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Research article

Investigation of Temporal and Spatial Variation of Mammalian Predation in Green Sea Turtle (*Chelonia mydas*) Nests on Samandağ Beach, Eastern Mediterranean Turkey

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Abstract. Nest predation is an important practical challenge for the protection of many endangered species of birds and reptiles, and has the potential to reduce hatching success and slow the recovery of the threatened populations. Estimating the temporal and spatial variation of the nest predation has the potential to optimize predation management. In this study, the temporal and spatial variation of mammalian predation was investigated in the green sea turtle (*Chelonia mydas*) nests on Samandağ beach, Eastern Mediterranean, Turkey. A total of 964 nests were examined between 2012 and 2017, which 733 of them were protected with screened metal grid and 231 of them unscreened control nests. The most effective nest predator was identified as the Jackal (*Canis aureus*). The protection of the nests with the screened metal grid has effectively increased the hatching success. The number of predated nests showed a positive trend over the years, but this trend was not statistically significant. The likelihood of predation increased towards the end of the incubation period, and did not change in the spatial variation according to the distance to the sea and vegetation. Also, the likelihood of the predation increased towards the end of the beach. Investigation of the likelihood of predation by nest density and nest depth in future studies is important. Also, the investigation of population ecology and status of the Jackals, which is predominant predators on the Samandag beach, is important for the both species.

Samandağ Kumsalı Yeşil Deniz Kaplumbağası (*Chelonia mydas*) Yuvalarında Memeli Predasyonunun Zamansal ve Mekansal Değişiminin İncelenmesi

Anahtar kelimeler:
Predasyon, *Canis aureus*, *Chelonia mydas*, Yeşil deniz kaplumbağası, Samandağ

Özet. Yuva predasyonu, birçok nesli tükenmekte olan kuş ve sürüngen türünün korunması için önemli bir pratik zorluktur ve yavru başarısını azaltma ve tehdit altındaki popülasyonların iyileşmesini yavaşlatma potansiyeline sahiptir. Yuva predasyonunun zamansal ve mekansal değişiminin tahmin edilmesi predasyon yönetimini optimize etme potansiyeline sahiptir. Bu çalışmada, Samandağ kumsalında yeşil deniz kaplumbağası (*Chelonia mydas*) yuvalarında memeli predasyonunun zamansal ve mekansal değişimleri araştırıldı. 2012 ve 2017 yılları arasında 733'ü metal ızgaralı kafes ile korunan, 231'i ise metal ızgara ile korumaya alınmamış kontrol yuvaları olan toplam 964 yuva araştırıldı. En etkili yuva predatörü Çakal olarak tespit edildi. Yuvaların metal ızgaralı kafes ile korunması yavru başarısını etkin bir şekilde arttırdı. Predasyona uğrayan yuva sayısı yıllara göre pozitif bir eğilim gösterdi, ancak bu eğilim istatistiksel olarak anlamlı değildi. Predasyon olasılığı kuluçka döneminin sonuna doğru arttı ve deniz ve bitki örtüsüne olan mesafeye göre mekansal değişimde farklılık ortaya çıkmadı. Ayrıca, kumsalın sonuna doğru predasyon olasılığı arttı. Yuva yoğunluğu ve yuva derinliklerine bağlı predasyon olma ihtimalinin ileride araştırılması önemlidir. Ayrıca Samandağ sahilinde baskın yırtıcı olan Çakalların populasyon ekolojisi ve statüsünün araştırılması da her iki tür için de önemlidir.

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INTRODUCTION

Turkey's Mediterranean coast have important nesting beaches for the green sea turtle (*Chelonia mydas*) and loggerhead sea turtle (*Caretta caretta*) (Canbolat 2004). Also, Samandağ beach is the most important nesting beach for the green sea turtle in the Eastern Mediterranean (Yalçın-Özdilek 2007). According to IUCN Red List criteria, the Mediterranean subpopulation of the green sea turtle is in the "Critical Endangered" (CR) status (Hilton -Taylor 2000), while the Mediterranean sub-population of the loggerhead sea turtle is in the "Least Concern" (LC) status (Casale 2015). Sea turtles, which typically have adapted to aquatic life, need coastal habitats for the nesting. Over the last 500 years, the consumption of sea turtles' flesh, eggs, shells, oil and skin has caused the generation of these species to face the danger of extinction (Ripple 1996). The main threats of sea turtles are dangers faced by nests in the coastal habitats. These threats can be biotic as predators (Başkale and Kaska 2005), and abiotic under the flood of beach, erosion, degradation of nesting beach (Sönmez and Yalçın Özdilek 2013).

Nest predation requires the application of practical and usable conservation methods for a number of endangered species of birds and reptiles (Stancyk 1982; Leighton *et al.*, 2011). Nest predators can be of various numbers, including mammals, birds, lizards, crabs, and insects (Stancky 1982; Brown and Macdonald 1995; Yerli *et al.*, 1997; Kaska 2000; Özdemir *et al.*, 2004; Başkale and Kaska 2005). The nest predation by the mammals is perhaps the most important biotic problem for the sea turtles to successfully complete their incubation (Kurz et al., 2011). It has been reported, however, that in some nesting beaches 97% of the nests are partially or totally predated by mammals (Hopkins and Murphy 1980; Talbert *et al.*, 1980; Schroeder 1981). Similar results were also reported in Mediterranean nesting beaches (Brown and Macdonold 1995; Yerli *et al.*, 1997; Kaska 2000; Başkale and Kaska 2005; Akçınar *et al.*, 2006). In addition, predation is an important reason of death for the eggs and hatchlings of endangered sea turtles (Stancyk 1982). It has been reported in the North Cyprus beaches that the hatching success is very low for the reason of mammalian predation (Kaska 2000). Although the populations of sea turtle in juvenile and adult period are very sensitive to the death, the nest predation may have adverse effects on future populations in the long term (Heppell *et al.*, 1996). In addition, experimental and theoretical research results have shown that it is important that the their eggs and hatchlings survive in order to continue the future population. (Dutton *et al.*, 2005; Mazaris *et al.*, 2006). However, it is known that significant reductions in survival rates in the first year of their life cause their populations to decline more rapidly (Crouse *et al.*, 1987; Crowder *et al.*, 1994). For this reason, the protection of the nests against the predation is important for the future population's existence. Against predation; a number of conservation methods are proposed, such as predator removal, transfer the eggs to other beach or hatcheries, use of chemical pesticides and nest protection (Yerli *et al.*, 1997). It has been reported that the method of removing the predator is advised to be used for intensive and repetitive predation (Windberg and Knowlton 1988), and the chemical repellent method is inadequate as it provides little success in removing the predators (McMurtray 1986). It has been stated that the transport of the nests to more suitable beaches or hatcheries changes the sex ratio due to the nest temperature (McMurtray 1986) and negatively affects the morphology of the hatchlings (Sönmez *et al.*, 2011). When the costs and benefits of these approaches are analyzed, it turns out that nest protection is the most promising approach and has the advantage of causing minimum level of destructive and highly specific (Hopkins and Murphy 1983; McMurtray 1986).

The risk of exposure of the nest to predation may change temporarily during the season and during the incubation period, but research on these effects are limited (Leighton *et al.*, 2011). Several authors have suggested that the risk of exposure of the nests to predation could be variably through nesting season because it could be changes depending on learn of the predators (Stancyk 1982; Leighton *et al.*, 2009). However, it has been reported that nest predation is more frequent at the beginning of the incubation (Stancyk *et al.*, 1980; Nellis and Small 1983; Leighton *et al.*, 2009) or at the end of the incubation (Fowler 1979; Nellis and Small 1983). Furthermore, several studies have indicated that there is a relationship between the spatial location of the nests on the beach and the risk of exposure to predation (Leighton *et al.*, 2009; Leighton *et al.*, 2011). It was reported that the areas near the vegetation have a higher risk of predation, and predation reduction methods need to be concentrated in these areas (Leighton *et al.*, 2011). On the contrary, Brown and Macdonald (1995) reported that the spatial distributions of the nests on the Akyatan nesting beach was not influenced by the likelihood of exposure to predation. In this study, the effectiveness of the nest protection activity with the screened metal grid was investigated against mammal predation on the Samandağ nesting beach, and also the temporal and spatial variation of mammal predation was examined.

MATERIALS AND METHODS

The study was carried out between 2012-2017 nesting seasons at the Samandağ beach (36° 07' N, 35° 55' E) in the Eastern Mediterranean, Turkey. Samandağ beach is 14 kms long, extending in the north-south direction, between Sabca Cape in the South and Çevlik Harbour in the North (Figure 1). Samandağ beach is divided into 3 sub-sections. These; Firstly Çevlik sub-section which is located between the Çevlik Harbour and the Şeyh-Hızır Tomb and it is the most northly point of the beach and is about 5.5 km long. Secondly Şeyh-Hızır sub-section, which is located between the Şeyh-Hızırr Tomb and Asi River and is about 4.1 km long, and finally, Meydan sub-section, located between Asi River and Sabca Cape 4.4 km long (Yalçın-Özdilek 2007). The most preferred sub-sections by the sea turtles for nesting are Şeyh-Hızır, Meydan and Çevlik sub-sections, respectively (Yalçın-Özdilek 2007). The study was carried out in Şeyh-Hızır and Çevlik sub-sections (between 0 and 10000 meters) where daily monitoring activities were carried out. In the study area, the port of Çevlik in North is defined as the reference point.

Daily monitoring was carried out by a team of five people between 1 June and 15 September on every nesting season. During the daily monitoring, the nesting and non-nesting emergences were recorded, and nest chambers were determined using reed sticks. Also, the all emergences tracks were removed after each examination to avoid duplication. Nest location was marked with the planting stick. After the nest has been determined, the distance from the nest to the sea (DFS) and vegetation (DFV) that is the vertical distribution of the nests was measured from the nest chamber with the tape meter. The distance to the reference point was recorded with the GPS (± 5 m, GARMIN) to find the horizontal distributions. The incubation duration of the nests is the time between the day when the egg was laid and the day when the first hatchlings was emergenced. The nest age was calculated as the time between the day when the eggs were laid by the turtle and the day when the nest predated by the mammals. Hatching success was calculated as a percentage of hatchlings in a clutch. The total number of eggs was calculated as the sum of the empty shell counts, dead embryo counts and unfertilized egg counts. The nest protection under threat from the predators such as mammalian were screened with a metal grid (72 x 72 cm), with a 9 cm mesh placed above the nest at a depth of 20 cm from the surface above the center of the egg chamber, and galvanize metal grid were used for this protection (Kaska 2000; Başkale ve Kaska 2005). All nests under threat from the predators were not screened and some of them were left as a control group (unscreened nest).

The normality analysis of the data was carried out using Levene statistics. One-way analysis of variance (ANOVA) was used to compare the DFS and DFV of the screened and unscreened nests. The non-parametric Mann-Whitney U test was used to compare the hatching success of the nests. Firstly, frequency distribution of the DFS, DFV, the nest age, horizontal location of all unscreened nests were separately obtained for each relationship test. No classification was made and it was assumed that all frequencies were raw data. The Pearson correlation test was performed for each data, and then Poisson regression analysis was subjected. Classical regression analysis is based on the assumption that the dependent variable

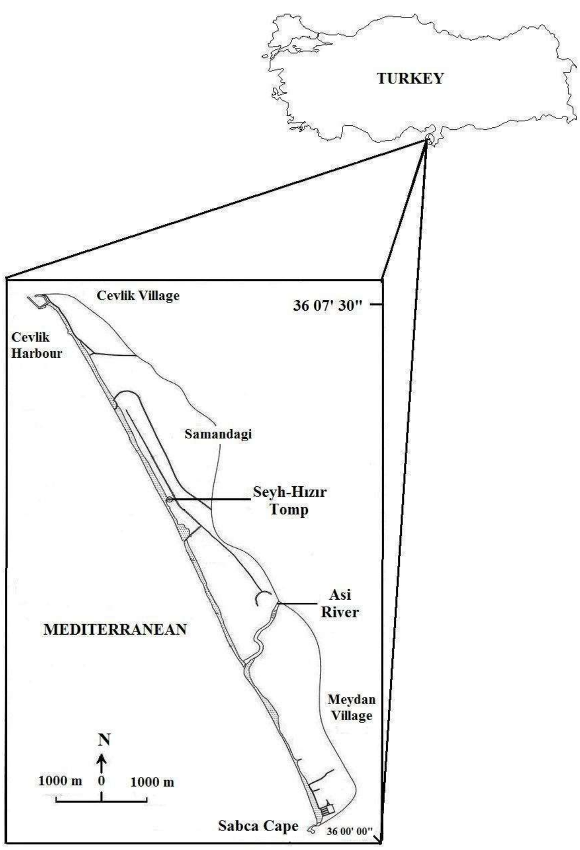

Figure 1. General view of the research area.
Şekil 1. Çalışma alanının genel görünümü.

is a continuous random variable. In addition, it is based on assumptions that it is established on the indepented variable with the error term. If the dependent variable shows events occurring at a certain time interval, applying the Poisson regression gives more accurate results (Gardner *et al.*, 1995). In the Poisson regression model, a distribution model is constructed on the probability number of occurrences of a rare event, and general estimates of the regression process are performed using the most likelihood methods (Gardner *et al.*, 1995). In a standard Poisson model with the simplest count data model, it is assumed that the variance is equal to the mean, but the actual data often have larger variance than the mean, ie overdispersed (Gardner *et al.*, 1995). For this reason, the data set should not be overdispersed. In the overdispersed test, the null hypothesis assumes that the data set shows the Poisson distribution, that is the calculated p-value means that the level of significance is greater than alpha = 0.05.

The frequency of predated nests over the years were performed by means of the nonparametric and nonseasonal Mann-Kendall Trend test (Hipel and McLeod 1994). In the trend analysis, the Theil-Sen regression was used to predict the regression constants based on the Mann-Kendall Trend test and the Kendall correlation coefficient (Sen 1968). The Mann-Kendall test is based on the calculation of Kendall's tau measure of association between two samples, which itself is based on the ranks with the samples. However, the existence of positive autocorrelation in the data increases the probability of detecting trends when actually none exists or vice versa. A modified non-parametric trend test which is suitable for autocorrelated data is proposed by Hamed and Rao (1998). They stated that the accuracy of the modified test in terms of its empirical significance level was found to be superior to that of the original Mann-Kendall trend test without any loss of power. The comparison of the screened and unscreened nests were performed with the SPSS 17.0 statistical package program, and also Mann-Kendall Trend, Pearson correlation, Poisson regression and overdispersion test were performed with the XLSTAT 2018 statistical package program.

RESULTS AND DISCUSSION

During the six nesting seasons, a total of 964 nests under the predation risk were examined. Of these, 733 were screened group and 231 were unscreened control group. The frequency distribution of the screened and unscreened control groups according to the years was shown in Figure 2.

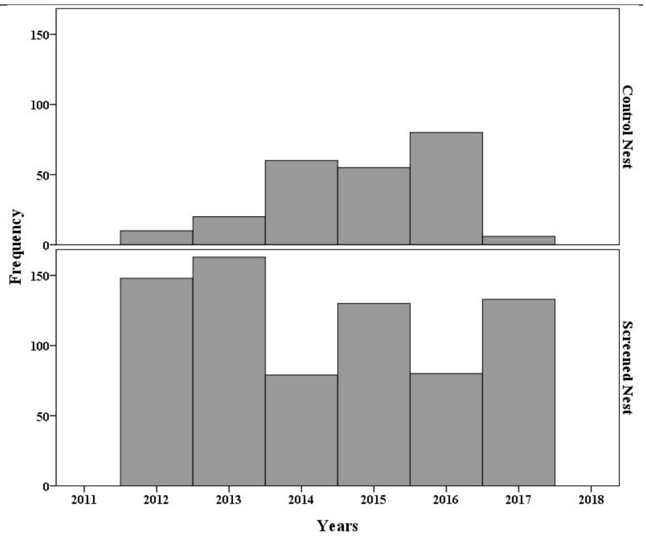

Figure 2. The frequency distribution of the nests according to the years.

Şekil 2. Yıllara göre yuvaların frekans dağılımı.

The mean DFS of screened nests is 37.64±13.31 (10-99) meters while the mean DFS of unscreened nests is 35.98 ±13.51 (8-79) meters. There were no significant differences between the screened and unscreened nests in terms of DFS (F=2.712, df=1, P=0.100). The mean DFV of screened nests is 11.12 ±12.58 (0-66) meters while the mean DFV of unscreened nests is 12.35±13.28 (0-55) meters. There were no significant differences between the screened and unscreened nests in terms of DFV (F=1.557, df=1, P=0.212). Out of 31 (4.2%) nests in screened groups, due to natural reasons, the incubation was unable to successfully completed, and at least 88% of the screened nests were predated by the mammals at least once. However; no damage was done to any nest due to being screened with metal grid. When the unsuccessful nests due to natural reason were included for hatching success, the average of the hatching success of screened nests was calculated as 76.85±25.80 (0-100). All nests in the unscreened control group were destroyed by the predator and no hatchlings emergences from any nests. Moreover, all the eggs in the nests were completely destroyed when the first predation was done. A total of 19328 eggs was destroyed, of which 98% were jackals and 2% were domestic dogs. The screened and unscreened nests showed significant difference for the hatching success (Mann-Whitney U test, Z=-22.164, P=0.0001).

Protection of the nests under threat of mammalian predation with metal grid is an effective protection method. Although 88% of the protected nests were exposed to mammallian predation at least once, the nest protection effect with metal grid was 100% successful, and increased hatchling success. It was reported that the nest protection with metal grid have achieved high success on the beach of Akyatan, which is an important nesting beach for the green sea turtle in the Eastern Mediterranean (Yılmaz *et al*., 2009). A similar result was also reported for the loggerhead sea turtle on the Dalaman beach (Başkale and Kaska 2005). The nest protection method with grid cage was reported to be successful for many species of the sea turtles on the many beaches (Addison and Henricy 1994; Jordan, 1994; Kaska, 2000; Longo *et al*., 2009; Kurz *et al*., 2011). It was found that predominant predator species on the Samandağ beach was the Golden Jackal (*Canis aureus*). Golden Jackal was reported as a nest predator on many nesting beaches for the green sea turtle (Brown and Macdonald 1995; Akçınar *et al*., 2006; Yılmaz *et al*., 2009; Yılmaz *et al*., 2015). However; the predators such as foxes, raccoons and domestic dogs were also reported for the same and different sea turtle species on the different beaches (Jordan 1994; Yerli *et al*., 1997; Başkale and Kaska 2005; Akademi 2006).

The variation of the predated nests according to the years are shown in Figure 3a. Although the predated nests showing a positive upward change with respect to the years, this change is not significant in the Pearson correlation test (r=0.271, P=0.603). Furthermore, the number of predated nests was analyzed by the Mann-Kendall Trend test. According to the results of this test, there were no significant trend in the number of predated nests from 2012 to 2017 (Kendall's tau=0.200, P=0.707, Sen's slope=10.00) (Figure 3b).

Although the number of predated nests has shown a positive trend in terms of the years, it did not show any significant difference. Aureggi *et al*. (2000) reported that the number of nest on the Akyatan beach during 1995- 1998 differs from year to year, but the number of predated nest is similar to the previous years. In contrast, Engeman *et al*. (2003) reported that the predation rate of 3 sea turtle species (loggerhead, green and leatherback) nest changed seasonally. However, it should not be forgotten that this difference will be related to the amount of food and population status of the predators (Fowler 1979).

The frequency distributions of the DFS, DFV, nest age and horizontal locations of the predated nests were shown in Figure 4. According to the distance to the sea, the frequency of predation showed a significant negative correlation (r=-0.461, P=0.001). As seen in the 95% confidence interval ellipsis graph in the relationship between the predation frequency and DFS, the probability of the predation decreases as the nests move away from the sea. (Figure 5a). It was found that DFS and the predation likelihood of the nests showed significance in the Poisson regression test (Table 1). However, DFS very weakly explained the probability of predation in the Poisson regression model (McFadden R^2 = 0.054)

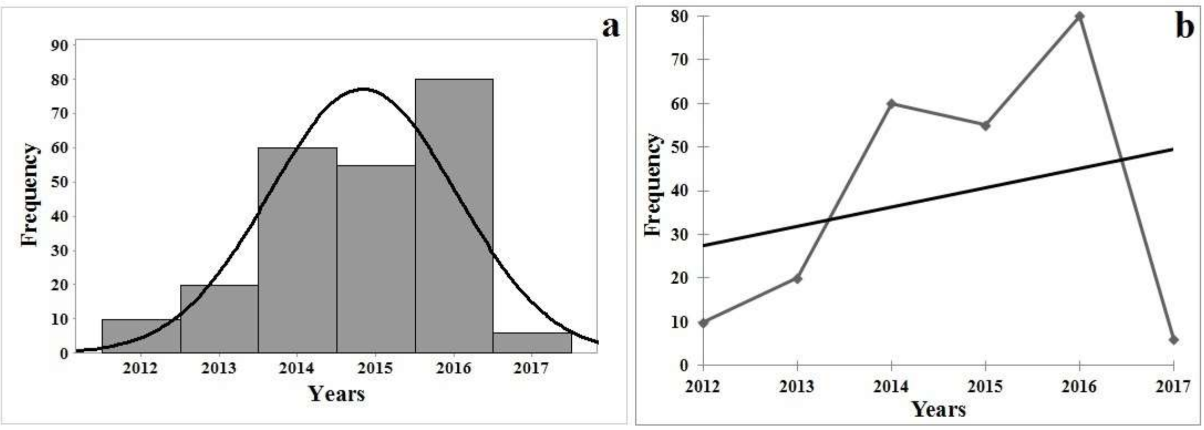

Figure 3. The variation of the predated nests according to the years (a), the temporal change of predated nest numbers and Theil-Sen Trend line (b).

Şekil 3. Predasyon olan yuvaların yıllara göre değişimi (a), predasyon olan yuva sayılarının zamansal değişimi ve Theil-Sen Eğim çizgisi (b).

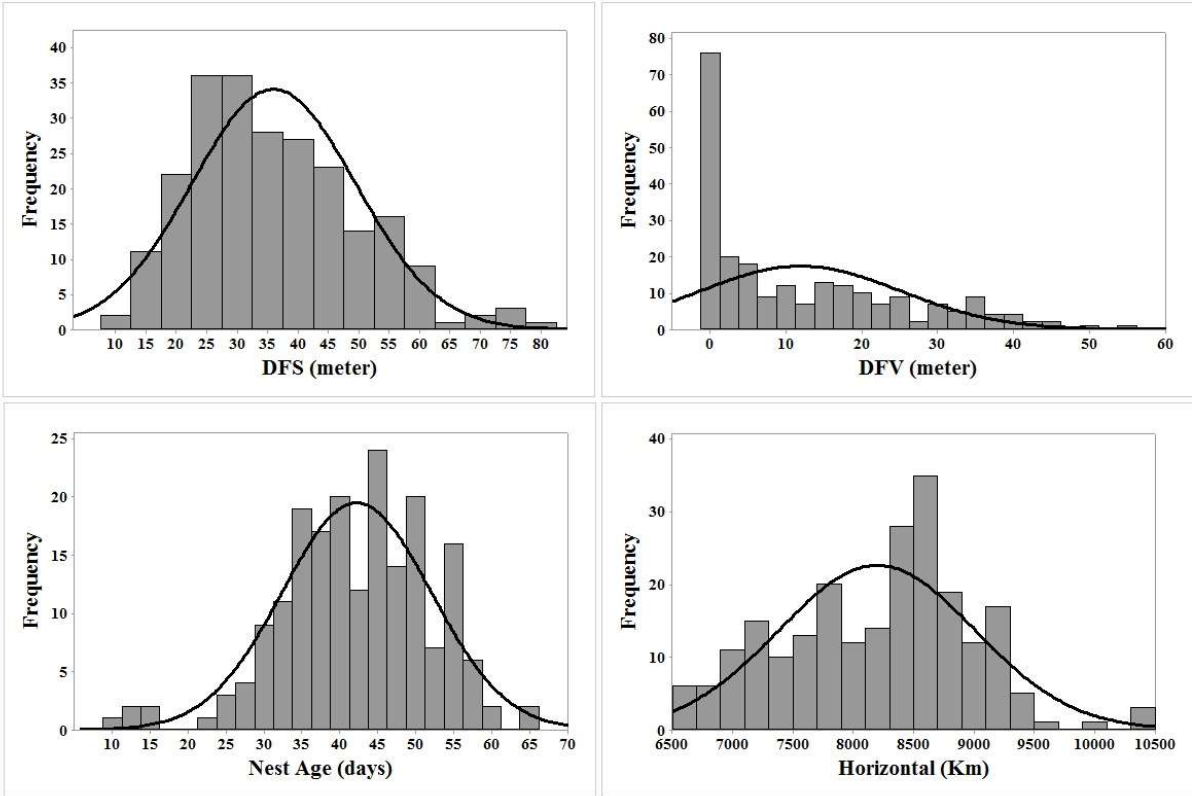

Figure 4. The frequency distributions of the DFS, DFV, nest age and horizontal locations of the predated nests (DFS: distance from sea, DFV: distance from vegetation).

Şekil 4. Predasyon olan yuvaların DFS, DFV, yuva yaşı ve yatay yerlerinin frekans dağılımları (DFS: denize uzaklık, DFV: bitki örtüsüne uzaklık).

In reference to the distance to the vegetation, the frequency of predation showed a significant negative correlation (r=-0.400, P=0.006). As seen in the 95% confidence interval ellipsis graph in the relationship between the predation frequency and DFV, is less likely to probability of the predation as the nests move away from the vegetation (Figure 5a). However; it was found that DFV and the predation likelihood of the nests not showed significance in the Poisson regression test (Table 1). Furthermore, DFV very weakly explained the probability of predation in the Poisson regression model (McFadden R^2 = 0.001).

In response to the nest age, the frequency of predation showed a positive correlation. On the contrary, this positive correlation was not statistically significant (r = 0.230, P = 0.154). The relationship between predation frequency and nest age is shown in the 95% confidence interval ellipsis graph (Figure 5c). In contrast, it was found that the age of the nests and the likelihood of predation were significant in the Poisson regression test (Table 1). The nest age is weakly explained the probability of predation in the Poisson regression model (McFadden R^2 = 0.216). The location of the predated nests in the horizontal distance and the frequency of predation showed a positive correlation. However, this positive correlation was not statistically significant (r = 0.664, P = 0.151). The relationship, which is not significant between the predation frequency and the horizontal distance of the predated nests, is shown in the 95% confidence interval ellipsis graph (Figure 5d). On the contrary, it was found that the horizontal distance and the predation likelihood of the nests showed significance in the Poisson regression test (Table 1). The horizontal distance location of nests strongly explained the probability of predation in the Poisson regression model (McFadden R^2 = 0.944).

The predation nests showed a significant correlation acording to both the distance from the sea and the distance from the vegetation. In the Poisson regression test, the spatial variation of the nests did not affect the possibility of predation on the Samandağ beach. It was reported that the spatial variation of predated nests on the Akyatan beach did not affect the predation rate (Brown and Macdonald 1995). On the other hand, it was reported that the predation probability of *Eretmochelys imbracata* nests in the vegetation habitats is high, and the survival rate of the hatchlings is less than 50% (Leighton *et al*., 2011). Vegetation on the beach, which uses as a habitat not only for mammalian predators, but also other predators such as invertebrata (Özdemir *et al*.,

Table 1. The model of predation probability of the nests according to the DFS, DFV, nest age and horizontal location in the Poisson Regression (DFS: distance from sea, DFV: distance from vegetation).

Çizelge 1 Poisson Regresyonunda DFS, DFV, yuva yaşı ve yatay konuma göre yuvaların predasyon olasılığının modeli (DFS: denize uzaklık, DFV: bitki örtüsüne uzaklık).

	Overdispersion		Poisson Regression (2 Log (Likelihood)		
	T	P	Chi-square	Pr > Chi^2	R^2 (McFadden)
DFS (m)	0.077	0.939	15.699	< 0.0001	0.054
DFV (m)	1.705	0.095	0.027	0.869	0.001
Nest Age (Days)	0.648	0.521	54.057	< 0.0001	0.216
Horizontal (Km)	2.168	0.082	799.534	< 0.0001	0.944

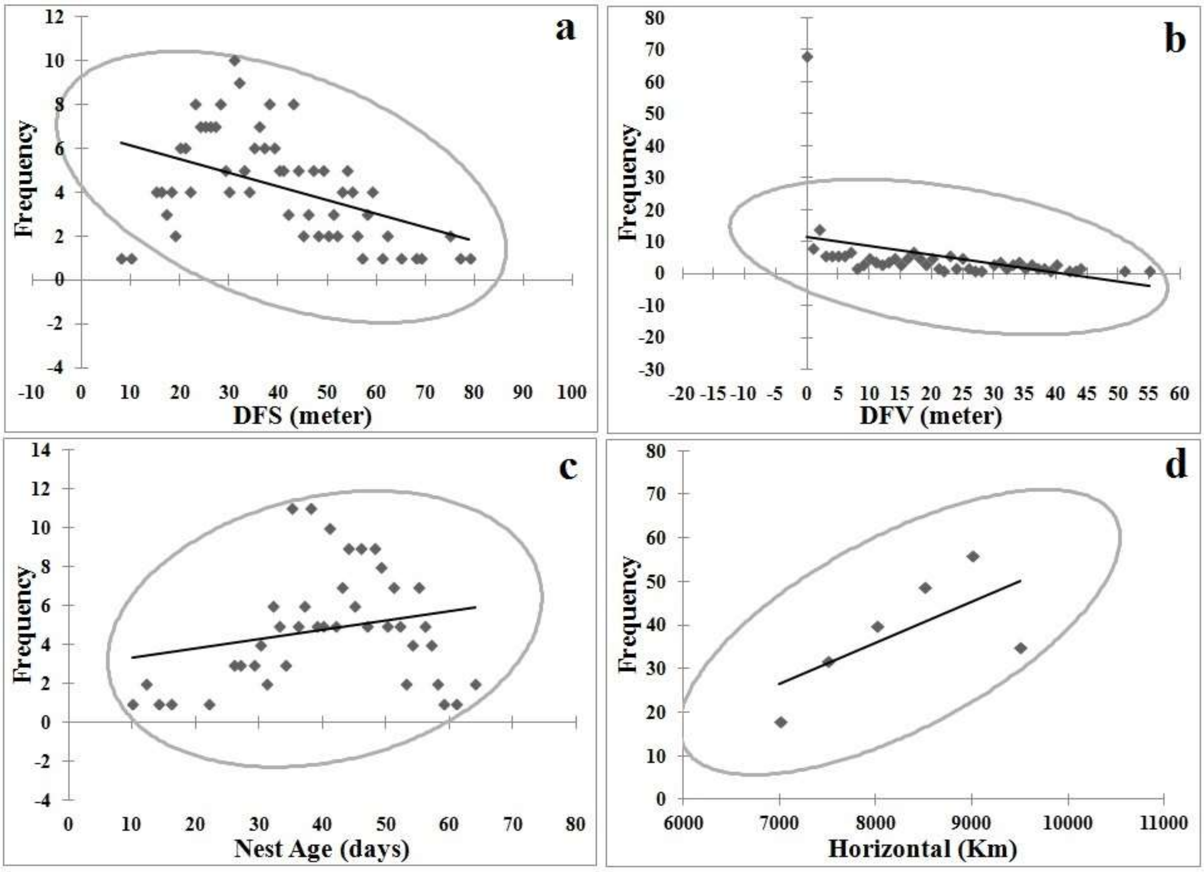

Figure 5. The relationships between the predation frequency and DFS (a), DFV (b), nest age (c) and horizontal location (d) in the 95% confidence interval ellipsis graph (DFS: distance from sea, DFV: distance from vegetation).

Şekil 5. %95 güven aralığı elips grafikte predasyon sıklığı ile DFS (a), DFV (b), yuva yaşı (c) ve yatay konum (d) arasındaki ilişkiler (DFS: denize uzaklık, DFV: bitki örtüsüne uzaklık).

2004; Wetterer *et al.*, 2007) are an important predictor for the predation. The nesting beaches of the sea turtles consists of a mixture of both vegetated and non-vegetated habitats. The beaches that are selected by sea turtles as a nesting area and selected as a habitat by the predators can reveal irregularities in the predation risk (Fowler 1979). In addition, the intensity of beach use by people also affects the risk of predation (Leighton *et al.*, 2011). In contrast, many predators, such as domestic dogs, jackals and foxes, can actively play a role in nest predation in all types of habitats and in all areas of the nesting beaches (Fowler 1979; Leighton *et al.*, 2011). The nest predation, which was destroyed by the jackals on the Samandağ beach, has emerged effectively both in the open area and in the vegetation area.

The predated nests assessed according to their horizontal position on the beach. There is a non-significant positive correlation between the horizontal distance position and the predation frequency of nests. However, in the Poisson regression test, the model, that is the nest position in the horizontal location, is strongly explain of the probability of predation. The likelihood of the predation is increasing towards the end of the beach. Perhaps this relationship is also related to the nest density of the beach. This is due because the nest density on the Samandağ beach increases towards the end of the beach (Yalçın Özdilek 2007). Leighton *et al.* (2011) stated that there is a strong negative relationship between the nest density and the possibility of predation in the open area, but also there is no relationship between nest density and predation in the vegetation areas. Spatial accumulation of the nests in an area can be attractive to the predators, and can increase the per capita risk of the nests (Leighton *et al.*, 2011). However, in a study conducted for freshwater turtles, it was reported that the nest density did not affect the risk of predation (Burke *et al.*, 1998). A similar finding was also reported for sea turtles (Fowler 1979). These differences between the beaches may be related to the feeding ecologies and habitats of the predators. At the same time, it is important which area of each beach is open for human use.

In the Poisson regression test, the probability of predation is increasing towards to the end of incubation. It was reported that predation is increasing towards the end of the incubation of the green sea turtle nests in northern Cyprus (Kaska 2000). A similar result was also reported in Costa Rica green sea turtle nests (Fowler 1979). It was reported that predation on the Akyatan beach is more frequent after the fourth week of incubation (Brown and Macdonald 1995). However, some researchers report that in different species and on different beaches, the nests are predominantly predated in the early days of the their incubation (Stancyk *et al.*, 1980; Nellis and Small 1983; Leighton *et al.*, 2011). Kaska (2000) stated that there is predation risk for the loggerhead sea turtle nests throughout to the incubation duration. It is suggested that because of changes depending on learning in predator, the predation probability must change throughout the nesting season (Stancyk 1982; Leighton *et al.*, 2009). Leighton *et al.* (2011) reported that the risk of predation may change temporarily during the incubation period. Since the predation risk is related to the availability and location of the nest (Fowler 1979), perhaps the nest depth of the green sea turtle has a negative impact on the availability of the nest. Leighton *et al.* (2009) stated that the shallow nests under the threat of mongoose predation in the *E. imbricata* should be primarily protected. The most of the predators are using smell to find the egg (Stancky 1982), and nest depth may help remove the nest sense by hiding the smell cue (Leighton *et al.*, 2009). The smell resulting from an increased metabolic activity due to the growth of the embryo towards the end of the incubation may increase the availability of the shallow nests. However; in this study, the relationship between probability of predation and nest depth is not investigated. In future studies, it is suggested to investigate relations between the depth of the nest and the probability of predation.

CONCLUSION

The protection of nests that are under threat mammalian predator by screened metal grid in the Samandağ beach effectively increases the hatching success. However, the galvanized metal grid used in nest protection have some negative effects on hatchlings orientation (Irwin *et al.*, 2004). For this reason, as well as increase the hatching success, the use of a grid made of plastic material can be an effective protection method without adverse effect on the orientation. While the probability of the predation were increasing towards the end of the incubation duration, the probability of the predation according to the spatial distance to the sea and vegetation had not changed. However, the probability of the predation towards the end of the beach, where the nest density was high, showed an increase. Investigation of the possibility of predation with nest density and nest depth in future studies, as well as the investigation of the population ecology and status of the Jackals, a predominant predator on the Samandağ beach, are important for future generations of both species.

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