Kastamonu Uni., Orman Fakültesi Dergisi, 2023, 23(2): 131-143 Research Article
Kastamonu Univ., Journal of Forestry Faculty
Doi:10.17475/kastorman.1368109

The Importance of Urban Green Spaces for Resident and Migrant Birds – A Case Study from Tepeören Cemetery in Istanbul-Türkiye

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Received Date: 10.01.2023 Accepted Date: 13.07.2023

Abstract

Aim of study: This study was carried out to determine the effects and importance of urban cemeteries on bird species diversity.

Area of study: The Tepeören cemetery is one of the oldest and most historically important cemeteries in the Istanbul region.

Material and methods: Field studies of birds were carried out between April-September 2018/2019. During the study period of 12 months, the cemetery was visited twice a month. The species list of the area was created by registering all feeding, lodging, roosting and nesting birds observed in the area.

Main results: It was determined that 36 bird species occured in the cemetery, out of which ten species were identified as breeding in the area. The main bird species that used the cemetery as breeding ground, was *Corvus monedula* (Western jackdaw) that utilizes the cavities of old oaks for nesting. The average number of eggs per nest was found to be 4.3 based on the examination of 49 active nests in 2018-2019. The number of fledged birds per nest was determined as 1.1.

Higlights: In the current study, the importance of the city cemeteries in terms of bird diversity has been revealed. The presence of plant species that provide suitable nesting conditions for the reproduction of birds in these cemeteries supports the survival of the birds in the city.

Keywords: Jackdaw, Old Oaks, Hollows, Old Cemetery, Green Spaces, *Corvus monedula*

Kentsel Yeşil Alanların Yerleşik ve Göçmen Kuşlar İçin Önemi İstanbul-Tepeören Mezarlığı Örneği

Öz

Çalışmanın amacı: Bu çalışma, kent mezarlıklarının kuş türü çeşitliliği üzerindeki etkilerini ve önemini belirlemek amacıyla yapılmıştır.

Çalışma alanı: Araştırma alanı olan Tepeören mezarlığı, İstanbul bölgesindeki en eski ve tarihi açıdan önemli mezarlıklardan biridir.

Materyal ve yöntem: Arazi çalışmaları Nisan-Eylül 2018/2019 tarihleri arasında gerçekleştirilmiştir. 12 aylık çalışma süresi boyunca mezarlık ayda iki kez ziyaret edilmiştir. Alanda gözlemlenen, beslenen, barınan, tüneyen ve yuva yapan kuşlar kayıt altına alınarak alanın tür listesi oluşturulmuştur.

Sonuçlar: Mezarlıkta 36 kuş türünün yaşadığı ve bunlardan on türün bölgede ürediği tespit edildi. Mezarlığı üreme alanı olarak kullanan ve yaşlı meşe ağaçlarının kovuklarını yuva yapmak için tercih eden kuş türü olarak Küçük Karga (*Corvus monedula* (Western jackdaw)) belirlendi. 2018-2019 yıllarında 49 aktif yuvanın incelenmesi sonucunda yuva başına düşen ortalama yumurta sayısı 4.3 olarak bulunmuştur. Yuva başına düşen uçan kuş sayısı 1.1 olarak belirlenmiştir.

Önemli vurgular: Yapılan çalışmada Kent mezarlıklarının kuş çeşitliliği açısından önemi ortaya konmuştur. Bu mezarlıklarda kuşların üremesi için uygun yuvalanma koşullarını sağlayan bitki türlerinin bulunması kentteki kuşların yaşamlarını sürdürmelerine destek olmaktadır.

Anahtar Kelimeler: Küçük Karga, Yaşlı Meşeler, Oyuklar, Eski Mezarlık, Yeşil Alanlar, *Corvus monedula*

Citation (Atıf): Arslangundogdu, Z., Hizal, E., Bergner, A., & Jansson, N. (2023). The Importance of Urban Green Spaces for Resident and Migrant Birds – A Case Study from Tepeören Cemetery in Istanbul-Türkiye. *Kastamonu University Journal of Forestry Faculty*, 23 (2), 131-143.

Introduction

Urban green spaces have an important function in urban life by serving the modern city people who are under physical and mental pressures, a green environment in which they can establish a relationship with nature, and serve various purposes in which they can perform recreational activities. Urban parks, sport complexes, recreational areas, zoos, botanical gardens, fair and exhibition areas, urban road-boulevards and medians, pedestrian roads, urban forests, woods, green belts and cemeteries are all examples of urban green spaces (Gül & Küçük, 2001).

Cemeteries are open green areas that should be handled with importance due to their aesthetic and functional characteristics in the physical structure of the city (Güçlü et al., 1996; Gül & Küçük, 2001). As building constuction has been the by far first priority of the urbanization in Türkiye, the environment and green space planning in urban areas have become major challanges. While green areas are rapidly decreasing, cemeteries are deemed untouchable areas with their functions and sanctity compared to other green areas. This means that they are guaranteed to maintain permanent green areas for the benefit of urban people and urban biodiversity (Sarı & Koçak, 2005; Kowarik et al., 2016).

According to Strohbach et al. (2013), biodiversity and bird species richnes are lower in urban areas, where housing is rapidly increasing, than in rural areas. The reason for this is that the distance to natural areas increases with the decrease and fragmentation in green areas. It was observed that especially insectivorous bird species decreased with the increase of urbanization (Chace & Walsh, 2006). With a broader study of urban ecosystems after the 1970s, it was revealed that despite rapid urbanization, green areas preserve various vegetative structures and support different wild animal species (Gilbert, 1989; Pontier & Yoccoz, 1991; Adams, 1994). Especially large green areas within cities, such as parks, cemeteries, golf courses, wetlands and forests, play important roles for maintaining urban biodiversity and provide valuable conditions for bird species richness (Blair, 2004; Canedoli et al., 2018; Rodrigues et al., 2018; Keten et al., 2020).

As birds are primarily affected by changes in biodiversity and environmental conditions, they are regarded as reliable and useful indicator organisms (Furness & Greenwood, 1993). Birds react to changes in the environment in a very short time compared to many other organisms. Due to these characteristics of birds, deterioration in nature can be clearly seen with population changes obtained as a result of periodic bird counts in long periods (Arslangündoğdu, 2006). In this study, the Tepeören Cemetery, a cemetery accepted as one of the urban green areas of Istanbul, was studied with regards to the bird diversity and the importance of this cemetery for birds over the course of two years. The purpose of the studies were to determine the effects and importance of urban cemeteries on bird species diversity.

Material And Methods

Study Area

Tepeören Cemetery is located in Tepeören neighbourhood on the Anatolian side of Istanbul (40 ° 54′ 35″- 40 ° 54′ 42″ north latitudes and 29 ° 23′ 03″- 29 ° 23′ 17″ east longitude). The size of the cemetary is approximately 41.500 m² (Figure 1). Most of the vegetation in the area consists of old and young Oak species (*Quercus cerris, Quercus infectoria, Quercus pubescens, Quercus frainetto*). Besides, there are a stand of Black pine (*Pinus nigra*) and a small number of Calabrian pine (*P. Brutia*). Tepeören Cemetery is an old cemetery originating from the Ottoman Empire. There are gravestones in the cemetery with Ottoman inscriptions belonging to the 18th and 19th centuries (Özdemir, 2011).

Figure 1. Location of Tepeören Cemetery, Istanbul-Türkiye

Method

Field studies of birds were carried out between April-September 2018/2019. During the study period of 12 months, the cemetery was visited twice a month. Transect counting method was used in the study (Figure 2).

Figure 2. Transects

A pair of binoculars (Nikon,8x42) were used to observe the species and a camera (Canon 60d) with a 50 mm / 400 mm lens was used for photograpic documentation. A snake camera was used to watch, take photos and record videos of the bird nests in the trunk hollows. Observation form was used for birds and breeding form for breeding birds. The locations of detected nests were transferred to maps. The data obtained as a result of the observations were transferred to tables in Excel. In order to observe the birds, studies started 1 hour after sunrise (at 07:00 approximately). Due to the small size of the area, the entire area was scanned within one hour (Bibby et al., 2000). The species list of the area was created by registering all feeding, lodging, roosting and nesting birds observed in the area. In this study, the statuses of the birds were based on our own observations and on the "İstanbul Kuşları" (Bacak et al., 2015). The status of birds shows, for which purpose that bird species was found in Istanbul. Some bird species may belong to more than one status. Individuals of a species can simultaneously be resident birds, summer

migrants, and passage migrants. Resident (R): Species of bird that can be seen and breed all year round. Summer Migrant (SM): Species of bird that arrive to breed and spend summer. Passage Migrant (PM): Species of bird that have been seen during migration. BDZ (2020) was used for taxonomic references of the identified species. Their conservation status was obtained from the IUCN (2020) The global conservation situation of the bird has been taken into consideration. Observations in nest of Jackdaw were carried out in the breeding seasons (four inspections per year from the beginning of April to the end of May) for the two years 2018 and 2019. Inspections were performed on all the identified tree hollows for nests and taking notes from the occupied nests and their contents. During the inspection of the tree hollows , the presence of a nest, the number of eggs, the number of new hatched and the number of fledglings in the final phase of the breeding period were recorded. The observations were carried out at relatively constant times of the day, between 08:00 and 10:00, on days with favorable weather conditions (rain-free days). Species diversity was calculated using Shannon index (H′) (Spellerberg & Fedor, 2003). Evenness was measured by Pielou index (J′) (Pielou, 1969). All analyzes and statistical calculations were undertaken using PAST 4.03 (Hammer et al., 2001).

Results and Discussion

In total 36 bird species (32 in 2018 and 35 in 2019) belonging to 20 families from 5 orders were identified in Tepeören Cemetery (Table 1). The most abundant species were: *Columba livia, Corvus monedula, Parus major, Sturnus vulgaris* and *Passer domesticus.*

Table 1. Number of observations of bird species in Tepeören Cemetery, Istanbul

Species	Year 2018						2019						Status	IUCN	Breeding
	Apr	May	Jun	Jul	Aug	Sep	Apr	May	Jun	Jul	Aug	Sep			
Columba livia	4	10	2	2	2		6	2	2	3	6		R	LC	
Streptopelia turtur			1					2			2		SM, PM	VU	
Streptopelia decaocto	2	1			2		2	2	1		2		R	LC	
Spilopelia senegalensis		2						1					R	LC	
Upupa epops	1	1					1	1					SM, PM	LC	
Dryobates minor											1		R	LC	
Dendrocopos syriacus	1	2	1			1	1	1	1				R	LC	
Psittacula krameri	2	2	2	2	3	2	3	2	2	2	2	2	R	LC	X
Lanius collurio											1		SM	LC	
Garrulus glandarius									1				R	LC	
Pica pica	4	4	2	3	4	3	4	4	2	5	3	4	R	LC	X
Corvus monedula	60	46	48	44	36	40	60	24	28	28	60	48	R	LC	X
Corvus corone	6	4	2	3	3		4	3	2	3	4		R	LC	
Periparus ater				1									R	LC	
Cyanistes caeruleus	2	1	4	2	1	2	2	2	6	2	2	1	R	LC	X
Parus major	10	2	4	6	3	4	8	1	3	4	4	6	R	LC	X
Lullula arborea		1						1				1	R	LC	
Galerida cristata		1						1					R	LC	
Iduna pallida		1						1					SM, PM	LC	
Phylloscopus collybita		2	1			1		1	2	1		1	R	LC	
Aegithalos caudatus		5			3			2	6			5	R	LC	

Table 1. (Continued)

Species	Year 2018						2019						Status	IUCN	Breeding
	Apr	May	Jun	Jul	Aug	Sep	Apr	May	Jun	Jul	Aug	Sep			
Sylvia atricapilla		1						1					SM, PM	LC	
Sitta europaea	1						1						R	LC	
Troglodytes troglodytes	1						1						R	LC	
Sturnus vulgaris	10	5	3	4	2	2	6	3	4	5	2	3	R	LC	X
Turdus merula	3	8	2	3			2	2		1			R	LC	X
Muscicapa striata									1				PM, SM	LC	
Erithacus rubecula				1						1			R	LC	
Luscinia megarhynchos	2	2	2	2	1	1	2	2	2	2	1	1	SM, PM	LC	X
Ficedula parva		1										1	PM	LC	
Ficedula hypoleuca	1						1						PM	LC	
Oenanthe oenanthe		1						1					SM, PM	LC	
Passer domesticus	8	2	3	4	5	4	2	3	6	2	10	6	R	LC	X
Motacilla alba						1			1			2	R, PM	LC	
Fringilla coelebs	3	4	2	4	2	3	2	2	2	2	3	2	R	LC	X
Chloris chloris											2		R	LC	

Bird species observed breeding in the cemetery are: *Psittacula krameri*, *Pica pica*, *Corvus monedula*, *Cyanistes caeruleus*, *Parus major*, *Sturnus vulgaris*, *Turdus merula*, *Luscinia megarhynchos*, *Passer domesticus* and *Fringilla coelebs.* Jackdaw breeds in colonies and prefers old hollow oaks, but the location of the nests is scattered depending on the location of the old oaks. Other species are nested in accordance with this distribution. Almost all the oaks with hollows of a suitable size are used by jackdaws for nesting. The *Pica pica* nests are in west part of the area where the pine trees are located. A pair of *Psittacula krameri* bred for two years at the top of a tall oak tree that can be considered the center of the cemetery. *Sturnus vulgaris* nests have been observed on oak trees that are not used by *Corvus monedula* where hollows have narrower entrances. *Passer domesticus* is breeding in the roof and hollows of the building in the cemetery. Nests of other species are spread throughout the area. Birds that were just observed flying above the area, and therefore not stated in the list, included *Tachymarptis melba*, *Apus apus*, *Ciconia nigra*, *Ciconia ciconia*, *Larus michahellis*, *Circaetus gallicus*, *Accipiter nisus*, *Buteo buteo*, *Merops apiaster*, *Corvus corax*, *Delichon urbicum* and *Hirundo rustica*.

Among other animal species, squirrels (*Sciurus anomalus*) commonly live in the area. More than five squirrels were seen at each visit to the cemetery. As reptiles, Istanbul lizard (*Podarcis siculus*) and tortoise (*Testudo graeca*) are found in the area. There are also a few stray cats inside and outside the cemetery. According to the Shannon-Wiener index, the month with the highest species diversity was May in 2018 (2.322) and 2019 (2.572), whereas September were the month with the lowest species diversity in both 2018 (1.512) and 2019 (1.667) in September. It is also similar to the Equitability_J index (Figure 3).

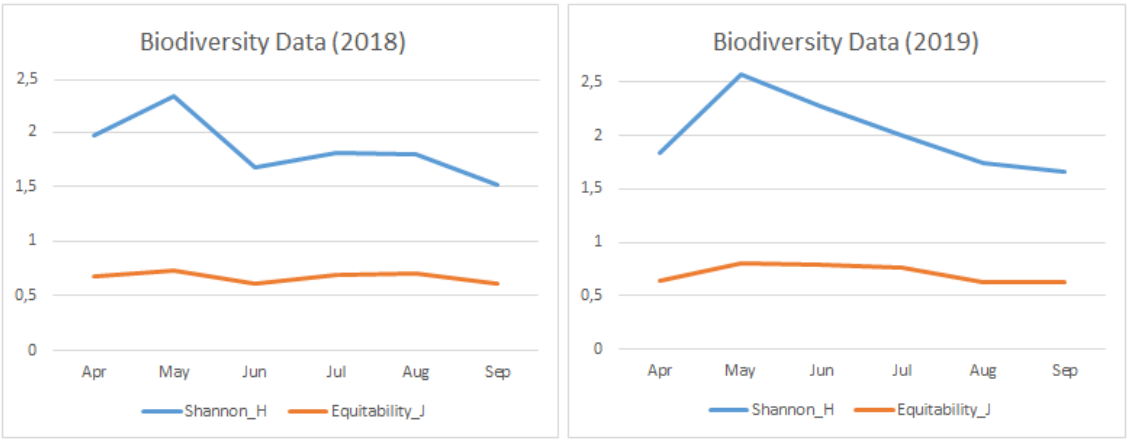

Figure 3. Biodiversity indexes of the bird species populations in Tepeören cemetery (Istanbul) by month

Corvus monedula was the bird in most frequently used the old oaks as a breeding place (Figure 4). Some oak trees have two nests of jackdaw. In each year from 2018 and 2019, the tree hollows were occupied by 26 and 23 pairs of Jackdaws (Table 2).

Figure 4. The nesting Jackdaws in Tepeören Cemetery, Istanbul

Table 2. Description of the breeding trees and nests for *Corvus monedula* at Tepeören Cemetery, Istanbul-Türkiye.

Nest number	Tree Species / Tree height (m) / Trunk diameter at 130cm (cm)	Height of the Nest from ground (m) / Nest type	Nest Material	Egg number		Fledglings number		Breeding success (Young Jackdaw)	
				2018	2019	2018	2019	2018	2019
1.1	*Quercus cerris* 6 m / 202 cm	1.8 / Tree Hollow	Twigs, paper, newspaper, wool, thread etc.	4	3	2	2	1	1
1.2	*Q. cerris* 6 m / 202 cm	3.2 / Tree Hollow	Twigs, bags, feathers etc.	5	-	3	-	1	-
2	*Q. infectoria* / 10 m / 265 cm	2.5 / Tree Hollow	Twigs, newspaper, cigarette box, thread etc.	5	5	3	2	1	1
3.1	*Q. pubescens* / 12 m / 166 cm	2.1 / Tree Hollow	Twigs, wool, thread, bags, paper etc.	3	-	2	-	-	-
3.2	*Q .pubescens* / 12 m / 166 cm	5.4 / Tree Hollow	Twigs, wool, newspaper, etc.	4	-	2	-	1	-
4	*Q. pubescens* / 12 m / 209 cm	6.2 / Tree Hollow	Twigs, newspapers, bags etc.	4	6	3	3	1	2
5.1	*Q. frainetto* / 10 m / 223 cm	4,0 / Tree Hollow	Twigs, bags etc.	3	4	2	3	1	1
5.2	*Q. frainetto* / 10 m / 223 cm	5.0 / Tree Hollow	Twigs, thread etc.	6	4	3	3	1	1
6.1	*Q. cerris* 7 m / 238 cm	3.2 / Tree Hollow	Twigs, feathers, bags etc.	5	4	3	3	1	1
6.2	*Q. cerris* 7 m / 238 cm	4.3 / Tree Hollow	Twigs, newspaper, feathers, grass etc.	5	5	3	3	2	1
7	*Q. pubescens* / 11 m / 273 cm	6.1 / Tree Hollow	Twigs, nylon, wool, etc.	4	5	2	2	1	1
8	*Q. cerris* 4.2 m / 281 cm	1.7 / Tree Hollow	Twigs, newspaper, feathers, grass etc.	4	3	2	1	1	-
9	*Q. cerris* 12 m / 228 cm	5.3 / Tree Hollow	Twigs, nylon, feathers, cloth, etc.	5	5	2	3	1	1
10	*Q. frainetto* 10 m / 273 cm	6.4 / Tree Hollow	Twigs, nylon etc.	5	5	3	2	2	1
11	*Q. cerris* 3.8 m / 249 cm	2.2 / Tree Hollow (Crownless tree)	Twigs, cloth, feathers, etc.	4	3	3	3	1	-
12	*Q. cerris* 10 m / 273 cm	4.6 / Tree Hollow	Twigs, feathers, newspaper, etc.	3	4	2	2	-	1
13	*Q. cerris* 16 m / 300 cm	5.8 / Tree Hollow	Twigs, feathers etc.	4	5	2	2	-	1
14.1	*Q. frainetto* 10 m / 160 cm	4.1 / Tree Hollow	Twigs, rag, shoddy etc.	5	3	3	2	2	-
14.2	*Q. frainetto* 10 m / 160 cm	6.4 / Tree Hollow	Twigs, paper	4	3	2	2	1	-
15	*Q. cerris* 14 m / 324 cm	5.6 / Tree Hollow	Twigs, newspaper,	3	4	2	1	1	1
16	*Q. frainetto* 13 m / 260 cm	6.5 / Tree Hollow	Twigs, bag pieces	4	5	3	3	1	-
17	*Q. frainetto* 3.2 m / 280 cm	2.4 / Tree Hollow (Crownless tree)	Twigs, walnuts, dried pieces of bread,	5	6	3	2	1	2
18	*Q. frainetto* 8 m / 218 cm	4.6 / Tree Hollow	Twigs,	6	5	3	2	1	1
19	*Q. infectoria* / 6.5 m / 195 cm	2.7 / Tree Hollow (Crownless tree)	Twigs, piece of land,	3	4	2	2	1	1
20	*Q. infectoria* / 2.5 m / 325 cm	1.8 / Tree Hollow (Crownless tree)	Twigs, wood scrapes,	5	4	2	2	-	-
21	*Q. cerris* 10 m / 260 cm	3.8 / Tree Hollow	Twigs, tiles,	6	2	3	1	1	-

A total of 211 eggs were laid in 49 complete nests. Most nests comprised five eggs, with a range from 2 to 6. In total, for the two years of the study, the average number of layed eggs was 4.30 per nest (SD = 0.92; N = 49). The average number of eggs per nest did not differ statistically significantly between seasons in 2018 and in 2019 (ANOVA test, $F_{5.46} = 1.714$; $p>0.05$). A total of 116 birds hatched from 211 eggs. Most often comprised of 2, with a range from 1 to 3. In total, for the two years of the study, the average number of fledglings was 2.37 (SD= 1.00, N=49). The average number of fledglings in a nest did only differ statistically significantly in nest number 3 between seasons in 2018 and in 2019 (ANOVA test, $F_{3.48} = 2.845$; $P>0.05$). In the years 2018 and 2019 at least one young Jackdaw fledgling flew from 38 of the 49 nests. Nest success in individual years ranged from 70% in 2019 to 85% in 2018. Total 43 young Jackdaws left the nests. Nest success (percentage of successful pairs in the entire breeding population) did not differ between years (ANOVA test, $F_{3.48} = 0.353$; $P>0.05$).

In total 36 bird species were identified in Tepeören Cemetery. The Bosphorus is recognized as one of the most important migration bottle-necks in all of Eurasia (Arslangündoğdu et al., 2018) and so far more than 350 bird species have been recorded in the Istanbul region (Bacak et al., 2015). Approximately 10% of the bird species ever observed in the area use the Tepeören Cemetery for nesting or as a stopover location during migration. Out of these birds, 10 species were found to breed in the cemetery. *Corvus monedula* is the most important bird species that prefers the cemetery as a breeding ground. That birds' breeding success relies on the trade-off between the benefit and the expense of specific stresses from habitats. Competition among species can influence their distributions and utilization of environmental resources (Han et al., 2019). In previous studius of birds in oak habitats in Türkiye it has been shown that for the number of species a positive effect can be seen from the age of the oaks (Bergner et al., 2015) and the size and density of oaks (Göktepe et al., 2019). For species that rely on the oaks for nesting and foraging, e.g. woodpeckers, the abundance can be explanied by the characteristics of the oaks, such as the depth of bark furrows (Bergner et al., 2016). But with increasing age, also complex structures like trunk hollows and deadwood develop (Regnery et al., 2013), creating stand heterogeneity that presumably supports a higher bird species richness (Tews et al., 2004). In this cemetery, hollows in old oaks have turned into an opportunity for the *Corvus monedula* to nest. It has an advantage over other species. Squirrel (*Sciurus anomalus*) is common among other animal species in the area. Whether there was a conflict between jackdaws and squirrels was not understood during this time. However, some studies have reported that jackdaw colonies can get along with squirrels by maintaining control of the area while also providing easier nesting oppurtunities for songbird species (Shuttleworth, 2001).

Although *Psittacula krameri* is considered an invasive alien species to the region, there was only one couple registered in this area. It has its nest in a hollow in the top of an oak tree, in the central part of the cemetery. The number of individuals and couples were stable during the study period. In some studies, competition between *Psittacula krameri* and native cavity-nesting species was found (Strubbe & Matthysen, 2007; 2009). However, in this study no signs of this was registered. According to both Shannon-Wiener diversity index and the Equitability_J index, species richness is highest in May and lowest in September. Index values show a decreasing tendency from spring to summer (Figure 2). Moreover, monthly index values of the two year survey period are similar to each other and their tendency is almost parallel to each other during the seasons. The month of May appears more prominently in the Shannon-Wiener diversity index. The reason for the high diversity index in the cemetery in May may be that some migratory bird species are observed intensively in the area during the peak of spring migration. Taylor (2006) and Erciyas-Yavuz et al. (2015) reported that in Türkiye the spring passage is usually in progress from April to the end of May while the autumn passage is usually in progress from August to the end of October. Migratory songbirds have been shown to undertake stopover for longer periods of time in the

autumn season as seen in bird ringing studies in Samsun Kızılırmak Erciyas-Yavuz et al. (2015). While autumn migration is spread over the course of three months, spring migration generally takes place in a much narrower temporal window (Arlt et al., 2015). According to all this information, normally more birds should have been observed in September, but there were no bird observations made in October which may have affected the results to some degree. Furthermore, it is possible that factors such as access to food and water differed between spring and autumn seasons which affected the willingness of birds to utilize the cemetery as a stop-over location. In some songbird species there is also a spatial variation in the routes taken by the birds in the spring and in the autumn (Klvaňa et al., 2018).

The range of egg numbers in a nest in this study were 2 to 6 eggs and a mean of 4.3 (N = 49). Some of the previous studies have found similar results in ovulation numbers, but it's a large variation between the studies (Kupko and Schlottke, 1999; Kaminski et al., 2015; Vasilev & Marinov, 2017; Czechowski et al., 2018). The breeding success, which measured as the ratio of young birds leaving, was 20.4% on average. The breeding success observed ranged from 21.9% (2019) to 18.6% (2018). Similar levels of success are seen in other studies (Kupko & Schlottke, 1999; Soler, 1990). The average number of fledglings per nest (1.1 individuals) the data obtained are similar to previous studies conducted in Europe (Switzerland, Czech Republic, Great Britain), where from 0.7 to 2.4 fledglings were recorded (Folk, 1968; Riggenbach, 1979; Czechowski et al., 2018).

Oak species have a long natural life span of 300 to 900 years and they have very durable wood, even in the decay stage (Mölder et al., 2019). Therefore, they offer suitable and particularly long-lasting habitats for many organisms. Most well-known are birds, bats and other mammals like squirells. When oaks age, hollows in the trunks fills with wood mould, i.e. wood soften by decomposing fungi, often with remains of animal nests, insect fragments and droppings from insect larvae. Trunk hollows with wood mould harbor a specialized fauna, mainly consisting of beetles and flies (Dajoz, 1980). The beetle fauna in tree hollows has intrigued entomologists for a long time, but only recently quantitative methods have been used in the studies (Ranius & Jansson, 2000; Brustel, 2004; Buse et al., 2008). In recent years many studies have reported of a very rich and unique beetle fauna living in the old oaks also in Türkiye (Novak et al., 2011; 2013; 2014; Platia et al., 2011; 2014; Sama et al., 2011; Soldati et al., 2019) and the importance of the Turkish habitats with old oaks for the biodiversity has also been sumerized by several authors (Jansson et al., 2016; 2018). In this cemetery, a colony of jackdaws breeds in trunk cavities of old oaks. Thus, the existence of old oaks is very important for this species. All jackdaws in this study breed in the hollows of old oak trees. Although some oak trees did not have tops, jackdaws still reproduced in three nests on the oaks of such situation. The reason for decreased occupancy of the hollows the second year of studies was because they were not suitable due to that part of the trees were broken and the cavities were too exposed or felled off when a big branch or the tree top collapsed

Old oaks in the cemetery create a living space for many birds but especially jackdaws, thanks to the cavities that they offer. As the Jackdaws often bring in a lot of nesting material to the hollows they are nesting in, it enriches the microhabitat and is potentially important for many invertebrate species. In conclusion this cemetary would be less rich without the old oaks. Therefore, the old oaks should be protected as a value that increases the importance of this cemetery for birds and other species. Formerly forest scientists called for the protection of hollow trees for the purpose of protecting insectivorous birds and bats (Mölder et al., 2017; 2019). These trees in the cemetery should not be left to perish, they should be protected and carefully managed to prolong their lives as long as possible. As the existing hollow oaks are old and will slowly die from natural reasons the area will lose a large part of its value for birds and other fauna dependent on hollow trees. There for it would be of great value if new oaks either could be planted or oak seedlings in place were protected and managed to fill the age gap to the older.

Cemeteries are open-green areas that need to be handled with great care in terms of maintaining the existence of green areas in places with intense urbanization (Güçlü et al., 1996; Gül & Küçük, 2001). Since cemeteries are different from other green areas and can have special vegetation structures, such as in this study, their associated biodiversity can be considered high. The presence of natural elements in the cemetery is important for the survival and general needs of wildlife, as well as enriching the well-being of urban people (Southon et al., 2018). In order for the cemeteries to fulfill the function of protecting and developing the wildlife of the city, studies should be done in the planning and management of these areas. For example, arrangements such as bringing plant species that will attract bird and insect species to the area should be taken into consideration at the design stage (Emery, 1986; Cranz & Boland, 2003).

Conclusions

The importance of urban cemeteries in terms of bird variety has been revealed. The presence of plant species that provide suitable nesting conditions for the reproduction of birds in these cemeteries supports the survival of the birds in the city. For this reason, the managers or user of the field should be ensured that the plant diversity in the urban cemetery is arranged as needed by the birds or the existing plant structure is protected. It is seen that cemeteries are important areas during bird migration periods. These areas should be taken into account in bird counting.

Acknowledgements

We thank Istanbul Metropolitan Municipality's Department of Cemeteries and its Technical Unit.

Ethics Committee Approval

N/A

Peer-review

Externally peer-reviewed.

Author Contributions

Conceptualization: Z.A., E.H.; Investigation: Z.A., E.H.; Material and Methodology: Z.A., E.H.; Supervision: Z.A., E.H.; Visualization: Z.A., E.H.; Writing-Original Draft: Z.A., E.H., A.B., N.J.; Writing-review & Editing: Z.A., E.H., A.B., N.J.; Other: All authors have read and agreed to the published version of manuscript.

Conflict of Interest

The authors have no conflicts of interest to declare.

Funding

The authors declared that this study has received no financial support.

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