will contribute to an increase in the roe deer population.

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