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Wildlife Management in Yedigöller Wildlife Reserve in Turkey

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Abstract

The study area covered 50.950 ha was established as a wildlife reserve on 18.01.2002, surrounding Yedigoller National Park. Target species, their densities, food, water, cover and space are important components to determine in wildlife management. In this study, numbers of red deer, roe deer, wild boars and bears, which were chosen as target species, were determined. Accordingly, densities of these target species in 100 ha for 2003, 2004 and 2005 are respectively 0.44; 0.47; 0.71 red deer (*Cervus elaphus* L.); 1.76; 1.48; 1.84 roe deer (*Capreolus capreolus* L.); 2.55; 2.52; 2.95 wild boar (*Sus scrofa* L.) and 0.15; 0.15; 0.24 bear (*Ursus arctos* L.). Amounts of herbaceous plants and shrubs as well as oak and beech seeds, which serve as foods for wildlife, are also studied, the amount of food was estimated as 64 318 940 kg oven-dried. Based on field observations, as well as forestry management plans and maps, it was determined that water resources did not have a restricting impact on the wildlife, and it was also argued that the preservation of available open, bushy and pasture areas within the study area would be enough for the wildlife's cover requirements.

Keywords: Wildlife management, Yedigoller Wildlife Reserve, red deer, roe deer, wild boar, bear

Yedigöller Yaban Hayatı Geliştirme Sahasında Yaban Hayatı Yönetimi, Türkiye

Kısa Özet

Çalışma alanı 18.01.2002 tarihinde Yedigöller Milli Parkı çevresinde, 50950 ha alanda yaban hayatı koruma sahası olarak ilan edilmiştir. Yaban hayatı yönetiminde tespit edilmesi gereken önemli bileşenler hedef tür veya türlerin sayıları, besin, örtü, su ve alandır. Bu çalışmada öncelikle hedef türler olarak seçilen geyik, karaca, domuz ve ayıların sayıları tespit edilmiştir. Buna göre yaban hayvanlarının 100 hektardaki yoğunlukları 2003, 2004 ve 2005 yıllarında sırasıyla geyik 0.44; 0.47; 0.71; karaca 1.76; 1.48; 1.84; domuz 2.55; 2.52; 2.95; ayı 0.15; 0.15; 0.24 olarak tespit edilmiştir. Yaban hayvanlarına besin oluşturan otsu ve çalı bitki türleri ile meşe ve kayın tohum miktarları araştırılmış, fırın kurusu olarak besin miktarının 64 318 940 kg olduğu tahmin edilmiştir. Sahadaki gözlemler, amenajman planları ve haritalardan yararlanılarak, su kaynaklarının yaban hayatını sınırlayıcı etkiye sahip olmadığı tespit

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edilmiş, ayrıca sahada bulunan açıklık, çalılık ve otlak alanların olduğu şekilde korunması ile örtü gereksiniminin sağlanacağı ortaya konulmuştur.

Anahtar Kelimeler: Yaban hayatı yönetimi, Yedigoller Yaban Hayatı Geliştirme Sahası, geyik, karaca, domuz, ayı

1. Introduction

The first practices concerning wildlife date back to Mongolian Ruler Kublai Khan (Peek, 1986). Wildlife is generally perceived as game mammals and birds, but all the trees, flowers, herbs, vertebrate and invertebrate animals can be included in the definition. The perception of wildlife as a natural and sustainable resource, such as forests, is relatively new. Because humans directly and indirectly impact the environment and affect this natural resources, sustainable management of this resource came up to be an obligation. A wildlife manager's ability to take correct decisions depends on his/her ability to conduct a perfect analysis of his/her situation. Wildlife Management, which was previously deemed only as management of hunting types, now raised to become a concept that manages all life forms. In the future, all resources will be managed as essential parts of the ecosystem (Patton, 1992).

Wildlife Management is based on applying scientific data to the art of regulating plant cover and animal population in order to achieve the goals determined by humans (Burger, 1979). In wildlife management, while protecting and developing a species, its habitat must be learnt in all aspects (Oğurlu, 2001). Wildlife management means arrangement of habitats (Shaw, 1985). Regardless of human factor, habitats are in a continuous change (Peek, 1986). When habitat is considered as a special place and area, in order to argue how an environment affects the wildlife, each of its components shall be individually examined. The main components of habitat are food, natural cover, water and space (Thomas & Toweill, 1982; Shaw, 1985, Ayberk et al., 2009).

The protected areas are least affected by humans and provide protection to the wildlife the most. Allocation of some areas for preservation of natural values is a common practice which dates back almost to the beginning of the history of humanity (Margules & Pressey, 2000). National parks, biological and wildlife reserves are the areas that ensure survival of many wild species and provide the habitat varieties for wildlife. Other areas are used by people for production of woods, food and raw materials (Shaw, 1985).

In our study, firstly habitat analysis was tried to make, wildlife habitat components, including food, natural cover, water and space was examined and then the actual status of red deer (*Cervus elaphus* L.), roe deer (*Capreolus capreolus* L.), wild boar (*Sus scrofa* L.) and bear (*Ursus arctos* L.) populations were tried to bring up as a model for wildlife management of Bolu Yedigoller Wildlife Reserve.

2. Materials and Methods

Yedigoller Wildlife Reserve, which was chosen as the study area, was declared by Bolu Provincial Directorate of Environment and Forestry, Branch Directorate of Nature Conservation and National Parks Protection, as a 50950 ha, around Yedigoller National Park, on 18.01.2002. Since 9168 ha of the study area was within the borders of Zonguldak province, it was separated as Yesiloz Wildlife Reserve with a Cabinet Degree on 16.08.2006 (The Official Gazette, 2008.). None of these wildlife reserves has any barriers that may limit the circulation of the wildlife. Additionally, for maintaining the integrity of our study, Yesiloz Wildlife Reserve was considered within Yedigoller Wildlife Reserve.

Yedigoller Wildlife Reserve is surrounded by Bolu's Mengen District on the east; Zonguldak's Devrek district on the north and Duzce's Yıgılca district on the west. The Wildlife Reserve is located between 31˚25′00 E″-31˚55′00 E″ longitudes and 41˚05′00 N″-40˚49′00 N″ latitudes. The study area is located on 11 forest administration and Yedigoller National Park Management (Figure 1).

Yedigoller and its surroundings are a typical part of the western Black Sea region's high mountainous nature. When the formulas Köppen and Thornhwaite are applied, compared to the other climate types (Eastern and central Black sea region climate types), the less rainy western Black Sea

region climate is dominant in the area (Erinç, 1996; Ozyuvacı, 1999). For 71 years, the annual mean temperature is 10.2°C, with the lowest temperature at -34°C and the highest temperature at 39.4°C. The annual mean precipitation is 536 mm and average number of the rainy days is 137.7day/year (Turkish Statistical Institute, 2001). The altitude of the study area changes from 240 m to 1982 m.

The main plant species determined in the study area include Beech (*Fagus orientalis*), Fir (*Abies nordmanniana* subsp. *bornmülleriana*), oak (*Quercus cerris, Q. frainetto, Q. petraea, Q. pubescens*), Scots pine (*Pinus sylvestris*), Austrian pine (*Pinus nigra*), Hornbeam (*Carpinus betulus, Carpinus orientalis*). The other important tree and shrub species are Common alder (*Alnus glutinosa),* strawberry tree *(Arbutus unedo),* Ash (*Fraxinus excelsior*), *Cornellian cherry (Cornus mas), Mediterranean medlar (Crataegus orientalis, Crataegus pentagyna),* European aspen (*Populus tremula*), European holly (*Ilex aquifolia*), Hazel (*Coryllus avellana*), Linden (*Tilia tomentosa*), Walnut (*Juglans regia*), *Apple (Malus sylvestris),* Maple (*Acer campestre*), Oriental plane (*Platanus orientalis*), Cherry *(Prunus avium),* English laurel *(Prunus laurocerasus),* Ornamental pear *(Pyrus eleagnifolia),* Rhododendron (*Rhododendron ponticum*), Grey willow *(Salix cinerea), Smilax excelsa,* Common yew *(Taxus baccata) and* Field elm *(Ulmus minor).*

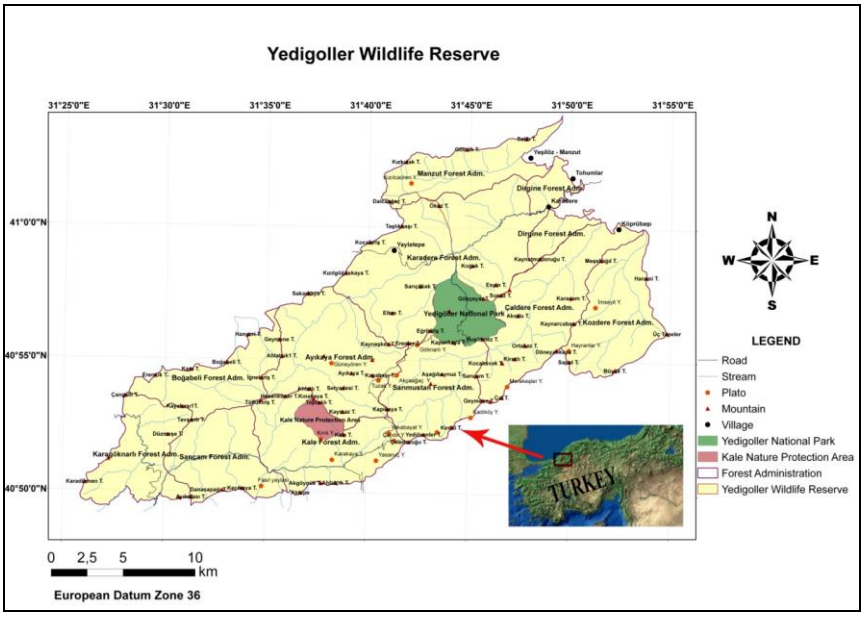

Figure 1. Yedigoller Wildlife Reserve

The four wildlife species red deer, roe deer, wild boar and bears, which progress in accordance with Yedigoller Wildlife Reserve's purpose of establishment, as well as our study, are researched. In order for a wildlife manager to manage wildlife in any area, first he/she must determine the number of wild animals within that region. Since Yedigoller Wildlife Reserve is 50950 ha large, determining the entire area for wildlife populations' density and size has always required considerable amounts of time and money. Therefore, in the study it was decided that a kind of drive count, which was combined with point count, would be applied between 2003 and 2005. Late October was chosen for counting and aimed to more clear observation because the broadleaf trees begin to shed their leaves late October in the study area. Choosing sample areas was determined using the simple random sampling method.

Initially, Yedigoller Wildlife Reserve's 1/25000 scaled maps were used to create a grid consisting of 509 units each 100 ha total 50900 ha. Among 509 sample areas, 62 sample units represented 12.14% of the total area determined by randomly and taking financial means into consideration (Figure 2). Later on, once the sample

areas determined were examined on the field and their compliance were scrutinized, their borderswere drawn on 1/25000 scaled maps. Additionally, to achieve counting animals easily, which the animals can't cross such as streams, road etc. were determined and noted in the study area.

For the drive counts in Yedigoller Wildlife Reserve, a counting team of roughly 25 people was employed. The team separated into two groups, driver and observer, then the numbers of drivers and observers were determined based on characteristics of the sample area. Observers were left at the points on the paths and courses where the animals would pass. On the other hand, drivers, using rifles, blank guns and hooters, created noises to make the animals run towards the observers. All the animals within each sample area are assumed to have been counted. Observers recorded the numbers, gender and age groups of animals on their observation cards. Furthermore, during the counting process, drivers observed that some animals had run back, breaking through the drivers' line. These were also added to the "Bottom Line" after the counting. In neighboring sample areas, reverse directions were selected for driving the animals.

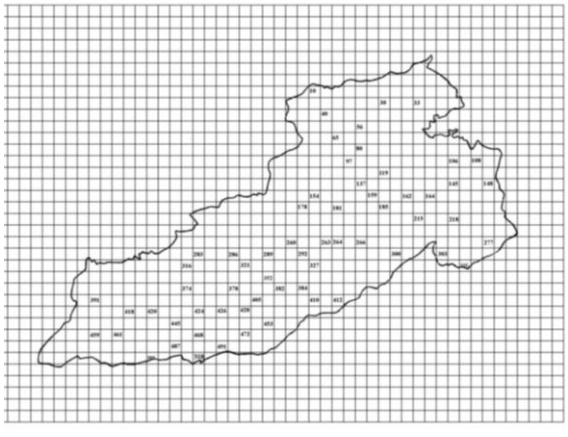

Figure 2. Yedigoller Wildlife Reserve sampling area

In the study, the data collected from the study area were analyzed by descriptive statistics. To estimate the animals' density the following formulas were used. The standard deviation sample averages series equals $\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$ (σ standard deviation). While the distribution of the sample averages and number of the sample units increase, it approaches to the normal distribution with the society average of $\overline{X}$, standard deviation of σ. When the population is infinite and the sampling done without replacement, it is multiplied by $\sqrt{\frac{N-n}{N-1}}$ (Kalıpsız, 1994). The confidence interval of the population average, if the population distributes normally (regardless of the sample size) or if the number of the sample units is n≥30

$\hat{\overline{X}} = \overline{x} \pm Z_{\alpha/2}\sigma_{\bar{x}} = \hat{\overline{X}}_{\text{down}} \leftrightarrow \hat{\overline{X}}_{\text{up}}$ (if the standard deviation is known)

$\hat{\overline{X}} = \overline{x} \pm Z_{\alpha/2}\hat{\sigma}_{\bar{x}} = \hat{\overline{X}}_{\text{down}} \leftrightarrow \hat{\overline{X}}_{\text{up}}$ (If the standard deviation is not known) is determined by using the Standard Normal Distribution table. The estimation interval (t) is determined using the table values.

Besides, apart from the estimation of the unknown population average ($\overline{X}$), the estimation of the total value of the population ($\sum_{i=1}^{N} x_i$) may be required. Since the arithmetic average is suitable for the mathematical transactions, such estimations are easily calculated using the average estimation.

$$\overline{X} = \frac{\sum_{i=1}^{N} x_i}{N}$$ (Kalıpsız, 1994; Orhunbilge, 2000)

Naturally, this equation leads to total value of the society. Thus, this means the total of a serial with known arithmetic average and number of units is also known.

$$\sum_{i=1}^{N} X_i = N\,\overline{X}$$

Since the number of units is n≥30, the estimation of the population's total value is.

$$\sum_{i=1}^{N} \hat{X}_i = N\,\overline{X} \pm Z_{\alpha/2}\, N\, \hat{\sigma}_{\bar{x}} \sum_{i=1}^{N} \hat{X}_{i\ \text{(lower bound)}} \leftrightarrow \sum_{i=1}^{N} \hat{X}_{i\ \text{(upper bound)}}$$ (Orhunbilge, 2000)

The estimated size of the population is $\hat{N}$, and the area occupied by the population is A. To estimate the density of the animals, the formula $D = \hat{N} / A$ was used (Williams et al., 2002).

The 1/25000 scaled standard topographical maps of the study area were obtained from Bolu Regional Forestry Directorate, and the stand maps were taken from General Directorate of Forestry. These maps were positioned according to the European Datum WGS Zone 36 coordinate system. Then, the contour, streams, roads, settlements, lakes, stand maps and the borders of the study area were digitalized with the GIS (Geographic Information Systems) software. Once the process of digitalization was completed, a TIN (Triangular Irregular Network) was created and altitude and inclination analyzes were made. The study area was separated into 9 altitude and 6 inclination classes, and the stand map was divided into 17 classes. 62 sample areas were also digitalized, and the numbers of wild animals seen during the study were entered into the database.

Determination of food produced within the area for red deer, roe deer and boars was completed in July 2006. Herbaceous and shrub plant samples were taken from 62 sampling areas previously selected with simple random sampling in order to estimate the population densities. In this study, *Rhododendron* and fern species within the area were not included in the calculation since they have no nutritional value for the animals.

Within the 62 sample areas, where wild animals were counted, 400 m^2 (20 × 20 m) plots were designated, where 2 × 1 m^2 herbaceous plant and 2 × 1 m^2 shrub samples were taken with simple random sampling method.

Shrub samples include all shrub species; leaves from beech, oak, linden, poplar, fir, alder, hazel, rowan, elm, wild pear, crabapple, and cherry seedlings' shorter than 1.30 m; as well as twigs and leaves from old individuals of the same species without natural pruning; and fruits of fruited trees of the season. Once the shrubby and herbaceous plant samples mowed from the field were separated to herbaceous plants, leaves, thin twigs, branches and fruits, their wet weights were recorded, and they were taken to the laboratory. The samples brought to the laboratory were dried at 60°C for 48 h in the stove. When they were completely dried, they were weighed to determine their dry weight.

Also, once all tree species within the 400 m^2 plots were determined, their diameters were measured and percentages of areas covered by herbaceous plants, trees and shrubs were respectively calculated. The shrubs' and herbaceous plants' rate of covering the ground was multiplied with herbs' and shrubs' oven dried weights and the amount of shrubs and herbaceous plants in all the plots' were revealed.

Oak and beech seeds are the most important source of food for wildlife during the autumn and winter (Payne & Bryant, 1998). In order to determine the amount of beech and oak seeds within the area, the number of trees, stand closure and data on age and diameters must be known.

The research made by Tosun (1990) in the western Black Sea region shows that the trees in III (between 36 cm to 51.9 cm) and IV (over 52 cm) diameter class are important and the average seed productivity of the trees in this diameter class for beech is 82.2 seed per m^2. According to Yılmaz (2005), one beech seed weighs 0.3075 g.

According to Payne and Bryant (1998), various old oak stands provide optimum habitat diversity for the wildlife. Based on the literature researched for oak seed productivity, a tree can produce 50.000 seeds in a rich seed year (Ertaş, 1996). Thinner more than 25 cm diameter oak trees are not significant in seed production (Izquierdo et al., 2006; Greenberg, 1999). In 1 ha area, where an average of 50 oaks are present, seed production is around 100 g/m^2 (250–600 kg/ha) and oak seeds' weights vary between 1.2 and 6.5 g; average 3.5 g (Izquierdo et al., 2006).

In the light of these explanations, to calculate beech seed productivity, III and IV diameter class seed amounts were considered, while seed amounts produced by II diameter class trees were ignored. In oaks, seed production of trees with 25 cm or larger diameter was included into the calculation.

To estimate oak and beech seed productivity, the numbers of oak and beech trees capable of producing seeds were studied. For this purpose, the 1997 forestry management plans and digitalized maps were examined to determine beech and oak covered areas. A ratio was created by dividing the 25 cm and larger diameter seed producing oaks found in 400 m^2 plots to all diameters and by dividing the 3rd and 4th diameter class beech trees to all diameters. This ratio was multiplied by the beech and oak seed productivity per m^2 and the entire area covered by these trees within the study area. Thus the seed productivity of Wildlife Reserve was revealed.

The natural cover, stand structure and water resources within the study area were obtained through the GIS program by digitalizing the forestry management plans.

Determination of many factors including habitat components (food, cover, water and space),

predators, competition, plants' succession statuses etc., are involved in determination of carrying capacity. However, for purposes of our study, the carrying capacity was examined only for the habitat components within the study area.

While trying to determine the carrying capacity for wild animals, particularly for deer, roe deer and wild boar populations, daily amounts of food consumed by an animal and size of the habitat needed by wild animals were collected from available sources of reference. Followed by the amount of foods produced in that field, available water sources, cover status, amount of space and domestic animals' numbers within the field. Overall the actual status of the field and data obtained from references were compared to reveal the carrying capacity of the target species. Furthermore, since 80 to 90 % of wild boars' diet consists of plants (Leaper et al., 1999), their carrying capacity was estimated together with red deer and roe deer. An animal has the ability to consume approximately 2% of its body weight in oven dried food (Payne & Bryant, 1998).

3. Results

3.1. Red deer, roe deer, wild boar and bear population in the Wildlife Reserve

In the years of 2003, 2004 and 2005, 62 sample areas made drive counts' results were given in Table 1, and this data were applied to descriptive statistics given in Table 2.

The standard error of mean was multiplied by the correction coefficient ($\sqrt{\frac{N-n}{N-1}}$ = 0.938), because of sampling without replacement and was used for estimating animal numbers

Table 1. Drive counts' results for 62 sample areas between 2003 -2005

Year	Red Deer				Roe deer				Wild boar				Bear
	♂	♀	J	T	♂	♀	J	T	♂	♀	J	T	T
2003	10	16	1	27	33	66	10	109	109	27	72		9
2004	11	18	0	29	29	28	38	92	25	43	88		10
2005	20	23	1	43	34	60	20	114	24	84	75		15

♂: Male ♀: Female J: Juvenile T:Total

Table 2. Descriptive statistics results between 2003-2005

	D03	D04	D05	R03	R04	R05	Wb03	Wb04	Wb05	B03	B04	B05
N	62	62	62	62	62	62	62	62	62	62	62	62
Mean	0.44	0.47	0.71	1.76	1.48	1.84	2.55	2.52	2.95	0.15	0.16	0.24
Standard. Error of Mean	0.164	0.127	0.163	0.232	0.201	0.171	0.578	0.606	0.453	0.051	0.057	0.059
Standart Deviation	1.288	1.004	1.285	1.826	1.586	1.345	4.547	4.773	3.569	0.399	0.451	0.468
Variance	1.660	1.007	1.652	3.334	2.516	1.810	20.678	22.778	12.735	0.159	0.203	0.219
Minimum	0	0	0	0	0	0	0	0	0	0	0	0
Maximum	8	4	6	9	6	5	28	19	12	2	2	2
Sum	27	29	44	109	92	114	158	156	183	9	10	15

D: Red deer R: Roe deer Wb: Wild boar Bear: B 03:2003 04: 2004 05:2005

The standard error of mean was multiplied by the correction coefficient ($\sqrt{\frac{N-n}{N-1}}$ = 0.938), because of sampling without replacement and was used for estimating animal numbers.

3.2. Estimated red deer, roe deer, wild boar and bear' numbers in 2003:

To estimate the number of animals, the following formula used, and all results were given in Table 3. Density also was calculated as D = $\hat{N}$ / A

$\sum_{i=1}^{N} \hat{X}_i = N \overline{X} \pm Z_{\alpha/2} N \hat{\sigma}_{\bar{x}} \sum_{i=1}^{N} \hat{X}_i$ (lower bound) $\leftrightarrow$ $\sum_{i=1}^{N} \hat{X}_i$ (upper bound) (Orhunbilge, 2000).

The results of the counting done over three years at the Wildlife Reserve were applied to the Kolmogorov – Smirnov test and the species were examined in terms of their normal distributions. Except for the 2004 counting for roe deer, the data results obtained from 3 years' counting show that the distribution of deer, roe deer and bears are in accordance with Poisson. However, when distribution of boars is examined, it is seen that they are not in accordance with Poisson (Table 4).

Table 3. Estimated Red deer, Roe deer, Wild boar and Bear' numbers and densities in 2003, 2004 and 2005

	Total (individual)	Male	Female	Juvenile	Animal density (per 100ha)
$\widehat{N}_{d\ 2003}$	224 ± 154	83	133	8	0.44
$\widehat{N}_{d\ 2004}$	239 ± 119	91	148	0	0.47
$\widehat{N}_{d\ 2005}$	361 ± 153	164	189	8	0.71
$\widehat{N}_{R\ 2003}$	896 ± 220	271	543	82	1.76
$\widehat{N}_{R\ 2004}$	753 ± 189	230	311	213	1.48
$\widehat{N}_{R\ 2005}$	937 ± 160	280	493	164	1.84
$\widehat{N}_{Wb\ 2003}$	1298± 546	222	592	484	2.55
$\widehat{N}_{Wb\ 2004}$	1283 ± 567	207	354	724	2.52
$\widehat{N}_{Wb\ 2005}$	1502 ± 424	197	689	616	2.95
$\widehat{N}_{B\ 2003}$	76 ± 48	0	0	0	0.15
$\widehat{N}_{B\ 2004}$	76 ± 53	0	0	0	0,15
$\widehat{N}_{B\ 2005}$	122 ± 55	0	0	0	0.24

The field data related to red deer, roe deer, boars and bears in Yedigoller Wildlife Reserve in 2003, 2004 and 2005 suggest that the distribution of these animals' population is not normal. Therefore, in order to argue any significant difference between the data taken from the average number of observed animals from recent years, the data were analyzed with the Kruskal Wallis H test, which is a non-parametric test, rather than ANOVA. For this purpose the following hypothesis were made;

H_0: There is no significant difference between the animal numbers observed in sample areas in 2003, 2004 and 2005.

H_a: There is a significant difference between the animal numbers observed in sample areas in 2003, 2004 and 2005.

As result of the test, H_0 hypothesis may be accepted for deer, roe deer and bears. There is no significant increase or decrease in the numbers of these three species' averages as result of 3 years of counting. However, when the analysis results for boars are examined, the H_a hypothesis is accepted. This demonstrates that there is significant difference between the average numbers of boars in recent years (Table 5).

Table 4. Kolmogorov-Smirnov Test

		D03	D04	D05	R03	R04	R05	Wb03	Wb04	Wb05	B03	B04	B05
N		62	62	62	62	62	62	62	62	62	62	62	62
Poisson Parameter (a,b)		0.44	0.47	0.71	1.76	1.48	1.84	2.55	2.52	2.95	0.15	0.16	0.24
Most Extreme Difference	Absolute	0.160	0.148	0.169	0.134	0.176	0.035	0.325	0.581	0.390	0.007	0.021	0.011
	Positive	0.160	0.148	0.169	0.134	0.176	0.035	0.325	0.581	0.390	0.006	0.020	0.009
	Negative	-0.04	-0.07	-0.06	-0.06	-0.14	-0.03	-0.10	-0.17	-0.18	-0.007	-0.02	-0.01
Kolmogorov-Smirnow Z		1.256	1.164	1.335	1.056	1.390	0.272	2.559	4.571	3.073	0.052	0.162	0.086
Asymp.Sig (2 tailed)		0.085	0.133	0.057	0.215	0.042	1.000	0.000	0.000	0.000	1.000	1.000	1.000

a Test distribution is Poisson. b Calculated from data.

D: Red deer R: Roe deer Wb: Wild boar Bear: B 03:2003 04: 2004 05:2005

Table 5. Test statistics for wild animals between 2003-2005

	Red deer	Roe deer	Wild boar	Bear
Chi-Square	3.781	2.942	7.803	2.643
df	2	2	2	2
Asymp. Sig.	0.151	0.230	0.020	0.267

a Kruskal Wallis Test b Grouping Variable: Year

3.3. Domestic animals

Within the Wildlife Reserve, 1500 sheep, 450 goats and 250 cattle were found to be grazing. The daily dry food consumption of these animals was 4455 kg and they are estimated to consume approximately 801900 kg food in a 6 month transhumance season.

3.4. Amounts of food

As specified in the material and method, amounts of foods within the study area were calculated from the samples taken from 2x1 m^2 sampling areas within 400 m^2 plots determined among 62 sampling areas. Their descriptive statistical results are given in Table 6.

Table 6. Herbaceous and shrub plants' descriptive statistics

	Herbaceous plants' oven-dried weight in 2 m^2'(g)	Amount of oven-dried weight of herbaceous plants in 1 ha (kg/1 ha)	Shrub plants' oven-dried weight in 2 m^2'(g)	Amount of oven-dried weight of shrub plants in 1 ha (kg/1 ha)
N	62	62	62	62
Mean	785.68	798.98	741.90	428.12
Std. Error of Mean	44.83	86.81	43.60	55.48
Standard Deviation	353.02	683.61	343.27	436.85
Variance	124626.50	467334.42	117831.24	190841.39
Sum	48711.85	49537.25	45997.84	26543.19

The amount of herbaceous and shrub plants' oven dried weight is estimated by the following formula and standard error of mean was multiplied by the correction coefficient ($\sqrt{\frac{N-n}{N-1}}$ = 0,938), because of sampling without replacement.

The oven dried herbaceous plants weight is calculated as:

$N\hat{\bar{X}} = N[\bar{x} \pm Z_{\alpha/2}\hat{\sigma}_{\bar{x}}] = 50950 \times [798 \pm 1{,}96 \times 81{,}43] = 40658100 \pm 8131763$ kg

The oven dried shrub plants weight is calculated as:

$N\hat{\bar{X}} = N[\bar{x} \pm Z_{\alpha/2}\hat{\sigma}_{\bar{x}}] = 50950 \times [428 \pm 1{,}96 \times 52{,}04] = 21806800 \pm 5196818$ kg

3.5. Oak and beech seed productivity

In the entire 2.48 ha sample plots, the average number of oaks over 25 cm diameter is 35 tree/ha, and they can produce between 185 and 420 kg oak seeds. The data obtained from forestry management plans shows the area covered by oaks in the Wildlife Reserve as 6166 ha. Since the ratio of 25 cm and larger diameter oaks to all oaks is 40.65%, the area covered by oaks with seed producing capacity should be 2.506 ha.

Accordingly, oak seed production within the area is estimated within 463,610 to 1.052.520 kg range. Our calculation was based on an average of these two figures.

The ratio of III and IV diameter classes to all diameter classes within the sample plot was found as 31.28%. In the area, beech seed productivity per m^2 was calculated as 25.3gr making 253 kg per hectare. The data obtained from forestry plans show the area covered by beech trees in the Wildlife Reserve as 14616 ha. The percentage of the area covered by III and IV diameter class beech is 31.3% (4.575 ha). Accordingly, beech seed production within the study area should be 1157475 kg.

3.6. Cover and closure degree

Oak and beech are the most important plant species in terms of wildlife. Therefore, areas covered by oak and beech were calculated by making use of stand compositions in forestry plans and the ratios showing their closure. Within the area, the area covered by beech was calculated as 14616 ha, while that covered by oak was calculated as 6167 ha. According to this data, 29% of the study area is covered by beech and 12% by oak. On the other hand, presence of open areas is also important for wildlife. Therefore, open areas were calculated, using digitalized maps, and it was determined that a 1928 ha part of the entire area was open area. These areas consist of plateaus and agricultural areas.

The closure degree of the forest is a characteristic of cover and is also important for wild animals. Based on forestry management plan data, stands within the Wildlife Reserve were grouped based on 4 closure levels 0 (0-10%), 1 (10-40%), 2 (41-70%), 3 (70-100%). According to data taken from digitalized maps, a closure level of 3489 ha (6.8%) of the area is 0; while the 1775 ha closure level is 1; the 18975 ha's closure level is 2; and the 6752 ha's closure level is 3.

3.7. Water within the area

According to data taken from digital maps, the total length of all water sources is 1185 km, while the length of mainstreams is 350 km. Figure 3 shows the main water sources within the area. The stream system demonstrated a web-like homogenous distribution within the entire area.

3.8. Carrying capacity of the area

Annual oven dried amounts of nutrients within the area, which is an important element for determining the carrying capacity, were determined as follows: shrubs 21785200 kg; herbaceous plants 40618200 kg; oak seed 758065 kg; beech seed 1157475 kg; making total of 64318940 kg. Based on the previous numbers the daily average producing oven dried food is 176216 kg. However, it should be considered that this amount is determined in a season where maximum food is available, so the figures vary widely based on the seasons of the year.

Also within the Wildlife Reserve, 1500 sheep, 450 goats and 250 cattle graze. These domestic animals consume 4455 per day and 801.900 kg during the transhumance season. Accordingly, the amount of nutrients left for the animals' consumption is 174.019 (63517840 kg /365 days). It is revealed that this amount of nutrients (63517840 kg) can suffice for 58006 red deer, 348038 roe deer and 69608 boars.

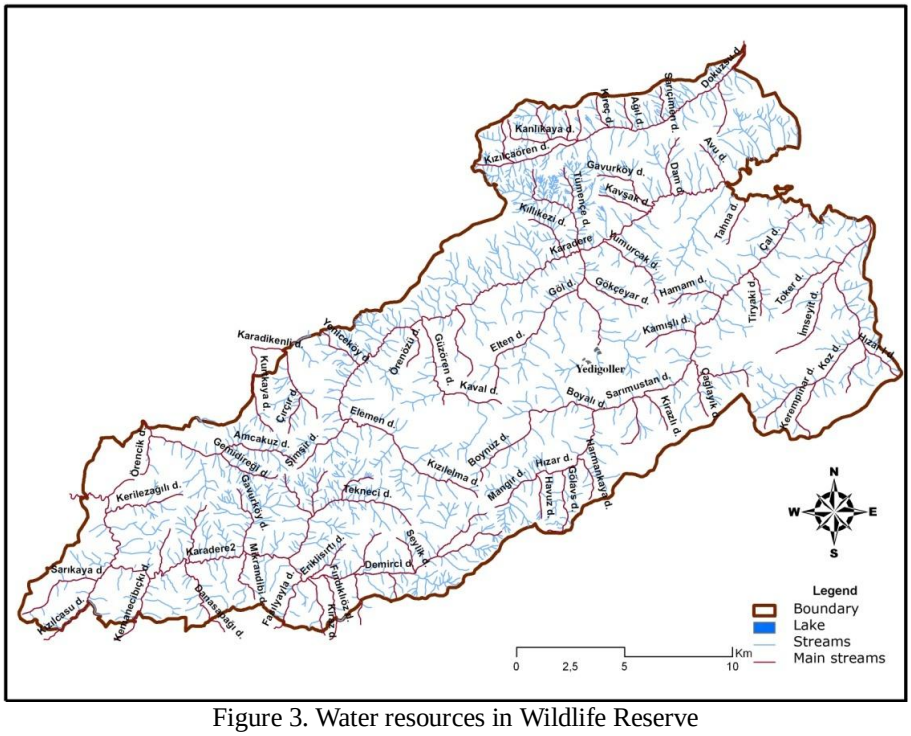

Figure 3. Water resources in Wildlife Reserve

4. Discussion

Surrounded by Bolu province's Devrek, Yığılca and Mengen districts and their villages, as well as manmade barriers, such as Istanbul-Ankara Highway, Yedigoller intermittently connects to Duzce forests in the east and Zonguldak forests in the north, through forested corridors. The forested corridors allows wild animals to spread, circulate and move across different habitats, or escape to other areas because of threats. The presence of corridors connecting the large forest habitats in western Black Sea region is quite important for the continuity of the wildlife and biological diversity in this area. Additionally, green areas and structures allowing animals to pass through shall be constructed between barriers, such as highways.

Yedigoller has all important characteristics of a reserve area for the survival and the reproduction of red deer, roe deer and other wild animals. Since villages being out of the reserve, this situation provides easy mobility for the wild animals, and they are less affected by human presence. Therefore, the animals within the region can easily maintain their wild characteristics. In addition, the reserve's plant composition consists of oak, beech, coniferous and shrub species, so the study area offers rich food and a diverse natural cover in every season.

In Yedigoller, when the animals' cover requirements are considered, 5264 ha (10.3%) of the area is at 0 and 1 (0-40 %) closure level, and 45727 ha (89.7) is at 2 and 3 (41-100 %) closure levels. Based on our study, it is revealed that the 10.3% rate of openings in the reserve is sufficient for red deer, roe deer and boars. Continuing to keep the openings at their current level within the Wildlife Reserve will help red deer and roe deer to maintain their population density at maximum.

It is important to adjust the silvicultural processes applied within the study area, protecting wild animals and managing forests, in a manner that will both sustain the forest and contribute to the development of wildlife. Especially red deer and roe deer like the forested areas which are rich in terms of substratum (Oğurlu, 1992). Therefore, while creating mixed stands, those that have a substratum should also be planned. Moreover, increasing the numbers of fruited trees, such as cherry, hazel, apple, wild pear, pear, cornelian cherry, English laurel, rose hip and strawberry trees, that of evergreen leaved shrubs will make a positive contribution to the animals' population.

Wood production in the Wildlife Reserve's forests begins in the spring months and continues

until early winter. Within this period, workers who set up tents in the forest may engage in illegal hunting with their weapons. In the sampling areas, where also wood is produced, it is seen that red deer, roe deer, wild boars and bears are leaving the area within this production period. Wild animals are discomforted by people and noise during the work and move to further areas. Furthermore, since forestry works here and there cause the wild animals to continuously move animals that leave their safe habitats become more vulnerable to predators. Particularly the animals that were pregnant in spring, as their newborn cubs and fawns are more affected by these movements. Since the tents are not removed for long periods, including winter, they offer shelter to illegal hunters. Forest administration chiefs and rangers must ensure these tents are removed once they become useless. If the tents are not removed, punishment, such as cash fines or not employing the tent owners the following year in the forest may be imposed.

When one wild species is considered, it is revealed that the foods available in the area may suffice to 58006 red deer, 348038 roe deer and 69608 wild boars. Although theoretically correct, intraspecific and interspecific competition and biotic and abiotic factors prevent a number of animals from reaching such high figures (Campbell & Reece, 2001) . Moreover, at the time the food amount sampling was made, plenty of food was available in the study area. Naturally, it is impossible to find such an amount of food in the winter. At the same time, although food is the most effective factor on the wild animals' population level, these animals' other needs, such as shelter, reproduction, migration and territories shouldn't be forgotten. In order to demonstrate the area's carrying capacity, the number of animals present in the area under difficult circumstances is a significant indicator. When the study area is examined in this aspect, the food resources in winter should also be demonstrated. Oak and beech production per year in the study area is calculated as 1915540 kg in total. When it is considered that each animal consumes seeds equal to approximately 2 % of its own weight each day, this seed amount can feed 5710 animals within 6 months the period between November and April. Whereas, according to the 2005 counting results, the total estimated number of animals is 2800. Naturally, a certain part of these seeds are also consumed by other animals, while some decay and some can't be consumed since they are covered with a heavy snow layer. Consequently, when counting data and the amount of produced food are examined, it is revealed that the amount of nutrients in Yedigoller Wildlife Reserve does not have a restrictive impact on the animal populations.

Water for all life forms is of virtual importance. The major rule is that wild animals' distance to water source should be less than 1 km (Öymen, 2010). Water resources in Yedigoller Wildlife Reserve are illustrated on Fig. 3. Main and secondary streams are distributed in a homogenous manner to the entire area. Consequently, wild animals living in the Yedigoller Wildlife Reserve have no problem in reaching to water resources. However, the most care shall be taken to protect the water resources.

As result of drive counts carried out in Yedigoller Wildlife Reserve in 2003, 2004 and 2005, a slight increase was observed in the numbers of red deer, wild boars and bears. Roe deer numbers, on the other hand, are in slight fluctuation. The data collected over the tree years was subjected to the Kruskal Wallis test. The results of this test showed the increase in red deer, roe deer and bear numbers were not significant, while the increase in boars was significant.

The population density of bears was also determined with drive counts. The density of bears as of 2005 was found to be 0.24 bear/100ha. The bear densities in the world include 0.014 bear/100 ha in Slovakia, 0.019 bear/100ha in Slovenia and 0.028 bear/100 ha in Romania (Kryštufek & Griffiths, 2003). A figure comparison shows that the bear density in Yedigoller region is almost 10 times that of the aforementioned countries. On the other hand, due to 50950 ha sized area, it is impossible to do simultaneous screenings of all 62 sampling areas in one day. Bears have a wide territory; therefore, some bears may have been counted multiple times in the drive counts. Briefly, there is a need for new studies to suggest a healthier overview of the bear population within the area.

As a result of drive counts, the confidence interval in the estimation of wild animals is revealed to be approximately between 17% and 70 %. The lowest confidence interval determined was of roe deer in 2005 as 17 % and largest was of bears in 2004 as 69.7 %. The most important reasons of large confidence interval include;

1. The fact that wild animals' unit per area density is low,
2. Although the sampling size was n > 30 (n=62) and the sampling ratio was 12.14%, populations

are not normally distributed and wild animals gather as flocks (especially boars and red deer),
3. Existence of errors due to not being able to observe wild animals,
4. Mobility of wild animals or sometimes their different reactions during counting processes. For example, instead of running away, they hide behind thick plant cover and remain unseen,
5. In some areas, there is an inability to see certain animals due to extremely thick plant cover,
6. In certain sampling areas, incapability to make a proper counting due to extreme inclination and a drivers' inability to frighten animals due to restricted movement,
7. Lack of experience and education among the personnel employed for the counting.

During the study in the Wildlife Reserve, both in the inventory period and in other times, predator species such as bear, wolf (*Canis lupus* L.), jackal (*Canis aureus* L.), fox (*Vulpes vulpes* L.), badger (*Meles meles* L.), wild cat (*Felis sylvestris* Schreber), weasel (*Mustela nivalis* L.) and marten (*Martes foina* Erxleben.) were also seen. Additionally, although forest workers claimed to see lynx (*Lynx lynx* L.) in wildlife reserve, lynx wasn't observed within the study period. A separate study in Yedigoller Wildlife Reserve related to predators and their population densities should be made.

In Yedigoller Wildlife Reserve, domestic animals such as cattle, cows, sheep and goats are taken to a plateau beginning from the spring months. Furthermore, in villages around the region, domestic animals graze in the openings within the study area. Consequently, due to excess nutrient production within the area, grazing domestic animals may be considered to have no negative impact on the wild animals in terms of nutritional competition. However, since wild animals are discomforted by people, domestic animals and shepherd dogs that obligate to leave from plateau and surrounding areas animals leave the plains in transhumance seasons. Moreover, shepherds may also hunt illegally and their dogs may harm roe deer, red deer and their fawns. It is obvious that reorganizing transhumance within the Wildlife Reserve will be advantageous for the wild animals. In today's conditions, it seems difficult to prevent local people from taking their animals to the plains within the area.

Another negative impact is the fact that the mountain houses built for transhumance provide a long term shelter to illegal hunters. The peak season for illegal hunting seems to be the winter months. In the winter, due to snow, it is not possible to carry out our conservation activities within the area because reaching one point to another by vehicle or confronting illegal hunters is impossible. Additionally, since the majority of illegal hunters consist of people from surrounding villages and districts, they know the land much better than the National Park personnel. Illegal hunters also prefers this season, because in this season the area is empty, tracking animal is easier, there are clearer views as there are little or no leaves on the trees and the animals lack camouflage due to snow cover.

Wildlife Reserve's biggest problem is the issue of ownership among the others. In the Wildlife Reserve, forestry activities are carried out by forest administration presently, while activities such as protection and production of wild animals and control over hunting are performed by the Directorate of Nature Conservation and National Parks. Nevertheless, there are also private lands close to the villages around the study area and some of which remain within the Wildlife Reserve. Ownership' problems cause various conflicts between organizations and bring many other problems together. Since the local people around reserve make their living from forestry, setting aside all wildlife reserve area for developing wildlife seems impossible. For the moment, before planning forestry activities within the area allocated to the as Wildlife Reserve, referring to a natural park engineer or wildlife manager will be more appropriate. However, when the welfare level of local people will increase, in order to bequeath Turkey's wildlife and natural areas to next generations, these areas must be completely protected and wildlife management plans should be made based on scientific data.

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