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# Green turtle nesting activity on Yeniyurt Beach, Hatay, Türkiye: Six-year results (2017–2022)

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**Abstract:** Conducting long-term conservation and monitoring activities for sea turtles provides a more precise depiction of their population status compared to studies conducted across a single year. The frequency of the nesting activity may fluctuate dramatically over time, depending on the environmental conditions. This study aimed to examine the nest count, female abundance, and reproductive output of green turtles on Yeniyurt Beach in the eastern Mediterranean between 2017 and 2022. The beach was surveyed via annual monitoring at consistent intervals. Temporal variations in the nest count and abundance of females were analyzed using the Mann–Kendall and Sen's Slope tests. A total of 803 nests were recorded, with an average of 133 nests per nesting season and an average nest density of 33.5 $km^{-1}$. A total of 326 nests were excavated, with 28,546 of the 36,394 eggs successfully hatched (78% hatching success). The nest count and female abundance exhibited an insignificant, monotonic upward trend. The average nesting female count per nesting season was estimated to be 138.5 based on the observed clutch frequency (CF) and 67 based on the estimated CF. Yeniyurt Beach has a high nesting activity rate, representing 6% of the Mediterranean in terms of the nest count and 5% in terms of female abundance. Approximately 12% of nests did not produce hatchlings due to flooding and predation. Yeniyurt Beach lacks a conservation status, making it vulnerable to future threats like industrialization. In addition to the designation of the area as a protected site, the rehabilitation of the backshore habitat is of significant importance.

**Key words:** Nesting, abundance, green turtle, *Chelonian mydas*, conservation, Yeniyurt

## 1. Introduction

Sea turtle populations have declined significantly globally and are therefore far below historical levels in numerous locations (Van Houtan and Kittinger, 2014). The deployment of essential conservation measures across breeding grounds has led to an increase in the population size in some locations (Yılmaz et al., 2022; Sönmez et al., 2024).

The Mediterranean coast is home to significant breeding sites for the green turtle (*Chelonia mydas*) and the loggerhead turtle (*Caretta caretta*) (Casale et al., 2018). Both the marine and terrestrial environments pose various threats to the populations of these two species. These include marine pollution, interactions with fisheries, erosion, beach armoring, and predation (Casale et al., 2018). A recent study classified the Mediterranean green turtle population as one of 11 Regional Management Units globally (Wallace et al, 2023). It has been categorized as Highly Threatened, according to Wallace et al. (2011). In addition, a recent study suggested a minimum of three management units for the Mediterranean population, namely MED1, MED2, and MED3 (Karaman et al., 2022). The Mediterranean subpopulation of the green turtle was evaluated for the International Union for Conservation of Nature Red List of Threatened Species and is classified as Near Threatened under Criterion B2b (Broderick et al., 2023).

Most of the worldwide research on sea turtles has concentrated on monitoring the nesting beaches. This is because sea turtles frequently migrate between different habitats and have a wide variety of habitats throughout their life cycle (Godley et al., 2010; Hawkes et al., 2012; Shimada et al., 2020). The reason for this is that nesting females (FNs) or their nests are easily examined (Ceriani et al., 2019; Yılmaz et al., 2022; Sönmez et al., 2024), and data on the nest count, clutch size, hatching success, incubation duration, and embryonic development can be obtained. Hence, the systematic collection of this data over an extended duration using established methods can be utilized as a framework for population assessments and the development of forecasts concerning the population's status (Blumenthal et al., 2021; Pritchard et

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al., 2022). Furthermore, the nest count on nesting beaches is commonly utilized to assess sea turtle populations (Ceriani et al., 2019). However, it is advisable to conduct comprehensive and continuous monitoring to gather precise data and evaluate changes and fluctuations in the population over an extended period of time (Broderick et al., 2001; Yalçın Özdilek, 2007). The nest count and abundance of FNs might vary significantly over time due to environmental conditions (Broderick et al., 2001); therefore, studies conducted over a single year may result in inaccurate population estimates (Yalçın Özdilek, 2007).

The result of comprehensive conservation studies conducted on individual nesting sites, which include data on the nest count and female abundance, could offer valuable insights into the present status of the Mediterranean population. According to Casale et al. (2018), the average annual nest count at 13 major green turtle breeding sites in the Mediterranean was estimated to be 2204. This estimate is likely to be conservative if it does not consider the presence of unreported or unmonitored nesting beaches (Casale et al., 2018). It is crucial to monitor new nesting beaches and accurately report the nest count to provide an accurate representation of the green turtle population's status in the Mediterranean region. Currently, comprehensive monitoring studies, such as the temporal change of female abundance and nest count, have not yet provided a definitive understanding of the associations between nesting beaches and the Mediterranean population, apart from a limited number of studies (Yılmaz et al., 2015, 2022; Omeyer et al., 2021; Sönmez et al., 2024). For instance, a recently published study indicated that the nest count on Samandağ Beach represents approximately one-third of the total nest count in the Mediterranean (Sönmez et al., 2024).

Sert et al. (2017) presented the initial documentation of green turtle nesting on Yeniyurt Beach at the National Sea Turtle Symposium. In their presentation, they suggested that Yeniyurt Beach could serve as a potential nesting beach, based on a single monitoring study. Subsequently, Turan et al. (2021) presented the findings of their single-year protection and monitoring studies. These two studies were based on single-year data and also only provide information on the nest count, hatching success, incubation period, and clutch size. Given the potential for single-year protection and monitoring studies to yield inaccurate information about the population, the results of long-term protection and monitoring studies on Yeniyurt Beach are significantly important. Considering the factors mentioned above, the objective of this study was to evaluate the long-term nest count, female abundance, and reproductive output of green turtles on Yeniyurt nesting beach. This will provide insight into the proportion of the Mediterranean population represented by Yeniyurt Beach.

## 2. Materials and methods

### 2.1. Study area and monitoring

The study was conducted on Yeniyurt Beach, Hatay, which spans approximately 4 km in length (36.8751 N, 36.1257 E), extending from Seçil Holiday Houses in the north to BOTAŞ Port in the south (Figure 1). The beach is divided into two distinct sections: the northern part, covering 2.6 km, and the southern part, covering 1.4 km (Sert et al., 2017; Turan et al., 2021). The maximum width of the beach is 70 m, and the minimum width is 15 m. Near the northern part of the beach, there are agricultural areas and lagoons that connect to the sea in certain locations (Figure 2). A small water channel at Yeniyurt Public Beach was selected as a reference point (Turan et al., 2021). The dune structure is characterized by a coarse-grained, stony, and rocky composition in certain areas (Figure 2).

The study at Yeniyurt Beach encompassed the period between 2017 and 2022, and the study schedule is presented in Table 1. Data regarding the nesting activity in 2019 were obtained from Turan et al. (2021). Their study was conducted between June 15th and September 15th in both subsections. During the nesting survey, successful nesting activities were recorded. The existence of nest chambers was confirmed by detecting an air gap over the eggs by carefully using a metal stick (Yalçın Özdilek, 2007; Omeyer et al., 2021; Sönmez et al., 2024). To prevent duplication in the next field survey, each nest was marked with a stick or piece of wood that was numbered. During the hatchling survey, all recorded nests were carefully examined, and those with hatchling tracks were excavated. Older nests that had completed incubation were examined for the presence of a depression on the nest chambers where the hatchlings had emerged from the nest. If a depression was detected on the nest, it was excavated, and the remains were examined. The number of dead and live hatchlings, hatched eggs (empty eggshells), unhatched eggs, and dead embryos were quantified during the excavation of the nest. The clutch size was determined by counting the number of unhatched eggs and dead embryos and the number of hatched eggs (Sönmez et al., 2024). The hatching success was calculated as the percentage of the clutch size divided by the number of hatched eggs (Sönmez et al., 2024). The emergence success in the nest was calculated as the percentage of the number of hatched eggs minus the number of dead and live hatchlings in the nest, divided by the clutch size (Patricio et al., 2018). The density of nests per kilometer (nest $km^{-1}$) was calculated as the ratio of the total nest count to the length of the beach (Casale et al., 2018).

The FN count was estimated based on the clutch frequency (CF), which was determined using both the observed CF (OCF) (2.9 nests per female) (Broderick et al., 2002) and estimated CF (ECF) (6 nests per female) (Esteban et al., 2017). The remigration interval (RI) for

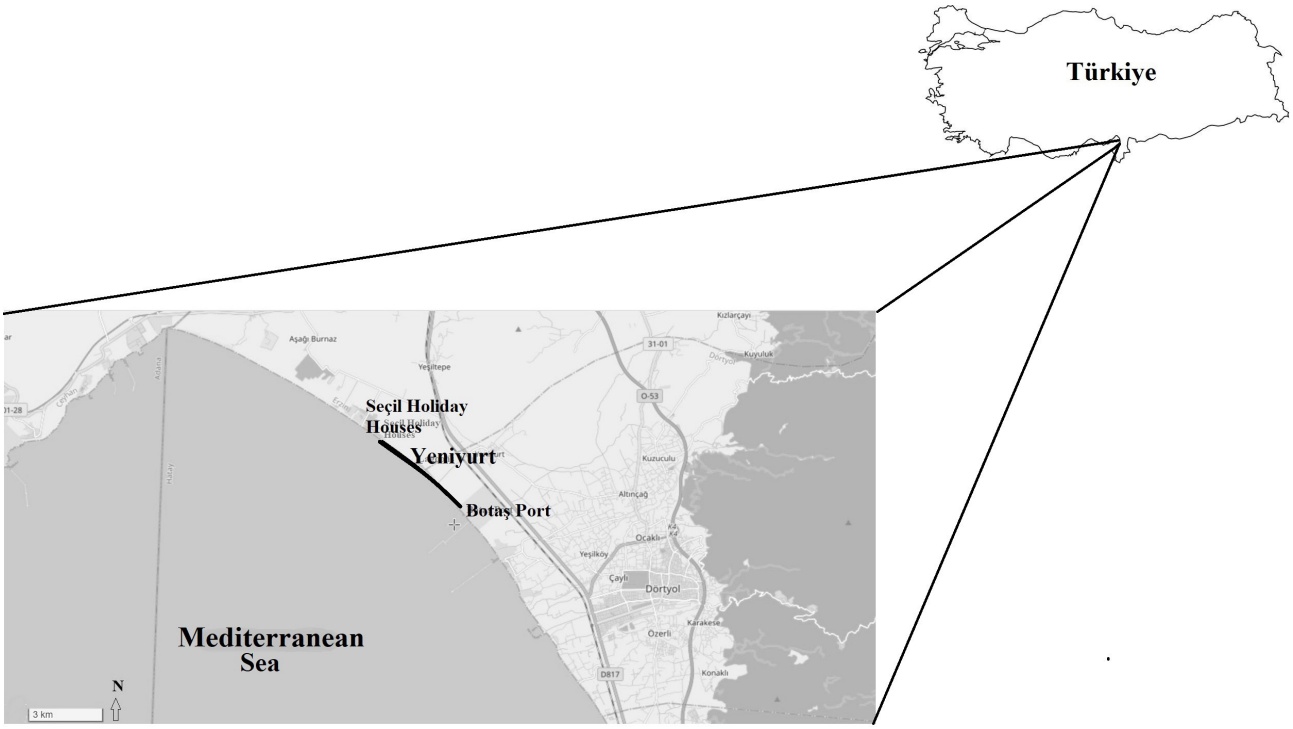


**Figure 1.** General view of Yeniyurt Beach (dark area indicates the nesting beach).

**Figure 2.** The lagoon extending in the northern subsection of the Yeniyurt nesting beach, and the part of the nesting beach with a coarse-grained, stony, and rocky structure.

Mediterranean populations has been estimated to be three years (Broderick et al., 2002). Accordingly, the following formula was employed to calculate the total average FN count (Yılmaz et al., 2022; Sönmez et al., 2024):

Mean FN = total nest count / CF × (RI / total years)

The current number of females (CFN) in the last three nesting seasons (2020, 2021 and 2022) was calculated using the following formula:

CFN = (mean nest count / CF) × RI

**2.2. Data analyses**

The temporal variation in nest counts and female abundance with the OCF and ECF were examined. Before examining the variations over time in these variables, the Durbin–Watson test was applied to determine whether there was an autocorrelation in the residuals of the regression model. Autocorrelation refers to the similarity of a time series at subsequent time intervals. This could result in an overestimation of the standard

**Table 1.** Field study schedule at Yeniyurt Beach between 2017 and 2022 (*data were obtained from Turan et al., 2020).

| | **Subsection** | |
|---|---|---|
| **Year** | Northern | Southern |
| **2017** | July 25th | - |
| **2018** | July 6th<br>August 5th<br>September 5th | |
| **2019*** | June 15th–September 15th | June 15th–September 15th |
| **2020** | July 24th<br>August 19th<br>September 2nd | July 24th<br>August 19th<br>September 2nd |
| **2021** | July 29th<br>September 7th<br>September 15th | July 29th<br>September 7th<br>September 15th |
| **2022** | August 4th | |

error, making estimators seem substantial when they are not, or vice versa.

The nonparametric and nonseasonal Mann–Kendall trend test (Hipel and McLeod, 1994) was used to examine the trend in the nest and FN counts. Comprehensive studies of sea turtles have widely used the Mann–Kendall trend test (de Silva et al., 2007; Marcovaldi et al., 2007; Sönmez, 2018; 2019; Sönmez et al., 2024). In addition, the Theil–Sen regression method and 95% confidence interval (95% CI) were utilized to calculate the regression constants using the Mann–Kendall trend test and Kendall correlation coefficient (Sen, 1968). The Mann–Kendall test relies on the computation of Kendall's tau, which quantifies the association between two datasets by considering the rankings of the observations within each dataset. The computations assume that the observations are independent, and that the data are ordered randomly. The trend test was conducted using XLSTAT 2018 statistical software (Addinsoft, NY, USA).

## 3. Results

A total of 803 green turtle nests were found between 2017 and 2022 throughout the all of Yeniyurt Beach. The average nest count each season was 133.3, ranging from 85 to 195 (Table 2). The average nest density was 33.5 nests $km^{-1}$, with a range from 21.3 to 48.8 nests $km^{-1}$ (Table 2). Red foxes or domestic dogs predated 8.7% (70 nests) of the nests during the incubation period (Table 2). Additionally, 3.5% of the total nest count (28 nests) failed to produce hatchlings due to erosion or inundation (Table 2).

Due to certain logistical considerations that arose in 2017 and 2022, excavation of the nests was not conducted (302 nests, except 14 predated nests). Instead, only nest records were received. In addition, an overall total of 91 nests were unavailable to be excavated during the last field survey for each year due to their ongoing incubation process. A total of 36,394 eggs were deposited in 326 excavated green turtle nests, with an overall mean clutch size of 107.4 ± 10 (range: mean 94.1–115.7) eggs (Table 3). In the excavation of these nests, 5,264 (14.4%) were found to be unhatched eggs and 2,584 (7.1%) were dead embryos. Of the total egg count, 28,546 (a hatching success of 78.4%) produced hatchlings, of which 28,078 (an emergence success of 77.1%) emerged from the nest (Table 3). It was to be expected that hatching success would be lower, given that the predated eggs cannot be counted.

The nest count varied considerably, ranging from a minimum of 85 nests in 2019 to a maximum of 195 nests in 2022, indicating a 129% difference. The nest count exhibited a statistically insignificant monotonic upward trend (Table 4, Figure 3). The estimated FN counts on Yeniyurt Beach between 2017 and 2022 are presented in Table 2. The percentage change in the minimum and maximum number of females was 129% for both estimates (OCF and ECF). The OCF estimated the overall FN count to be 276, while the ECF estimated it to be 133. Therefore, OCF estimated the total mean FN count on Yeniyurt Beach to be 138.5, while the ECF estimated it to be 67. The current FN count on Yeniyurt Beach was estimated by the OCF as 172.5 and as 83.5 by the ECF. The Durbin–Watson test indicated that there was no autocorrelation in the residuals for either the OCF or ECF. The estimated female abundance exhibited an insignificant monotonic upward trend (Table 4, Figure 3).

## 4. Discussion

This paper presented the results of long-term monitoring investigations conducted for the first time on Yeniyurt Beach, which currently lacks any form of protected status. In 2017, Sert et al. (2019) were the first to visit the beach

**Table 2.** Comparison of the nest counts and female abundance between 2017 and 2022 on Yeniyurt Beach (the abundance values were estimated by two distinct methodologies, based on the OCF and ECF).

| Year | Nests (n) | Inundation nests (n) | Predated nests (n) | Abundance with OCF (n) | Abundance with ECF (n) | Nest density (nest km$^{-1}$) |
|---|---|---|---|---|---|---|
| **2017** | 107 | - | 7 | 36.9 | 17.8 | 26.8 |
| **2018** | 108 | 7 | 13 | 37.2 | 18 | 27 |
| **2019** | 85 | - | 15 | 29.3 | 14.2 | 21.3 |
| **2020** | 125 | 13 | 12 | 43.1 | 20.8 | 31.3 |
| **2021** | 183 | 8 | 16 | 63.1 | 30.5 | 45.8 |
| **2022** | 195 | - | 7 | 67.2 | 32.5 | 48.8 |
| **Overall** | 803 | 28 | 70 | 277 | 134 | 201 |
| **Mean** | 133.3 | 5.3 | 11 | 46 | 22.3 | 33.5 |

n: Number

**Table 3.** Variation in the reproductive output between 2018 and 2021 on Yeniyurt Beach (2017 and 2022 were not included, as no nest excavation was carried out).

| Year | Excavated nests (n) | Clutch size (n) | Mean clutch size (n) | Hatched eggs (n) | Hatchlings (n) | Dead embryos (n) | Unhatched eggs (n) | Dead hatchlings in and out of the nest (n) | Mean hatching success (%) |
|---|---|---|---|---|---|---|---|---|---|
| **2018** | 20 | 1882 | 94.1 | 1377 | 1316 | 159 | 346 | 61 | 73.1 |
| **2019** | 70 | 7362 | 105.2 | 6274 | 6154 | 314 | 774 | 120 | 85.2 |
| **2020** | 82 | 9488 | 115.7 | 6839 | 6672 | 1183 | 1466 | 167 | 72.1 |
| **2021** | 154 | 17,662 | 114.6 | 14,056 | 13,936 | 928 | 2678 | 120 | 79.5 |
| **Overall** | 326 | 36,394 | 107.4 | 28,546 | 28,078 | 2584 | 5264 | 468 | 78.4 |

n: Number

**Table 4.** Durbin–Watson, Mann–Kendal Trend, and Sen's Slope analysis results of the variables based on a long-term survey on Yeniyurt nesting beach.

| Variable | Durbin–Watson | p-value | Mann–Kendall tau | p-value | Sen's slope | 95% CI |
|---|---|---|---|---|---|---|
| **Nest count** | 1.4171 | 0.388 | 0.733 | 0.0603 | 19 | –14.6–51.7 |
| **Abundance with OCF** | 1.4171 | 0.378 | 0.734 | 0.0603 | 6.5 | –5.03–17.8 |
| **Abundance with ECF** | 1.4171 | 0.378 | 0.734 | 0.0603 | 3.1 | –2.4–8.6 |

and identify it as a possible nesting site for green turtles. They visited the beach once and reported a total of 114 nests and a nest density of 38 km$^{-1}$. Subsequently, Turan et al. (2020) performed a comprehensive study on the beach in 2019, monitoring the beach throughout the entire season. They found a total of 85 nests and calculated a nest density of 21.2 km$^{-1}$. In the Mediterranean population, the nest count and density vary across nesting beaches. For example, on Akyatan Beach, the average nest count was reported to range between 366 and 387, with a nest density between 16 and 17.6 km$^{-1}$ (Yılmaz et al., 2015, 2022). The average nest count on Samandağ Beach was reported as 774 with a nest density of 55.3 km$^{-1}$ (Sönmez et al., 2024). In comparison, Rees et al. (2010) reported a nest count of 140 with a nest density of 12 km$^{-1}$ on Lattakia Beach in Syria. Ilgaz and Baran (2001) reported 22 nests with a density of 9.2 km$^{-1}$ in Northern Karpaz, Cyprus. In contrast, the nest count was 154 and the density was 44 km$^{-1}$ on Alagadi Beach, Cyprus (Casale et al., 2018). A six-year study on Davultepe Beach in Türkiye reported an average of 105 nests and a nest density of 37.2 km$^{-1}$ (Ergene et al., 2016).

The current study recorded an average of 133 nests and a nest density of 33.5 km$^{-1}$ on Yeniyurt Beach over six years. This nest count indicates that Yeniyurt Beach has a "high" level of nesting activity. Casale et al. (2018) categorized breeding sites according to the nest count, determining that a beach with an annual average of 100 to 300 nests should be considered to exhibit high nesting activity. Yeniyurt Beach has a high nesting activity rate, accounting for approximately 6% of the entire Mediterranean nesting population and 9% of the nests on the whole Turkish coast (Casale et al., 2018). The relatively large number of

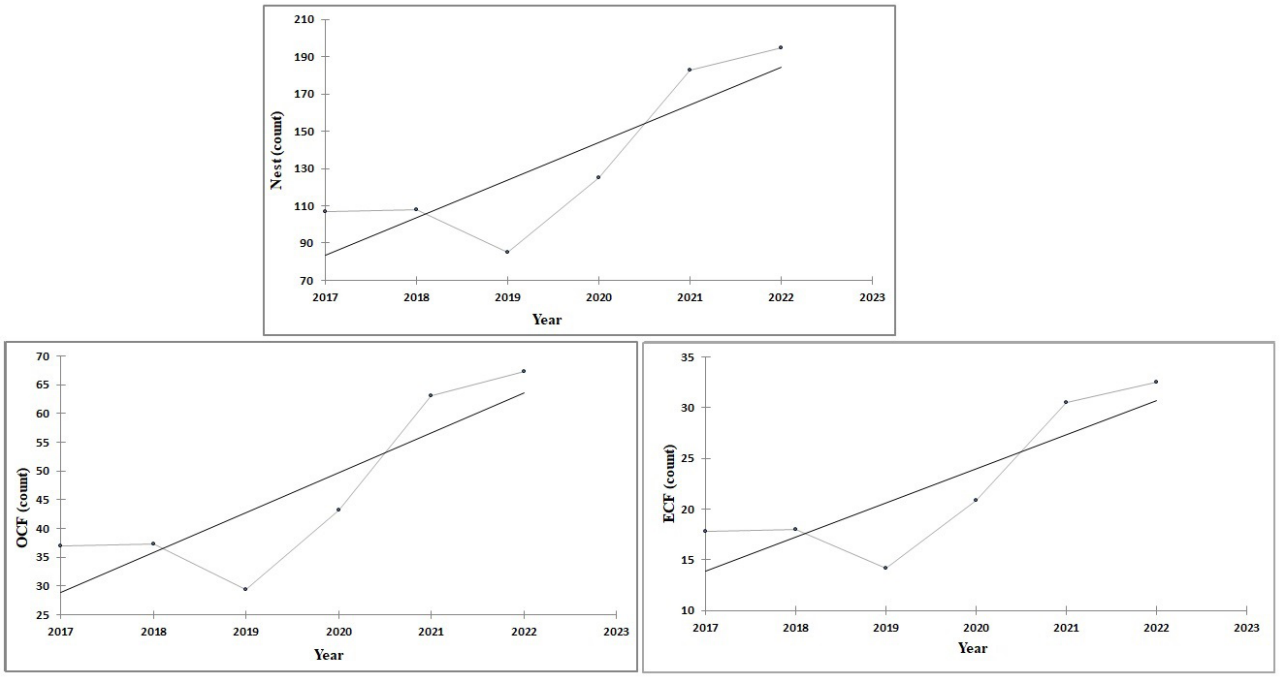


**Figure 3.** Temporal variation of the nest count and female abundance estimated via the OCF and ECF between 2017 and 2022.

nesting events on Yeniyurt Beach clearly demonstrate its crucial significance as a breeding site for green turtles in the Mediterranean. However, it should not be forgotten that it is important for the future of the population to reveal the contributions to genetic diversity and sex ratio for the Mediterranean population, as well as the high nest count in future studies.

A nonsignificant monotonic upward increase in nest count was found on Yeniyurt Beach over a six-year period. This is consistent with a report that roughly 75% of all sea turtle populations are increasing (Mazaris et al., 2017). For example, there have been reports of an increase in the number of green turtles nesting on Aldabra Atoll in the western Indian Ocean (Pritchard et al., 2022) and Cayman Island in the Caribbean Sea (Blumenthal et al., 2021). Moreover, Casale et al. (2018) stated that there was a substantial 47% increase in the green turtle nest count in the Mediterranean. For example, the green turtle nest count on Akyatan Beach has exhibited an increasing tendency (Yılmaz et al., 2022). In addition, Sönmez et al. (2024) documented an upward trend in the green turtle nest count and female abundance on Samandağ Beach. Moreover, female abundance also increased insignificantly in the present study, with a 129% change in the minimum and maximum number of females (with both the OCF and ECF). The percentage change in the female abundance on Akyatan Beach was given as 1.3% (Yılmaz et al., 2022). Omeyer et al. (2021) calculated this value as 337% at Alagadi Beach. Moreover, the percentage change in female abundance at Samandağ Beach was reported as 769% for the OCF and 764% for the ECF (Sönmez et al., 2024). Although it is presumed that the observed increase in the abundance of female individuals in recent years will exert a beneficial effect, it is also essential to ascertain the extent to which the beaches contribute to the Mediterranean population. In this context, Yeniyurt Beach contributes 5% and 4% to the FN count in the Mediterranean, according to both the OCF and ECF, respectively (Casale and Heppell, 2016).

It is unclear whether the increase in the nest count will be sufficient to return the green turtle to its previous levels of abundance in the Mediterranean population. Moreover, an increase in the nest count is expected to lead to substantial reproductive output, encompassing successful hatching (Sönmez et al., 2024). However, on Yeniyurt Beach, approximately 12% of the total nests (98 nests) were exposed to either flooding or destruction by predators such as foxes. This has the potential to significantly reduce the expected hatching success or entry into the marine area. Therefore, it is recommended to carry out additional research to mitigate these adverse consequences in subsequent endeavors. In addition to successful reproductive output, it is also important to reduce post-pelagic anthropogenic mortality (Omeyer et al., 2021; Sönmez et al., 2024). Hence, it is crucial to mitigate the negative effects, specifically those occurring in marine areas, on juveniles, males, and females.

Given its contribution to the Mediterranean population in terms of nest count and abundance, Yeniyurt Beach can be

considered as a potential new nesting beach for green turtles. The first detailed study along the Aegean and Mediterranean coasts of Türkiye identified 17 nesting beaches for green turtles and loggerhead turtles (Baran and Kasparek, 1989). In the following years, monitoring studies continued along the Turkish coast, and new nesting beaches were found, such as Antalya's Çıralı Beach (Sönmez et al., 2021), Adana's Sugözü beaches (Canbolat et al., 2005), Alata, Mersin (Ergene et al., 2006), and Davultepe, Mersin (Ergene et al., 2016). Casale and Ceriani (2019) stated that despite all the studies based on the relevant literature, new nesting beaches can always be found. In a recent study, it was reported that Yakacık Beach in Gazipaşa, Antalya Province, could be a potential nesting beach for loggerhead turtles (Sözbilen, 2024).

Recent reports have indicated an increase in sporadic nesting along the northwest Mediterranean coast. For example, Mazaris et al. (2023) reported the presence of 25 sporadic nesting beaches along the Aegean coasts of Türkiye and Greece. Furthermore, a total of 25 nests were reported to be laid on sporadic nesting beaches along the Turkish coasts of Çanakkale, Aydın, and İzmir provinces (Sürücü et al., 2017; Başkale et al., 2018; Yalçın Özdilek et al., 2020; Sandık et al., 2023). A recent study reported that a total of 54 loggerhead turtle nests were laid on sporadic nesting beaches along western Antalya (Şirin and Başkale, 2024). It has been estimated that these sporadic nests in western Antalya contribute only 1%–2% of the total nests in Türkiye annually (Şirin and Başkale, 2024).

Sporadic nesting records for the green turtle are relatively lower than for the loggerhead turtle. On sporadic nesting beaches along the southwestern Mediterranean coast of Türkiye (Kumluca, Patara, and Göcek-Fethiye), green turtles laid a total of five nests (Olgun et al., 2016; Başkale et al., 2018; Maden et al., 2022). Future niche modeling of sea turtle distribution based on climatic data predicts that green turtles will not spread from existing nesting beaches (Arslan et al., 2023). Small beaches and other remote, inaccessible beaches still serve as nesting beaches for sea turtles. Therefore, it is important to identify possible unrecognized or unreported green turtle nesting beaches and conduct detailed surveys in these areas.

### 4.1. Conservation implications

The absence of a protected status for Yeniyurt Beach makes it vulnerable to certain risks, including urbanization and industrial investment. The area of the beach designated as a reference point is utilized as a public beach. This scenario will lead to a rise in nocturnal coastal activity, thus resulting in an escalation of light pollution. In addition, the beach is prone to the collection of marine debris that is carried from the sea. The beach cleaning, particularly before the start of the nesting season, will clearly have a positive effect on the female nesters and their hatchlings. Furthermore, it is imperative to save and rehabilitate the ecosystem in the inland area adjacent to the shore to mitigate the potential for inundation. To minimize the influence of predators, such as foxes, on the southern part of the beach, it is advisable to promote the use of nest protection cages.

### 4.2. Study limitations

The most obvious limitation of the study was that in most years, the nesting surveys were limited to only one or three days during the entire season. This may have led to the possibility that some nests may have been missed, resulting in a low total nest count. The first detailed sea turtle monitoring study in Türkiye counted nests in three separate periods, using single-day counts based on the emergence of adults and hatchlings (Baran and Kasparek, 1989). In addition, Yakacık Beach, which has been proposed as a potential loggerhead nesting beach, was monitored twice in two years (Sözbilen, 2024). The SWOT Scientific Advisory Board has stated that any monitoring protocol that limits the error in nesting abundance estimates within a season to <20% is acceptable (SWOT, 2011). Note that the predefined objectives of a monitoring project should guide the choice of monitoring protocol on nesting beaches (SWOT, 2011). In this study, due to logistical constraints, nest counting was carried out intermittently as it was desired to see the general trend in the total nest count and female abundance estimates. This demonstrates the importance of determining the objectives of a monitoring study before designing a beach survey.

## 5. Conclusions

The results of the six-year study suggest that Yeniyurt Beach exhibits a significant level of nesting activity. Moreover, the results suggest that Yeniyurt Beach contributes to 6% of the nests and 5% of the female abundance in the Mediterranean. Conversely, the primary concerns on the beach pertain to the potential for flooding and predation. The most significant outcome is that the beach should be given protection status as soon as possible.

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**Competing interests**

The author has no relevant financial or nonfinancial interests to disclose.

**Author contributions**

BS conceived the ideas, designed the methodology, analyzed the data, and wrote the manuscript.

## References


Arslan G, Ertürk A, Candan O (2023). Predicting the distribution of green turtle nesting sites over the Mediterranean with outcoming climate driven changes. Journal for Nature Conservation 71: 126320. https://doi.org/10.1016/j.jnc.2022.126320

Baran I, Kasparek M (1989). Marine turtles of Turkey: status survey 1988 and recommendations for conservation and management. Heidelberg, Germany.

Başkale E, Sözbilen D, Katılmış Y, Azmaz M, Uzuner M et al. (2018). The sporadic nesting sites of loggerhead and green turtles on western Anatolian coasts. In: Proceedings of the 38th Annual Symposium on Sea Turtle Biology and Conservation Kobe, Japan, Pp. 237.

Blumenthal JM, Hardwick JL, Austin TJ, Broderick AC, Chin P et al. (2021). Cayman Islands sea turtle nesting population increases over 22 years of monitoring. Frontiers in Marine Science 8: 461. https://doi.org/10.3389/fmars.2021.663856

Broderick AC, Glen F, Godley BJ, Hays GC (2002). Estimating the number of green and loggerhead turtles nesting annually in the Mediterranean. Oryx 36 (3): 227-235. https://doi.org/10.1017/S0030605302000431

Broderick AC, Godley BJ, Hays GC (2001). Trophic status drives interannual variability in nesting numbers of marine turtles. Proceedings of the Royal Society B: Biological Sciences 268 (1475): 1481-1487. https://doi.org/10.1098/rspb.2001.1695

Broderick AC, Türkozan O, Demetropoulos S, Mastrogiacomo A, Demetropoulos A et al. (2023). *Chelonia mydas* (Mediterranean subpopulation). The IUCN Red List of Threatened Species 2023. https://doi.org/10.2305/IUCN.UK.2023-1.RLTS.T4616A83319449.en

Canbolat AF, Atatunç K, Candan O, Barcak D (2005). A new green turtle (*Chelonia mydas*) nesting site in the Mediterranean: Sugözü beaches, Adana (Turkey). In: Second Mediterranean Conference on Marine Turtles, Türkiye. P. 15.

Casale P, Ceriani SA (2019). Satellite surveys: a novel approach for assessing sea turtle nesting activity and distribution. Marine Biology 166: 47. https://doi.org/10.1007/s00227-019-3494-4

Casale P, Heppell SS (2016). How much sea turtle bycatch is too much? A stationary age distribution model for simulating population abundance and potential biological removal in the Mediterranean. Endangered Species Research 29: 239-254. https://doi.org/10.3354/esr00714

Casale P, Broderick AC, Camiñas JA, Cardona L, Carreras C et al. (2018). Mediterranean sea turtles: current knowledge and priorities for conservation and research. Endangered Species Research 36: 229-267. https://doi.org/10.3354/esr00901

Ceriani SA, Casale P, Brost M, Leone EH, Witherington BE (2019). Conservation implications of sea turtle nesting trends: elusive recovery of a globally important loggerhead population. Ecosphere 10 (11): e02936. https://doi.org/10.1002/ecs2.2936

Ergene S, Aymak C, Uçar AH (2006). Nesting activity of the marine turtles (*Chelonia mydas* and *Caretta caretta*) during 2005 in Alata, Mersin-Turkey. In: Book of Abstracts, 26th Annual Symposium on Sea Turtle Biology and Conservation. Island of Crete, Greece. p. 293

Ergene S, Ergene M, Uçar AH, Aymak C, Kaçar Y (2016). Identification of a new nesting beach in Mersin, Turkey: Nesting activity of green and loggerhead sea turtles over 6 nesting seasons (2009-2014) at Davultepe Beach. Marine Turtle Newsletter 149: 6-9.

Esteban N, Mortimer JA, Hays GC (2017). How numbers of nesting sea turtles can be overestimated by nearly a factor of two. Proceedings of the Royal Society B: Biological Sciences 284: 20162581. https://doi.org/10.1098/rspb.2016.2581

Godley BJ, Barbosa C, Bruford M, Broderick AC, Catry P et al. (2010). Unravelling migratory connectivity in marine turtles using multiple methods. Journal of Applied Ecology 47(4): 769-778. https://doi.org/10.1111/j.1365-2664.2010.01817.x

Hawkes LA, Tomas J, Revuelta O, León YM, Blumenthal JM et al. (2012). Migratory patterns in hawksbill turtles described by satellite tracking. Marine Ecology Progress Series 46: 223-232. https://doi.org/10.3354/meps09778

Hipel KW, McLeod AI (1994). Time series modeling of water resources and environmental systems. Elsevier, Amsterdam, The Netherlands.

Ilgaz Ç, Baran İ (2001). Reproduction biology of the marine turtle populations in Northern Karpaz (Cyprus) and Dalyan (Turkey). Zoology in the Middle East 24 (1): 35-44. https://doi.org/10.1080/09397140.2001.10637884

Karaman S, Turkozan O, Carreras C, Yılmaz C, Sönmez B et al. (2022). Population genetic diversity of green turtles, *Chelonia mydas*, in the Mediterranean revisited. Marine Biology 169: 77. https://doi.org/10.1007/s00227-022-04068-1

Maden M, Ayyıldız H, Altın,A, Alver C (2022). The nesting activity of sea turtles (*Chelonia mydas* and *Caretta caretta*): Results of 2017 monitoring study on Kumluca Beach. Acta Natura et Scientia 3(1): 77-84. https://doi.org/10.29329/actanatsci.2022.351.09

Mazaris AD, Schofield G, Gkazinou C, Almpanidou V, Hays GC (2017). Global sea turtle conservation successes. Science Advances 3 (9): e1600730. https://doi.org/10.1126/sciadv.1600730

Mazaris AD, Dimitriadis C, Türkozan O, Papazekou M (2023). Sea turtles in the Aegean Sea. In: Anagnostou CL, Kostianoy AG, Mariolakos ID, Panayotidis P, Soilemezidou M, Tsaltas G (editors). The Aegean Sea Environment. The Handbook of Environmental Chemistry, vol 129. Springer, Cham. https://doi.org/10.1007/698_2023_1043

Marcovaldi MA, Lopez GG, Soares LS, Santos AJB, Bellini C et al. (2007). Fifteen years of hawksbill sea turtle (*Eretmochelys imbricata*) nesting in northern Brazil. Chelonian Conservation and Biology 6: 223-228. https://doi.org/10.2744/1071-8443(2007)6[223:FYOHST]2.0.CO;2

Olgun K, Bozkurt E, Ceylan S, Tural M., Özcan S et al. (2016). Nesting activity of sea turtles, *Caretta caretta* (Linnaeus, 1758) and *Chelonia mydas* (Linnaeus, 1758) (Reptilia, Cheloniidae), at Patara Beach (Antalya, Turkey) over four nesting seasons. Turkish Journal of Zoology 40 (2): 215-222. https://doi.org/10.3906/zoo-1505-8

Omeyer LCM, Stokes KL, Beton D, Çiçek BA, Davey S et al. (2021). Investigating differences in population recovery rates of two sympatrically nesting sea turtle species. Animal Conservation 24: 832-846. https://doi.org/10.1111/acv.12689

Patricio AR, Varela MR, Barbosa C, Broderick AC, Airaud MBF et al. (2018). Nest site selection repeatability of green turtles, *Chelonia mydas*, and consequences for offspring. Animal Behaviour 139: 91-102. https://doi.org/10.1016/j.anbehav.2018.03.006

Pritchard AM, Sanchez CL, Bunbury N, Burt AJ, Currie JC et al. (2022). Green turtle population recovery at Aldabra Atoll continues after 50 yr of protection. Endangered Species Research 47: 205-215. https://doi.org/10.3354/esr01174

Rees A, Saad A, Jony M (2010). Syria. In: Casale P, Margaritoulis D (editors). Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities. IUCN, Gland, Switzerland, p 233-243.

Sandık E, Dermancı P, Sönmez B, Özdilek ŞY (2023). First record on Loggerhead nest in Gökçeada, Türkiye in Northern Aegean. Commagene Journal of Biology 7: 171-173. https://doi.org/10.31594/commagene.1383679

Sen PK (1968). Estimates of the regression coefficient based on Kendall's Tau. Journal of the American Statistical Association 63: 1379-1389. https://doi.org/10.1080/01621459.1968.10480934

Sert M, Sönmez B, Yalçın Özdilek Ş (2017). Hatay kıyılarında yeşil deniz kaplumbağası (*Chelonia mydas*) populasyonu için potansiyel yeni bir yuvalama kumsalı: Dörtyol/Yeniyurt kumsalı. V. Ulusal Deniz Kaplumbağaları Sempozyumu, Kuşadası/Aydın, pp:36 (in Turkish).

Shimada T, Limpus CJ, Hamann M, Bell I, Esteban N et al. (2020). Fidelity to foraging sites after long migrations. Journal of Animal Ecology 89: 1008-1016. https://doi.org/10.1111/1365-2656.13157

Sönmez B, Mestav B, Yalçın Özdilek Ş (2024). A 21-year recovery trend in green turtle nesting activity: 2002-2022. Aquatic Conservation: Marine and Freshwater Ecosystems 34 (1): e4043. https://doi.org/10.1002/aqc.4043

Sönmez B (2018). Sixteen year (2002-2017) record of sea turtle strandings on Samandağ Beach, the eastern Mediterranean coast of Turkey. Zoological Studies 57: e53. https://doi.org/10.6620/ZS.2018.57-53

Sönmez B (2019). Morphological variations in the green turtle (*Chelonia mydas*): A field study on an eastern Mediterranean nesting population. Zoological Studies 58: e16. https://doi.org/10.6620/ZS.2019.58-16

Sönmez B, Elginöz E, Ilgaz M, Altınkaya H (2021). Nesting activity of loggerhead turtles (2013–2020) and 20 years abundance trend (2001–2020) on Çıralı Beach, Turkey. Regional Studies in Marine Science 44: 101758. https://doi.org/10.1016/j.rsma.2021.101758

Sözbilen D (2024). A potential nesting site for loggerhead turtle (*Caretta caretta*): Yakacık beach, Türkiye. Commagene Journal of Biology 8 (1): 1-8. https://doi.org/10.31594/commagene.1359514

Sürücü B, Çetinkaplan B, İnanç S, Taşcı A, Kurt G (2017). Deniz kaplumbağa yuvalama bölgeleri dışında yuva; Kuşadası (Aydın)'nda, iribaş deniz kaplumbağa yuvaları V. Ulusal Deniz Kaplumbağaları Sempozyumu, Kuşadası/Aydın, pp: 41 (in Turkish).

SWOT Scientific Advisory Board (2011). The state of the world's sea turtles (SWOT) minimum data standards for nesting beach monitoring. Technical Report, 24 pp.

Şirin A, Başkale E (2024). New sporadic nesting sites of loggerhead turtles (*Caretta caretta*) on the western Antalya coast, Türkiye. Zoology in the Middle East 70 (2): 104-110. https://doi.org/10.1080/09397140.2024.2359171

Turan C, Sönmez B, Gürlek M, Doğdu S, Ayas D et al. (2021). The investigations of the nesting status of the Green turtle *Chelonia mydas* on Yeniyurt beach (Hatay) in the Northeastern Mediterranean, Turkey. Ecological Life Sciences 16 (1): 40-47. https://doi.org/10.12739/NWSA.2021.16.1.5A0147

Van Houtan KS, Kittinger JN (2014). Historical commercial exploitation and the current status of Hawaiian green turtles. Biological Conservation 170: 20-27. https://doi.org/10.1016/j.biocon.2013.11.011

Wallace BP, Di Matteo AD, Bolten AB, Chaloupka MY, Hutchinson BJ et al. (2011). Global conservation priorities for marine turtles. PLoSONE 6 (9): e24510. https://doi.org/10.1371/journal.pone.0024510

Wallace BP, Posnik ZA, Hurley BJ, DiMatteo AD, Bandimere A et al. (2023). Marine turtle regional management units 2.0: an updated framework for conservation and research of wide-ranging megafauna species. Endangered Species Research 52: 209-223. https://doi.org/10.3354/esr01243

Yalçın Özdilek Ş (2007). Status of sea turtles (*Chelonia mydas* and *Caretta caretta*) on Samandağ Beach, Turkey: a five-year monitoring study. Annales Zoologici Fennici 44 (5): 333-347.

Yalçın-Özdilek Ş, Kırbeci S, Yalçın S, Altın A, Uzatıcı A et al. (2020). The first record of loggerhead turtle (*Caretta caretta*) nesting on the northernmost Aegean coast, Turkey. Natural and Engineering Sciences 5: 198-203. https://doi.org/10.28978/nesciences.833003

Yılmaz C, Oruç A, Türkozan O (2015). Marine turtles (*Chelonia mydas* and *Caretta caretta*) nesting along the eastern Mediterranean coast of Turkey: Results from six years of surveying. Herpetological Journal 25: 197-204.

Yılmaz C, Oruç A, Türkozan O (2022). Abundance trend and nesting biology of green turtles *Chelonia mydas* (Testudines: Cheloniidae) during ten consecutive nesting seasons (2012-2021) at Akyatan Beach, Turkey. Zoological Studies 61: 53. https://doi.org/10.6620/ZS.2022.61-53