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Monitoring and conservation of Loggerhead Turtle's nests on Fethiye Beaches, Turkey

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Abstract. Fethiye beaches are the one of the most important sea turtle nesting beaches from Turkey. The reproductive biology of nesting loggerhead turtles was investigated there during three consecutive nesting seasons (2011-2013). A total of 253 nests were recorded in three seasons, and these nests included an average 80.4 eggs per nests. The incubation periods have decreased considerably over the last decade, potentially pointing to a climate change effect. The nest density was 7.2 nests/km in 2011, 10.7 nests/km in 2012 and 12.6 nests/km in 2013. Despite this 3-year increase, the overall number of nests over the last two decades shows a gradual decline, although the pattern differs from beach to beach. It was determined that the habitat loss and tourism activities are the main problems and are effect breeding activities of the species. In this respect, site-specific conservation actions were started at the Fethiye beaches.

Key words: *Caretta caretta*, sea turtles decline, breeding season, nests, Fethiye.

Introduction

The loggerhead turtle (*Caretta caretta*) nests regularly in the Mediterranean costs and is listed as endangered (EN) on the IUCN Red List (IUCN 2015). Loggerheads are abundant in the waters of all Mediterranean countries but face numerous threats at their foraging and nesting habitats (Broderick et al. 2007, Witt et al. 2011, Schofield et al. 2013). The implementation of sea turtle conservation measures requires knowledge about basic biological characteristics. This includes understanding life history traits, spatial and temporal distributions, demography, abundance, behavior, and the effects of human interaction on these characteristics (Eguchi et al. 2012). Most female loggerheads have remigration intervals or 2 to 3 years or more (Miller et al. 2003), while the remigration interval was calculated as 2 years for Mediterranean loggerheads. Accordingly, a consecutive three-year study, like the one presented here, coupled with examining long-term trends, is required in order to determine the current population status of a nesting ground. Importantly, sea turtles are wide-ranging animals that migrate between their breeding, foraging and wintering areas. Their natal homing makes every nesting beach important and requires implementing site-specific conservation measures. This also calls for increasing our knowledge about their biology to take more comprehensive conservation measures for the conservation of endangered sea turtles.

Fethiye has been identified as one of the most important nesting beaches of Turkey (Baran & Kasparek, 1989). Previous studies were showed a negative population trend of the loggerhead sea turtle population at Fethiye beach, Turkey based on nesting data (Ilgaz et al. 2007). Tourism development in recent years has increased risks that may cause the loss of sea turtle nesting habitats. The various studies were identified that the problems in the area as intensive human activity, sun beds and parasols, light and noise pollution, traffic on the beach and night visitors (Başkale et al. 2012, 2013).

In this study we investigate the reproductive biology of nesting loggerhead turtles during three consecutive breeding seasons (2011, 2012 and 2013) on Fethiye beaches to determine the current population size and threats to the study site to take conservation concern. We also aimed to protect the adults, hatchlings and nests from the negative factors documented at Fethiye. We believe the nesting trends documented in Fethiye are relevant for more rigorously monitored beaches worldwide.

Materials and methods

Study site

The beaches of Fethiye are located in southwestern Turkey and are designated as "*Specially Protected Area, Natural site area, and Sea turtle nesting site*". Fethiye beaches are approximately 8 km in length and consist of three subsections: Çalış, Yanıklar, and Akgöl (Fig. 1). Characteristics of these subsections were given previous studies (Ilgaz et al. 2007).

Figure 1: Map of the Fethiye beaches.

Field studies and Statistical Analysis

This study was carried out during the nesting seasons (between mid-May and mid-September) of 2011-2013. The beaches were patrolled both from ca. 21:00 to 02:00 and from 06:00 to 09:00 to observe and record all *C. caretta* activity. Depending on the number of volunteers available, night and morning patrols were conducted daily by alto-

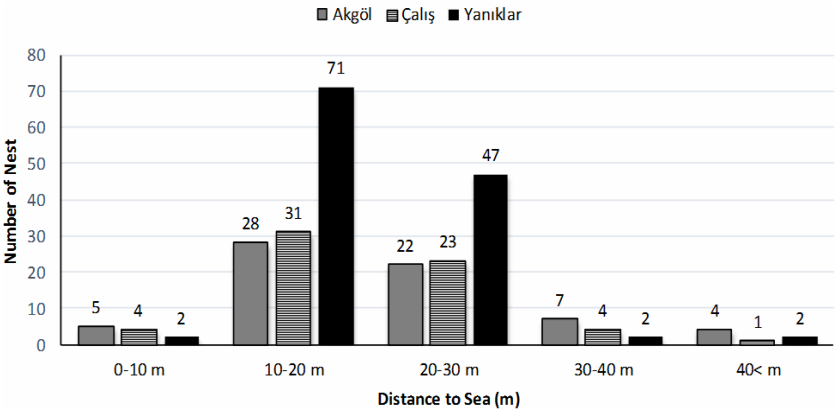

Figure 2: Spatial distribution of *C. caretta* nests on Fethiye beaches

Table 1. Total emergences, number of nests, clutch size and number of hatchlings reached to the sea during the 2011, 2012 and 2013 breeding seasons.

	2011	2012	2013	Total	Average
Total emergences	145	247	258	650	216.67
Total nests	60	89	104	253	84.33
Total non-nesting emergences	85	158	154	397	132.33
Total eggs	5015	7223	8104	20342	6780.67
Hatching success (%)	76.84	72.5	74.48	74.37	
Number of empty eggshells	3854	5238	6036	15128	5042.67
Dead embryos	421	1309	1467	3197	1065.6
Unfertilized eggs	767	669	601	2037	679
Number of hatchlings reaching sea	3813	4835	5553	14201	4733.67

gether three groups consisting of 2-3 persons on each beach. All activities from the previous night were recorded and evaluated as the next day's activity.

Sea turtle nests were recorded based on tracks leading to an area of disturbed sand where digging and covering had occurred. Tracks with no nests were counted as non-nesting emergences. Such "false crawls" were recorded in one of two ways: when some digging in the sand occurred but no covering was apparent (i.e., an attempt to dig a body pit and/or egg chamber by the female) or when a turtle made no nesting or digging attempts but simply crawled on the beach and subsequently went back into the sea. During morning patrols, the shape and pattern of all tracks were noted. Nest locations were confirmed with probes and then marked. The positions of the nests were also recorded by GPS. Certain nests that were within 10 m of the sea and that were considered to be threatened by tidal inundation were relocated further inland on the beach. Relocation of the nests always occurred within the first 24 hours after nests were laid.

During the hatching season, all hatchling tracks coming from the nests were counted to determine the total numbers of hatchlings reaching the sea. When turtle tracks were interrupted by those of predators such as foxes, dogs, birds, or crabs, we assumed that the hatchlings were predated and therefore did not reach to the sea. All predated hatchlings and eggshells were counted and disposed of elsewhere. After 8 to 10 days from the first emergence of the hatchlings, nests were opened and checked for the number of remaining hatchlings, empty eggshells, undeveloped eggs, and dead-in-egg embryos. Undeveloped eggs and dead embryos were identified according to Kaska & Downie (1999). Hatching success was the percentage of eggs that produced hatchlings. This was determined by counting hatched eggshells (fragmented eggshells were pieced together to represent one egg). The total numbers of eggs in the clutch were calculated as the sum of empty eggshells (Ee), unfertilized eggs (Ue), dead-in-egg embryos (DiEE), and predated embryos (PE).

The hatching success rate (HSR) was calculated using the following equation: HSR=Ee/(Ee+Ue+DiEE+PE)x100. The incubation period was calculated from the length of the time from oviposition to first hatchling emergence. All data were listed and tabulated in MS Office programs.

Results and Discussion

The nesting season for *C. caretta* in all three seasons started in mid-May and extended until mid-September on Fethiye beaches. The nesting occurred mainly in June and July for each of the three years. The respective temporal distribution of nests was 1.6% in May, 41.1% in June, 49.8% in July, and 7.5% in August. These date show that nests were nearly equally distributed among the months of June and July during the 3-year study period.

A total of 253 nests were recorded on Fethiye beaches. Of these nests, the fewest nests in 2011 (n=60 nests) and 89 nests in 2012 and 104 nests in 2013 were recorded. The annual mean number of nests and non-nesting emergences were 84 (min. 60, max.104) and 132 (min. 85, max. 158), respectively. Note that the number of non-nesting emergences is a minimum estimate because, although all nest are recorded, not all tracks are detected. Approximately, one in three emergences resulted in nests, with the overall nesting success for these 3 consecutive seasons being 38.9%. This value is similar to that of other Turkish beaches (Kaska et al. 2013, Kaska et al. 2014, Olgun 2012).

Most nests (87.7%) were concentrated between 10 and 30 m from the sea, but nesting and non-nesting emergences sometimes extended up to 76 m from the waterline. This pattern was consistent for all years of the study (Fig. 2). The

nest densities were calculated as 7.5 nests/km in 2011, 11.1 nests/km in 2012 and 13 nests/km in 2013. Importantly, the nest densities differed in the three different sections, with 8.4 nests/km in Çalış, 9.2 nests/km in Yanıklar and 22 nests/km in Akgöl. Moreover, the nests were also unevenly distributed within the individual subsections. At Akgöl, for example, nests were concentrated at the sandy westernmost corner of the beach, whereas lengthier gravel/cobble stretches were avoided. Türkozan (2000) reported 15.5 nests/km on Fethiye beaches based on the annual mean number of nests in 1995, 1996, and 1997. Nest density was given as 14.8 nests/km by Türkozan & Baran (1996).

A total of 20,342 eggs were deposited during the 3 successive nesting seasons (Table 1), with an average 74.4% hatching success, which is close to earlier studies here and elsewhere (Wyneken et al. 1988, Christens 1990, Peters et al. 1994, Kaska et al. 1998, Matsuzawa et al. 2002). The rate of hatchlings reaching the sea was very high (93.4%) during the 2011-2013 breeding seasons. Hatching success and reaching the sea are therefore not major concerns in Fethiye if the original nest location is protected properly.

The incubation periods of nests for each year were 48 (range 42-62) days in 2011, 47.6 (range 41-60) days in 2012, 46.3 (range 41-63) days in 2013. The mean incubation period of these nests was 47.1 days (min. 41, max. 63). *In situ* nests on Fethiye beaches had average incubation time of 52.2 ± 6.9 days for 77 nests in 2001 (Başkale & Kaska 2005) and 58 ± 5.5 days for 21 nests during the 2000-2002 nesting seasons (Kaska et al. 2006). The incubation period was 48 days in 2011 (range 42-62), 47.6 days in 2012 (range 41-60), and 46.3 days in 2013 (range 41-63). The mean incubation period of these nests was 47.1 days (min. 41, max. 63). The incubation period is strongly correlated with nest temperature, whereby a 1°C increase in the nest shortens the incubation by 5 days (Mrosovsky et al. 1999, Matsuzawa et al. 2002, Kaska et al. 2006). In this light it will also be interesting to examine whether the declining trend in incubation times from 2011-2013 continues and could be interpreted to reflect climate change.

Conservation Efforts

Beach furniture and equipment are a major issue at Fethiye, especially in the Çalış subsection. More recently, sunbeds are being uprighted or stacked along the promenade stretch before sunset. Along certain stretches – in particular those belonging to the township of Çiftlik – a virtually continuous and impenetrable barrier of tables, sunbeds, beanbags and even carpeting on the beach have made nesting nearly impossible. Vehicle access remains a continued threat. At some sites, wooden poles were placed and ditches were dug at vehicle entrance points to prevent vehicle access, but these measures had only a limited lifespan (less than a single season). In the Yanıklar subsection, major hotels now turn off their pier lights after midnight. To reduce light pollution at one hotel, the sides of the lampshades facing the nesting beach were painted black for one season, but have since been replaced. Such light pollution mitigation measures would be more effective if all lights in the area were shaded in order to prevent hatchling disorientation. Heavy beach use by tourists and day trippers is also causing pollution in all subsections of Fethiye SPA. Beach litter accumulates on the beaches and is only periodically cleaned by the sea turtle project team, volunteers and municipality personnel; some less accessible stretches (in Yanıklar) are never cleaned. Experiments conducted at Fethiye show that marine debris has the potential to trap and kill hatchlings (Triessnig et al., 2012). Motorized water sports are also an important threat to the nesting sea turtles. Their activities have been reported to the authorities but no action has been taken. Although a variety of information signs about the nesting biology of sea turtles have been placed on Fethiye's beaches to protect sea turtles and raise awareness, they are few in number, often not strategically placed, and few survive for more than one season. A major new hotel complex has been under construction at the end of Yanıklar beach in 2014/2015 (pers. comm. M.S.), and its facilities are expected to ultimately occupy a lengthy stretch of beach here. Finally, there have been ongoing efforts to approve construction of a yacht harbor/drydock facility that would render the important Akgöl beach subsection useless for loggerhead nesting. Educational programs and meetings with hotel owners and personnel have been organized, and tourists and visitors are at least marginally informed at some hotels. More detailed information about sea turtles is also being given to both local and international tourists by volunteers at the information booth on the Çalış Beach promenade every night during nesting seasons. In this spectrum of developments, however, the negative ones outweigh the positive ones. Overall, this is reflected in the deteriorating condition of the beaches and in the declining number of nests. This calls for increased nature conservation and species protection efforts in the future.

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