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***Research Article/Araştırma Makalesi***

# A Potantial Nesting Site for Loggerhead Turtle (*Caretta caretta*): Yakacık Beach, Türkiye

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**Abstract:** Monitoring of sea turtle nesting beaches in Türkiye have been conducted since 1988 and the number of beaches reached to 22. Mediterranean coast of Türkiye has many small pocket beaches and other inaccessible remote sandy beaches. In this study, I introduce a new nesting site, Yakacık Beach, for the loggerhead turtles (*Caretta caretta*) in the border of Antalya and Mersin provinces. Following the preliminary field studies on the 1.7 km long beach, 201 and 197 nests were found in 2020 and 2021, respectively, and the average nest density of the two years was calculated as 117.6 nests/km$^{-1}$. Satellite images were also used to ensure and estimate the number of nests. The number of nest and the nest density were compared with the literature and Yakacık has the second highest nest density in Türkiye with a high predation rate up to 68%. The potential importance of Yakacık Beach and threats to the nesting beach and mitigation measures were discussed. Türkiye has one of the most important nesting sites for the loggerhead turtles and the green sea turtles (*Chelonia mydas*) in the Mediterranean, with 17 nesting beaches identified in 1989. With the discovery of additional nesting sites such as Çıralı, Alata, Sugözü, Davultepe, and METU-Kocahasanlı beaches in the following years, the importance of Türkiye for sea turtle populations in the Mediterranean has gradually increased. With this study, a new nesting beach was identified and the importance of Türkiye for the Mediterranean Sea turtles was emphasized.

**Keywords:** Sea turtle, Mediterranean, New nesting site, Satellite imagery.

## İribaşlı Deniz Kaplumbağası (*Caretta caretta*) için Potansiyel Bir Yuvalama Alanı: Yakacık Kumsalı, Türkiye

**Öz:** Türkiye'de yuvalama kumsallarının izlenmesi 1988 yılından beri sürdürülmektedir ve toplam yuvalama kumsalı 22'ye ulaşmıştır. Türkiye'nin Akdeniz kıyılarında çok sayıda küçük cep kumsalları ve diğer erişilemeyen uzak kumsallar bulunmaktadır. Bu çalışmada, Antalya ve Mersin illeri sınırında iribaşlı deniz kaplumbağası (*Caretta caretta*) için yeni bir yuvalama alanı olan Yakacık Kumsalı sunulmuştur. Toplam 1,7 km uzunluğundaki kumsalda ön arazi çalışmalarının ardından 2020 ve 2021 yıllarında yapılan çalışmalarda sırasıyla 201 ve 197 yuva bulunmuş ve iki yılın ortalaması olarak yuva yoğunluğu 117,6 yuva/km$^{-1}$ olarak hesaplanmıştır. Yuvalama dönemi boyunca yuva sayısını tahmin etmek için uydu görüntüleri de kullanılmıştır. Yuva sayısı ve yuva yoğunluğu literatürle karşılaştırılmış ve Yakacık'ın yüksek predasyon oranıyla (~%68) Türkiye'deki en yüksek ikinci yuva yoğunluğuna sahip kumsal olduğu tespit edilmiştir. Yakacık Kumsalı'nın potansiyel önemi tartışılmış ve yuvalama kumsalına yönelik tehditler ve azaltım önlemleri ele alınmıştır. Türkiye, 1989'da tanımlanan 17 yuvalama kumsalı ile birlikte iribaşlı kaplumbağa ve yeşil kaplumbağa (*Chelonia mydas*) için Akdeniz'deki en önemli yuvalama alanlarını barındıran ülkelerdendir. Sonraki yıllarda Çıralı, Alata, Sugözü, Davultepe, ODTÜ-Kocahasanlı kumsalları gibi ek yuvalama alanlarının keşfi, Akdeniz'deki iribaş deniz kaplumbağası ve yeşil deniz kaplumbağası popülasyonları için Türkiye'nin önemi giderek artmıştır. Bu çalışma ile yeni bir yuvalama kumsalı daha tanımlanırken Türkiye'nin Akdeniz deniz kaplumbağaları için önemi vurgulanmıştır.

**Anahtar kelimeler:** Deniz kaplumbağası, Akdeniz, Yeni yuvalama alanı, Uydu görüntüsü.

## 1. Introduction

Sea turtles in the Mediterranean are important species for which conservation efforts have gradually increased since the 1980s and which have also contributed to increasing public awareness as a flagship species in conservation studies. Two species of sea turtles nesting in the Mediterranean are the Loggerhead Turtle (*Caretta caretta*) and Green Turtle (*Chelonia mydas*) and both species are nesting in sandy beaches of Turkish coastline (Casale et al., 2018). The loggerhead turtle, one such charismatic species, is categorized as ''Vulnerable'' (VU) globally (Casale and Tucker, 2017), while the Mediterranean subpopulation is categorized as the ''Least Concern'' (LC) with conservation dependent (Casale, 2015) according to the International Union for Conservation of Nature (IUCN).

Especially after the mid-80s, studies on sea turtles started to increase in Türkiye and afterwards, a major survey was carried out on the Aegean and Mediterranean coasts of Türkiye in 1988. As a result of this study, 17 sea turtle nesting beaches were identified, 13 (10 for loggerhead turtles, 3 for green turtles) of which were determined as major nesting beaches (Baran and Kasparek 1989). In 1988, in this first detailed study covering the entire Mediterranean coast of Türkiye, nests were counted in three separate periods with single-day counts based on beach tracks and hatchling emergence and beaches with high nesting density were identified as main nesting beaches, while beaches with low nesting density were defined as minor but important. Since then, the studies carried out on the coasts of Türkiye have continued and new nesting beaches have been identified such as Çıralı

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Beach, Antalya for the loggerhead turtle (Sönmez et al.2021), and Sugözü Beaches, Adana (Canbolat et al.2005), Alata, Mersin (Ergene et al. 2006), Davultepe, Mersin (Ergene et al. 2016), and Middle East Technical University (METU), Mersin for the Green sea turtle (Kıdeyş and Özkan 2019). There are several papers reviewing nesting beaches in Türkiye and their nesting data (i.e., Canbolat 2004, Türkozan & Kaska, 2010). Five of these beaches (Dalyan, Fethiye, Patara, Belek, and Göksu Delta), as they were designated as specially protected area, have been monitored every year since 1990 with the coordination of the Ministry of Environment, Urbanization and Climate Change. There are other beaches (Dalaman-Sarıgerme, Çıralı, Kumluca, Manavgat, Demirtaş, Anamur, Alata, Kazanlı, Akyatan, Yumurtalık-Sugözü, and Samandağ) monitored by the local NGOs, universities and government officials but some of the beaches (Ekincik, Demre, Tekirova, Kızılot, Gazipaşa, and Davultepe) identified have not been monitored on a regular basis making a total of 22 nesting beaches in Türkiye (Tebliğ, 2020). Although, almost entire Mediterranean coasts of Türkiye have been monitored for sea turtle activities in the last 35 years.

In this paper, it is aimed to present the monitoring results of Yakacık Beach on the border of Antalya and Mersin provinces, which is an unknown nesting beach for loggerhead turtles, and the results on nesting biology and beach characteristics of this new area.

## 2. Material and Methods

### 2.1. Study area

Yakacık is a 1.7 km long beach located between 36°06.026'N 32°33.639'E and 36°05.546'N 32º34.561'E. The location of Yakacık Beach is shown in Figure 1 with other nesting beaches. In the north-western part of the beach, the Kaledran stream, which is the borderline of Antalya and Mersin provinces, flows into the sea. Yakacık Beach is between two important loggerhead turtle nesting beaches, Gazipaşa (30 km as the crow flies) in the west and Anamur (25 km as the crow flies) in the east. Although green turtle nests have been detected in these areas, this region is located in an area where loggerhead turtles are predominantly nesting. The beach has a width ranging from 8 to 36 meters wide and a fine sand structure. The general view of the beach and land use is given in Figure 2.

### 2.2. Beach Surveys

The beach was visited for the first time in 2017 and it was found that there was intensive nesting, and when it was visited again in 2018 and 2019, it was observed that nesting activity continued at the same intensity. The beach was then surveyed in detail for one day on September 1, 2020 and September 13, 2021. During these surveys, sea turtle activities were checked all over the beach, nests with hatchling tracks and predated nests were identified. Since it was at the end of the nesting season, fresh nest and non-nesting emergences could not be detected. Various standards are used to recognize and monitor a beach as a nesting beach. One of the most valid methods is the number of clutch criterion and to verify a sea turtle activity as a nest; 1) direct observation of nesting, 2) excavation for egg detection in an area with fresh tracks, 3) confirmation by observing eggs in a nesting area, and 4) observing hatchling emergence in specific nesting areas (SWOT 2011). In this study, the criteria in items 3 and 4 were used. In the implementation of Criteria 3 and 4, the following three conditions were sought; 1) sand was dug and eggs were observed, 2) tracks of hatchling emergence were observed, and 3) predated eggs were detected. Any tracks where no eggs were observed were not recorded as a nest. The coordinates of the identified nests were taken with GPS Status Android based mobile application. The length of the high-tide line from the sea and to the total distance of the nest from the sea was measured with tape measure.

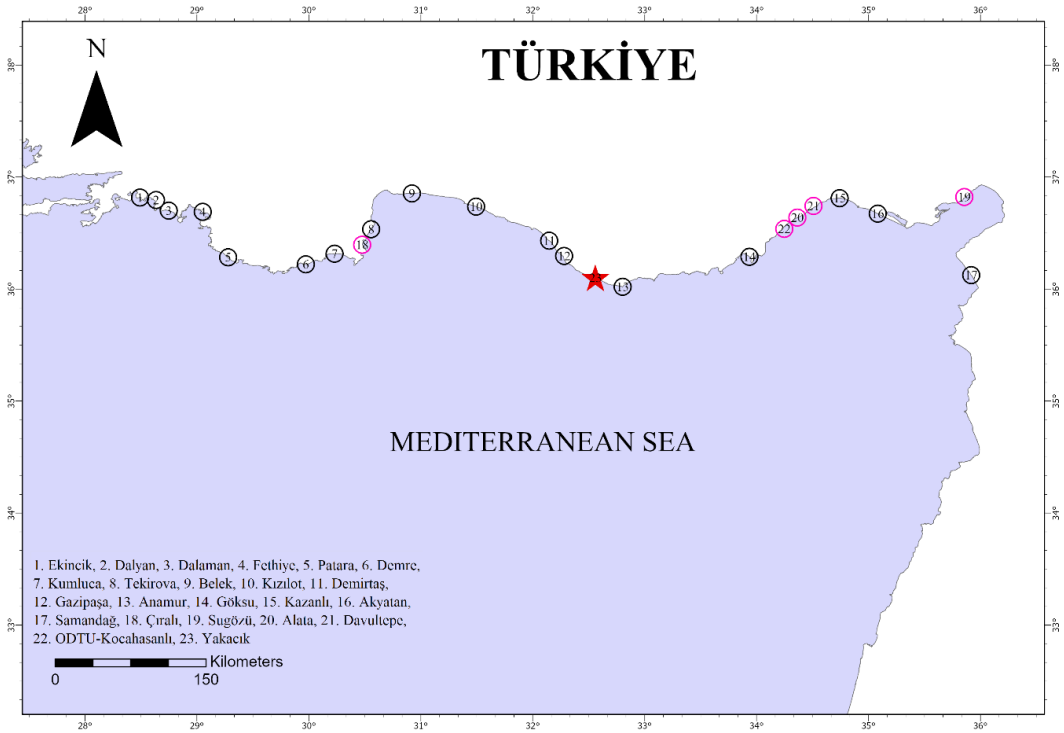


Figure 1. The main nesting beaches in Türkiye and the location of Yakacik (red asterisk). Black circles represent the first 17 beaches identified; pink circles represent the nesting beaches recognized later.


Figure 2. General view of Yakacık Beach. (Blue polygon represents agricultural area in hinterland)

Additionally, dead hatchlings and embryos were detected in the excavated nests.

Due to time constraints, not all of the nests where hatching emergence was detected could be excavated. For this reason, some of the nests with hatchlings were excavated randomly and nest information was obtained. Empty eggshells, unfertilized eggs, and dead embryos were identified and counted and hatching success was calculated as the ratio of empty eggshell to the total number of eggs (Table 1). Nest content and the embryonic development were determined according to Withmore and Dutton (1985). To verify the nest, the nests that dug to observe eggs were later covered and the term excavated nest was used for nests where a full nest count was made.

Table 1. The Mean distances of the nests from the sea

| | Year | N | Mean | StDev | Minimum | Maximum |
|---|---|---|---|---|---|---|
| High-Tide Line | 2020 | 119 | 7.96 | 1.838 | 6.0 | 12.0 |
| | 2021 | 182 | 14.38 | 6.495 | 2.5 | 34.0 |
| Distance from the Sea | 2020 | 119 | 18.81 | 5.801 | 6.5 | 32.0 |
| | 2021 | 182 | 19.84 | 6.998 | 7.0 | 44.0 |

Since the studies were carried out near the end of the nesting season in both years, it was not possible to see the density during the nesting period. Therefore, satellite images were analyzed to check the activities of female turtles during the 2021 nesting period. Casale and Ceriani (2019) suggested that satellite imagery could be a suitable method to monitor the activity of sea turtles on the nesting beach. I used Google Earth CNES/Airbus images in order to count the tracks on the beach, I determined that the satellite image with the most suitable resolution among the nesting periods was on 26 June 2021. The image of this date was followed along the beach and two sea turtle tracks were counted as one emergence by eye (Fig. 3). Only tracks that could be clearly identified as turtle tracks were counted to ensure that the activity seen during the visual count was as recent as possible and to eliminate the possibility of confusion with other artificial tracks on the beach. I was not able to determine whether an emergence ended up with a nest or not. Although previous studies have given different values for different beaches in Türkiye, approximately one out of every three emergences in Türkiye results in a nest e.g. 36,4% for Dalyan beach (Ilgaz and Baran 2001), 26.4% for Fethiye beach (Türkozan 2000), 48.5% for Kızılot (Kaska 1993), 23.6% for Göksu beach (Piggelen and Trijbosch 1993), and 28.9% for Patara beach (Canbolat 1996). I therefore calculated the number of nests by assuming that the image analyzed represents the week of 21st June 2021 and one of every third countable emergences resulted in a nest. GPS locations of all nets were tabulated and nest density map were produced by using Hot Spot Analysis Tool on ArcGIS Pro 3.0.2.

## 3. Results

A total of 201 nests were estimated in 2020 and 197 nests were estimated in 2021 as a combination of three methods (direct count, predation, and hatchling tracks) described in the materials and methods section. Then, the average nest density was calculated as 117.6 nests/km$^{-1}$ as a mean of both years. The nest density results were compared with other nesting beaches and Yakacık had the highest nest density after Dalyan Beach in Türkiye (Fig. 4). I determined that the nesting is not evenly distributed along the beach and nest density concentrated on the middle parts of the beach (Fig. 5). The average distance of the nests from the sea was 18.8 meters for 119 nests measured in 2020 and 19.8 meters for 182 nests measured in 2021 (Table 1). A total of 112 nests were predated (%55.7) in 2020 and 133 nests were predated (%67.5) in 2021 (Fig. 6). All of the predated nests detected were fully predated. I was not able to determine the nest predator mammals of all nests. Hatching was observed in 26 nests in 2020 and 14 nests in 2021. I also counted 57 sea turtle tracks on the satellite

image on the date of 26th of June 2021 and estimated nest number for the week of June 26th 2021 was 19. Nesting season usually starts in the middle of May and continues until the end of July, which we can accept that nesting period lasts for 11 weeks. Taking the June 26 is the peak nesting period, this can be calculated as the maximum number of nests could be 209, confirming my field surveys results. Hatching season ends usually at the end of September in Türkiye (Türkozan and Kaska 2010). Therefore, my surveys of hatching were in 2020 and in 2021 matches the estimated weekly nest numbers. A total of 12 nests were excavated for the determination of the clutch size and hatching success in 2020 and eight nests were excavated in 2021, these data were presented in Table 2. For all excavated nests, overall hatchling success was found to be 65.5% for 2020 and 58.0% for 2021. In 2020, 46% of the dead embryos detected were in the early period, 11.1% in the middle period and 42.9% in the late period, and in 2021, 63.4% were in the early period, 9.8% in the middle period and 26.8% in the late period. All hatchlings and dead late-stage embryos found in the nests belong to loggerhead turtles, supporting that the area is a loggerhead turtle nesting area.

**4. Discussion and Conclusion**

In this study, I introduced an unknown loggerhead turtle nesting beach. The beach is comparatively shorter than the most major loggerhead turtle nesting beaches in Türkiye but has one of the highest nest densities. While the highest loggerhead turtle nest density in published data in Türkiye is given in Dalyan, it is seen that there is a higher nest density in Yakacık Beach. The estimated annual number of loggerhead turtle nests is 6751, based on 52 regularly monitored beaches across the Mediterranean (Casale et al., 2018). This indicates that Yakacık Beach contributes 1.7% to the whole Mediterranean not only in terms of density but also in terms of total number of nests. When the whole basin is considered, the potential importance of the region is highlighted.

The fact that there is still important nesting beaches 35 years after the first detailed study in 1988 by Baran and Kasparek (1989) in Türkiye demonstrates the importance of long-term routine monitoring programs and shows that Türkiye's importance for sea turtles in the Mediterranean could be greater than estimated. An open question remains as to the reasons why nesting beaches that were identified afterwards could not be found despite the detailed surveys. One answer to this question may be that in the past, turtle activity in remote areas that could not be accessed. Another possibility is that the site has been visited before but was not recognized due to the very low number of turtle activities. Casale and Ceriani (2019) discussed this issue in detail and stated that despite all the studies based on the relevant literature, the distribution of sea turtles is far from complete and new nesting beaches can always be found. In addition, Pike (2013) stated that sea turtle breeding areas may expand due to climate change. In the last two decades, it has been reported that sporadic nesting has increased on the north-west coasts of the Mediterranean Sea in areas where sea turtle nests were not previously recorded, and that regular nesting has started to occur on some beaches (Carrera *et al.* 2018, Hochscheid *et al.* 2022, Tomillo *et al.* 2022), and that sporadic nesting records have started to be observed on the Aegean coast of Türkiye (Başkale *et al.*, 2018, Sandık *et al.*, 2023). Regardless of the reason, Yakacik Beach has become important for the loggerhead turtles in the period of time that has passed since the first detailed surveys, and investigating the origin of the population of this new nesting beach remains a subject for future research. Furthermore, sea turtle nesting beaches can still be found on the beaches in remote areas in Türkiye and detailed surveys can be carried out in areas that have not yet been surveyed in more detail.


Figure 3. Example of sea turtle activity count from satellite image (west end of the beach). Each arrow indicates a single sea turtle activity.

Table 2. Nest content of excavated nests

| Year | Empty Egg Shell | Unfertilized Eggs | Total Dead Embryos | Total Number of Eggs | Hatching success (%) |
|---|---|---|---|---|---|
| 2020 | 5 | 1 | 48 | 54 | 9,3 |
| 2020 | 50 | 0 | 13 | 63 | 79,4 |
| 2020 | 17 | 1 | 50 | 68 | 25,0 |
| 2020 | 97 | 0 | 4 | 101 | 96,0 |
| 2020 | 6 | 0 | 2 | 8 | 75,0 |
| 2020 | 27 | 0 | 34 | 61 | 44,3 |
| 2020 | 84 | 0 | 18 | 102 | 82,4 |
| 2020 | 49 | 0 | 5 | 54 | 90,7 |
| 2020 | 89 | 0 | 0 | 89 | 100,0 |
| 2020 | 55 | 0 | 1 | 56 | 98,2 |
| 2020 | 0 | 0 | 33 | 33 | 0,0 |
| 2020 | 89 | 0 | 15 | 104 | 85,6 |
| 2021 | 60 | 0 | 0 | 60 | 100,0 |
| 2021 | 71 | 1 | 8 | 80 | 88,8 |
| 2021 | 0 | 0 | 83 | 83 | 0,0 |
| 2021 | 0 | 1 | 13 | 14 | 0,0 |
| 2021 | 77 | 11 | 17 | 105 | 73,3 |
| 2021 | 49 | 0 | 8 | 57 | 86,0 |
| 2021 | 83 | 1 | 8 | 92 | 90,2 |
| 2021 | 16 | 0 | 46 | 62 | 25,8 |
| **Total** | 924 | 16 | 406 | 1,346 | |
| **% Sum** | 68.7 | 1.2 | 29.7 | | |

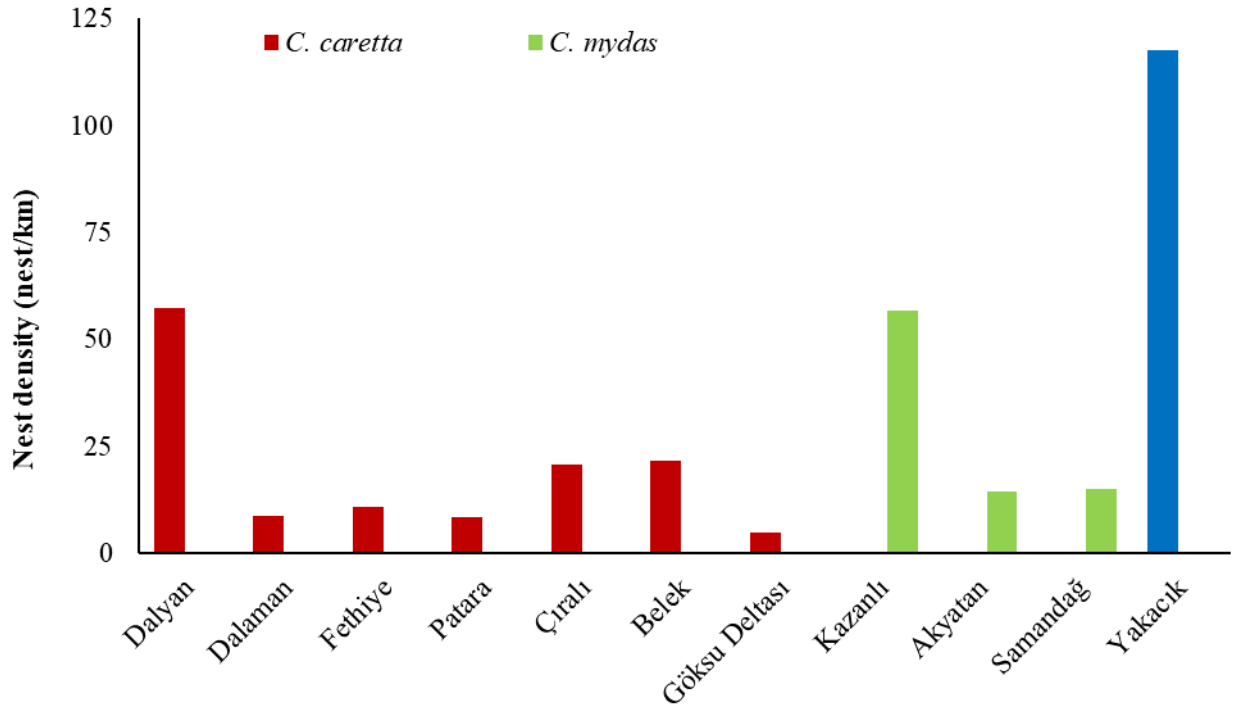


Figure 4. Comparison of nest densities among important nesting beaches of Türkiye and Yakacık. Source of data: Türkozan, O., Kaska, Y., Oruç A. (2020).

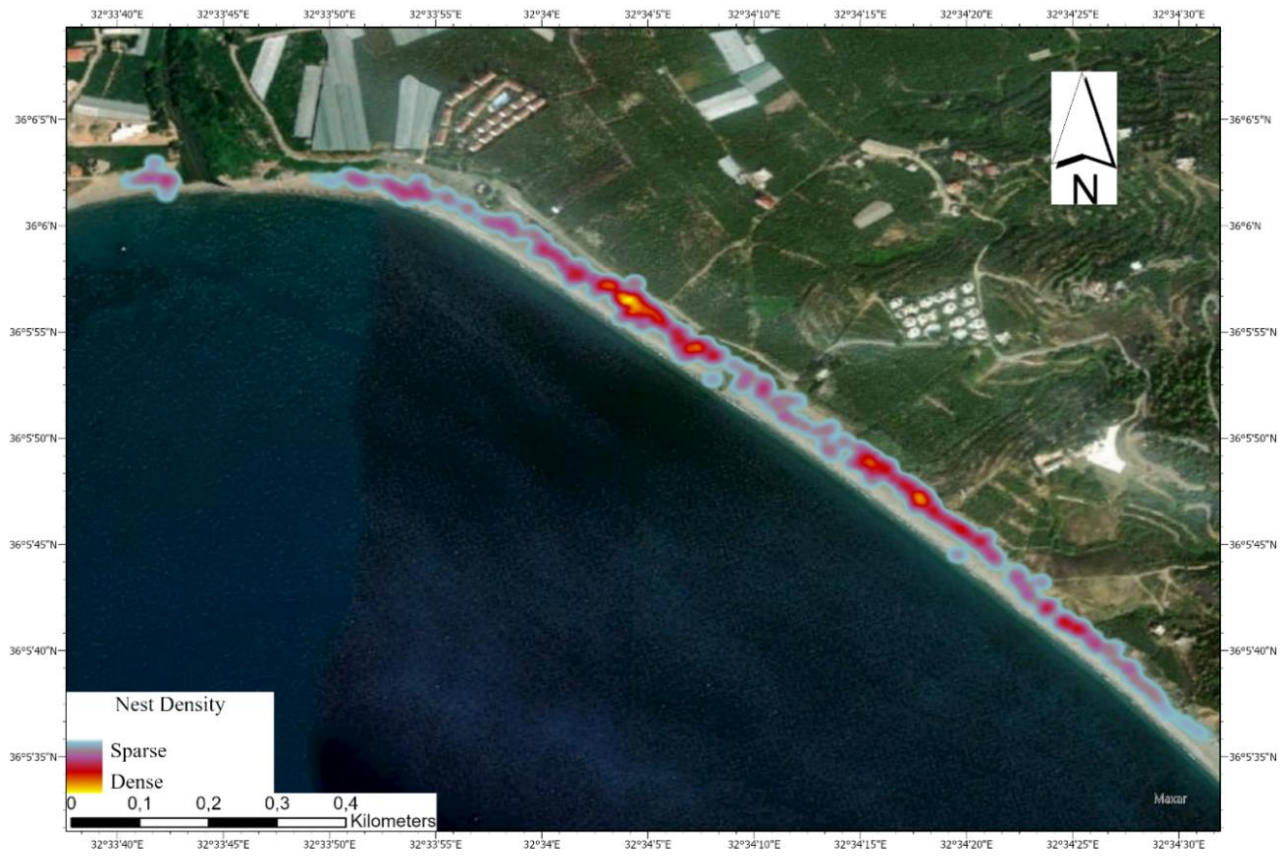


Figure 5. Nest density distribution map of all nests identified on Yakacık Beach.


Figure 6. The locations of the nests in two-years survey data. Predated nets were presented in red, intact nests were shown as green dots.

Sea turtle activity can be observed on any beach along the entire Mediterranean coast of Türkiye. It is not possible to characterize the result of every sea turtle activity as an important nesting beach. Canbolat (2004) identified six criteria for the evaluation of nesting beaches in Türkiye based on standardized data. This study also fulfils all but one criterion of the study covered the entire nesting season. Indeed, the most valid method to determine the exact number of nests on a beach and to identify the problems in the area is to carry out monitoring studies during the nesting season. On the other hand, the method chosen in this study has taken into account that only the presence of nests was confirmed by observation of eggs (predated or in the egg chamber) and hatchlings.

In recent years, novel technologies have emerged that can indirectly support monitoring studies and provide high accuracy information in addition to the previously determined criteria. In particular, unmanned aerial vehicles (Rees *et al.* 2018) and satellite imagery (Casale and Ceriani 2019) have been used commonly in recent years. The satellite images used in this study to estimate the number of nests during the peak nesting period matched the number of nests detected in the field. Satellite imagery was not used to obtain a precise number of nests, but to compare my field detections with the activity during the peak nesting period and to provide a better resolution. Nevertheless, it is possible that there were nests that could not be detected due to the lack of direct observation during the nesting period. These results could be underestimated and the monitoring the beach during the entire nesting season is required to determine the actual number of nests. Since the lengths of nesting beaches will naturally vary, nest density also varies. While Canbolat (2004) used nest density and number as criteria, he classified those with the number of nests greater than 7.5% as first degree importance. It has not been possible to obtain published data giving current nest numbers from all nesting beaches in Türkiye and therefore it is not possible to make such a comparison in a reliable way under these conditions. On the other hand, when the nest density is compared with the numbers reported according to the number of nests of the most regularly monitored nesting beaches in Türkiye (Türkozan et al., 2020), Yakacık Beach has the potential to be a nesting beach of first degree importance. Among the compared beaches, there are also beaches such as Dalyan and Belek which are defined as having first degree importance by Canbolat (2004). This shows that Yakacık Beach meets an important criterion for being defined as a nesting beach.

Although Yakacık Beach is important in terms of the number of nests, it is seen that natural and artificial threats on the beach could lower the nest and hatching success. Predation rates were above 50% in both study years. In addition, there is water leakage to the beach due to the agricultural activities behind the beach. The results obtained from the excavated nests showed that some nests did not produce hatchlings or had very low rates of hatching success. In published studies in Türkiye, hatching success rates in natural nests were 59.1% for Dalyan Beach and 77.7% for Fethiye Beach (Özdemir et al., 2011) and between 58.1% and 68.4% for Fethiye Beach (Türkozan et al., 2003). While these studies gave hatching success by adding predation rates, in this study, I separated the predated nests and gave hatchling production rates in intact nests. In another study conducted in the hatchery without predation effect, hatching success was found to be 72.8% (Sarı and Kaska, 2017). This indicates that Yakacık beach has a lower hatching success compared to other beaches but this can be clearly demonstrated with more detailed studies because the number of nests excavated in this study was limited. I found that the nests are concentrated in the central part of the beach and it can be seen that intensive agriculture is carried out behind this area. Chemicals such as pesticides can easily reach the nests from agricultural areas. In addition, I observed that some of the excavated nests had deterioration of the normal egg form and discoloration with the possibility of microbial activity such as mold and fungi (Candan *et al.* 2020). Future studies are needed in order to determine the factors affecting the hatching success.

In conclusion, a new loggerhead turtle nesting beach was identified. The number of nests detected for this beach seems to be quite significant and detailed studies are needed on the beach. It remains an open question whether the population in this area is due to the growth of the existing population or as a result of expansion from other areas and this question can be answered by genetic and satellite tracking studies. It is important to work locally where human and financial resources are not enough. In the Mediterranean, a process that starts with sporadic nesting in the western Mediterranean and moves to regular nesting is currently reported (Hochscheid *et al.*, 2022). Similarly, there may be new colonization of sea turtle population in Türkiye as the increased sample size provided new genetic haplotypes recently (Kaska *et al.* 2023). Given the difficulty of monitoring all beaches along the coastline, developing communication networks, using novel technologies, and working with local NGOs may be of greater importance in the future in identifying and monitoring the new and current beaches.

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**Ethics committee approval:** Ethics committee approval is not required for this study

**Conflict of interest:** The author declares that there is no conflict of interest.

## References

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., Sürücü, B., & Kaska, Y. (2018). The sporadic nesting sites of loggerhead and green turtles on western Anatolian coasts. In The 38th Annual Symposium on Sea Turtle Biology and Conversation.

Canbolat, A.F. (1996). Dalyan ve Patara *Caretta caretta* (Linnaeus, 1758) Deniz Kaplumbağası Populasyonlarının Biyolojisi. – Hacettepe Üniversitesi Fen Bilimleri Enstütüsü, Doktora Tezi.

Canbolat, A.F. (2004). A review of sea turtle nesting activity along the Mediterranean coast of Turkey. *Biological Conservation*, **116**, 81–91. https://doi.org/10.1016/S0006-3207(03)00179-4

Canbolat, A.F., Atatunç, K., Candan, O., & Barcak, D. (2005). A new green turtle (*Chelonia mydas*) nesting site in the Mediterranean: Sugözü beaches, Adana (Turkey). In The Second Mediterranean Conference on Sea Turtles (Vol. 4, No. 7).

Candan, A.Y., Katılmış, Y., Ergin, Ç. (2020). First report of Fusarium species occurrence in loggerhead sea turtle (*Caretta caretta*) nests and hatchling success in Iztuzu Beach, Turkey. *Biologia,* 76, 565–573. https://doi.org/10.2478/s11756-020-00553-4

Carreras, C., Pascual, M., Tomás, J., Marco, A., Hochscheid, S., Castillo, J.J.,……., & Cardona, L. (2018). Sporadic nesting reveals long distance colonisation in the philopatric loggerhead sea turtle (*Caretta caretta*). *Scientific reports*, 8(1), 1435. https://doi.org/10.1038/s41598-018-19887-w

Casale, P. (2015). *Caretta caretta* (Mediterranean subpopulation). In: The IUCN Red List of Threatened Species 2015. http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T83644804A83646294.e, e.T83644804A83646294.

Casale, P., Broderick, A.C., Camiñas, J.A., Cardona, L., Carreras, C., Demetropoulos, ……& Türkozan, O. (2018). Mediterranean sea turtles: current knowledge and priorities for conservation and research. *Endangered Species Research*, 36, 229–267. https://doi.org/10.3354/esr00901

Casale, P., & Tucker, A.D. (2017). *Caretta caretta* (amended version of 2015 assessment). The IUCN Red List of Threatened Species 2017: e.T3897A119333622. https://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T3897A119333622.en. Accessed on 14 September 2023.

Casale, P., & Ceriani, S.A., (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

Ergene, S., Aymak, C., & Uçar, A. H. (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, A. H., 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.

Hochscheid, S., Maffucci, F., Abella, E., Bradai, M. N., Camedda, A., Carreras, C.,……& Jesus, T. (2022). Nesting range expansion of loggerhead turtles in the Mediterranean: Phenology, spatial distribution, and conservation implications. *Global Ecology and Conservation*, 38, e02194. https://doi.org/10.1016/j.gecco.2022.e02194

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

Kaska, Y. (1992). Kızılot ve Patara *Caretta caretta* Populasyonunun Araştırılması. – Dokuz Eylül Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi.

Kaska, A., Koç, G., Sözbilen, D. *et al.* (2023). Increased sample size provides novel insights into population structure of Mediterranean loggerhead sea turtles. *Conservation Genetics Resources,* 15, 67–75 https://doi.org/10.1007/s12686-023-01303-9

Kıdeyş AE., & Özkan K. (2019). ODTU/Kocahasanlı Kumsalı Raporu

Özdemir, A., Ilgaz, Ç., Durmuş, S. H., & Güçlü, Ö. (2011). The effect of the predicted air temperature change on incubation temperature, incubation duration, sex ratio and hatching success of loggerhead turtles. Animal Biology, 61(4), 369-383.

Piggelen, D.C.G., & Strijbosch, H. (1993). The Nesting of Sea Turtles (*Caretta caretta* and *Chelonia mydas*) in the Göksu Delta, Turkey, June-August 1991. – *Turkish Journal of Zoology,* 17, 137–149

Pike, D.A. (2013). Forecasting range expansion into ecological traps: Climate-mediated shifts in sea turtle nesting beaches and human development. *Global Change Biology*, 19(10), 3082-3092. https://doi.org/10.1111/gcb.12282

Rees, A.F., Avens, L., Ballorain, K., Bevan, E., Broderick, A.C., Carthy, ……., & Godley, B.J. (2018). The potential of unmanned aerial systems for sea turtle research and conservation: a review and future directions. *Endangered Species Research*, 35, 81-100.

Sandık, E., Dermancı, P., Sönmez, B., Özdilek, Ş.Y. (2023). First Record on Loggerhead Nest in Gökçeada, Türkiye in Northern Aegean. *Commagene Journal of Biology*, 7(2), 1-3.

Sarı F., & Kaska, Y. (2017). Assessment of hatchery management for the loggerhead turtle (*Caretta caretta*) nests on Göksu Delta, Turkey. Ocean & *Coastal Management*, 146, 89-98. https://doi.org/10.1016/j.ocecoaman.2017.06.010

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

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.

Tebliğ: 5/1 Numaralı Ticari Amaçlı Su Ürünleri Avcılığının Düzenlenmesi Hakkında Tebliğ (TEBLİĞ NO: 2020/20)

Tomillo, P.S., Tomás, J., Marco, A., Panagopoulou, A., & Tavecchia, G. (2022). Environmental changes in the Mediterranean Sea could facilitate the western expansion of loggerhead turtles. *Marine Ecology Progress Series*, SHIFTav1. https://doi.org/10.3354/meps14149

Türkozan, O., Yılmaz, C., Uçar, A., Carreras, C., Ergene. S., Aymak, C., Karaman, S., (2018). Local differentiation in the origin of stranded loggerhead turtles, *Caretta caretta*, within an eastern Turkey foraging area. *Ocean Environmental Monitoring* 153(1), 70-75. https:// doi. org/ 10. 1016/j. oceco aman.2017. 12. 011

Türkozan, O. (2000). Reproductive Ecology of the Loggerhead Turtle, *Caretta caretta*, on Fethiye and Kızılot beaches, Turkey. *Chelonian Conservation and Biology,* 3(4), 686–692

Türkozan, O., Taskavak, E., & Ilgaz, Ç. (2003). A review of the biology of the loggerhead turtle, *Caretta caretta*, at five major nesting beaches on the south-western Mediterranean coast of Turkey. *Herpetological journal*, 13(1), 27-34.

Türkozan, O., & Kaska, Y. (2010). Turkey: Eds. Casale, P. and Margaritoulis, D. Sea turtles in the Mediterranean: Distribution, threats and conservation priorities. Gland. Switzerland, IUCN, 294.

Türkozan, O., Kaska, Y., & Oruç, A. (2020). Türkiye. . In: Casale P., Hochscheid S., Kaska Y., Panagopoulou A. (Eds.). Sea Turtles in the Mediterr Region: MTSG Annual Regional Report 2020. Report of the IUCN-SSC Marine Turtle Specialist Group, 2020.

Whitmore, C. P., & Dutton, P. H. (1985). Infertility, embryonic mortality and nest-site selection in leatherback and green sea turtles in Suriname. *Biological conservation*, 34(3), 251-272.