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Nesting Activity of the Loggerhead Turtle, *Caretta caretta*, on Fethiye Beach, Turkey, in 1994

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Previous surveys have revealed 17 important sea turtle nesting areas in Turkey (Baran and Kasparek, 1989). Two species, the loggerhead turtle, *Caretta caretta*, and the green turtle, *Chelonia mydas*, nest on the coast of Turkey (Hathaway, 1972; Basoglu, 1973; Baran et al., 1992). Green turtle nesting is more or less confined to a few eastern beaches (Kazanli, Akyatan, and Samandagi), with almost all other nesting beaches utilized only by loggerhead turtles (Baran and Kasparek, 1989) (Fig. 1). In recent years, these species have become endangered in the Mediterranean. Turkish coasts are therefore of great importance in providing nesting continuity for these species. Fethiye Beach is among the most important sites for loggerhead turtle nesting in Turkey (Baran and Kasparek, 1989). The beach is among the first three areas designated as "Specially Protected" in the framework of the Barcelona Convention of 1988. An important archaeological site is also situated within the boundaries of the nesting area. In order to provide for improved planning as regards the protection of sea turtles on Fethiye Beach and to satisfy a deficiency of information concerning its sea turtle population, we carried out the following research.

Materials and Methods. — Fethiye Beach is situated in southwestern Turkey (Fig. 1) and is about 8 km long. The overall beach is divided into three separate small beaches (Fig. 2). These three subsections are: Calis Beach, 2.2 km in length; Yaniklar Beach, 4.8 km in length; and Akgöl Beach, 1 km in length, but only 500 m of its beach is suitable for nesting.

Our investigation was carried out in a single breeding season without interruption between 9 May – 2 October 1994. Depending on the number of personnel available, continuity of night and morning patrols was provided by three groups consisting of three people each on the beaches on foot. During night patrols, after sea turtles had completed their nesting process, body measurements were taken and turtles tagged with metal tags on the right front flipper. Carapace lengths and widths (curved and straight) were measured using tape and wooden calipers. When we found an opportunity to observe turtles without disturbing them, eggs were counted while laying. During morning patrols, the shape and pattern of tracks were noted and those tracks that resulted in nests were marked. It was not possible to observe all emergences of turtles on the beach at night. Nest locations were confirmed by probing with a metal stick and then marked. Tracks with no nests were counted as non-nesting emergences. Because of pebbles and stones on the beach we were not able to find all nests. Some nests were subsequently found by following hatchling tracks during hatching season. The oviposition time of such nests was estimated based on the mean incubation period for the beach subsection.

Nests near the influence of human activities, especially in front of a camping site and Botanik Bar, were protected by either wooden warning signs or wire cages placed on the surface of the sand. In cases of partial animal predation, the nest chamber and surrounding area were cleared of destroyed eggs and the remaining unpredated eggs in the nest counted and fully covered with moist sand. All destroyed eggs and egg shells were also counted and then buried elsewhere.

During hatchling emergence season, the number of hatchling tracks coming from each nest were counted, and by following them, the number of hatchlings reaching the sea determined. When tracks were interrupted by such predator tracks as fox, dog, bird, or crab, we assumed that the hatchlings were taken by those predators. After 8 or 10 days from the first emergence of hatchlings, nests were opened and checked. The number of retained hatchlings, empty egg shells, unfertilized eggs, and developmentally delayed eggs were counted and the total number of eggs in the clutch determined exactly.

Some nests at risk for inundation or nests constructed on the beach vehicle path were transplanted to artificial hatch-

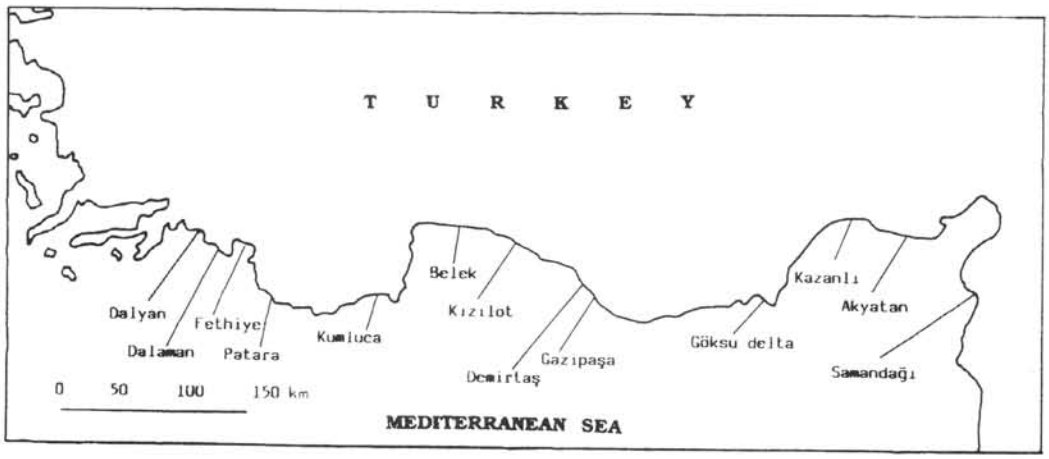

Figure 1. Major nesting beaches of *Caretta caretta* and *Chelonia mydas* in Turkey (Baran and Kasparek, 1989).

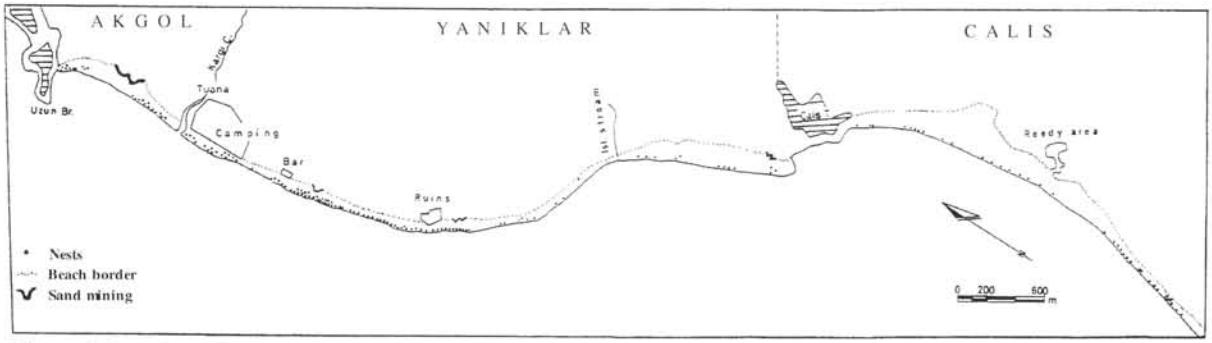

Figure 2. Location of nests and section borders on Fethiye Beach, Turkey.

eries on the beach. Transplantation of the nests occurred within the first 24 hours after oviposition.

Results and Discussion. — The first non-nesting emergence of *Caretta caretta* for the 1994 season at Fethiye Beach occurred on 9 May and the first nesting occurred on 10 May. The distribution of nests and non-nesting emergences with respect to months of the nesting season are given in Figure 3. From a total of 158 recorded nestings, 33 (20.9%) occurred in May, 81 (51.3%) were in June, 41 (25.9%) occurred in July, and 3 (1 .9%) were in August. The last nesting occurred on 7 August.

A total of 439 emergences was recorded, with 158 (35.9%) resulting in nests. This percentage seems quite high for this region. One of the reasons for this is that the beach consists of large pebbles in some areas, making it very difficult to record all of the tracks from non-nesting emergences. Also, we did not have enough personnel to monitor nesting as thoroughly in May as we did in the following months. We therefore believe that the nesting percentage, as a calculated percentage of total emergences, was artificially high.

A total of 29 females was tagged and measured, 26 for the first time, 3 recaptures were previously tagged in 1992. The mean straight carapace length of these females was 73.2 cm, the mean curved carapace length 77.3 cm. Successful nesting was accomplished 23 times by 16 females, for a clutch frequency of 1.4 clutches per female per season (range 1–3), an internesting interval of 16.2 days (range 12–34), and a clutch size of 84.0 eggs (range 46–137). Data on these tagged females are given in Table 1. One female (straight carapace length 72 cm) nesting three times laid a total of 252 eggs (clutches of 92, 96, and 64 eggs) and another three-time nester (curved carapace length 81 cm) laid a total of 319 eggs (137, 117, and 65).

Table 1. Data on 29 female *Caretta caretta* tagged on Fethiye Beach, Turkey, in 1994. Of these, 3 were recaptured from previous tagging in 1992. Successful nesting was accomplished 23 times by 16 females.

	n	mean	S.D.	Range
straight carapace length (cm)	22	73.2	± 4.57	66-87.5
straight carapace width (cm)	22	54.4	± 4.20	47.5-65.5
curved carapace length (cm)	27	77.3	± 5.26	68-91
curved carapace width (cm)	27	69.2	± 4.88	61-79
re-emergence interval (days)	31	10.0	± 10.17	0-34
internesting interval (days)	6	16.2	± 7.98	12-34
clutch frequency per female nesting	23	1.4	± 0.70	1-3
clutch size (no-of eggs)	21	84.0	± 20.70	46-137

As summarized by Dodd (1988), internesting intervals for loggerheads have been recorded as 12–15 days in Florida, USA, 14.6 days in Greece, 14–17 days in Tongaland, South Africa, and 13.9–15 days in Queensland, Australia. Mean carapace lengths have been recorded as 72 cm in northern Cyprus (Broderick and Godley, 1994), 83.1 cm in Kiparissa Bay, Greece (Margaritoulis, 1988), 93.7 cm in Tongaland, South Africa (Margaritoulis, 1982), and 90.3–100.6 cm in Florida, USA (reviewed in Dodd, 1988). These comparisons demonstrate that the loggerhead turtles nesting in the Mediterranean are smaller than elsewhere in the world.

The distribution of 158 nests and 281 non-nesting emergences on Fethiye Beach is presented for each separate beach subsection in Table 2. Most of the emergences and nesting activity occurred on Yaniklar Beach. In contrast, less emergences but a higher percentage of nests occurred on Calis Beach. Akgöl Beach had the lowest successful nesting percentage.

The location of the 158 nests showed generally homogeneous distribution. However, some nests concentrated in certain places on the beach (Fig. 2). On Calis Beach nesting was densest between Calistepe and the first stream, on Yaniklar Beach from Yonca Camping to the archaeological ruins, and on Akgöl Beach 200 m from Kargi Cayi and the westernmost 150 m of beach covered with fine sand. The overall track density was 54.9 tracks/km and nest density 19.8 nests/km on the Fethiye Beaches.

Hatchling emergence first occurred on 5 July on Calis Beach and the last occurred on 28 September on the same beach. Of the 158 nests, 5 did not produce any hatchlings. Of these nests, 4 were completely predated by foxes and another could not be found again, but did not produce hatchlings (Fig. 2). Another 19 of the 158 nests were partially depredated by foxes or dogs.

The total number of eggs laid in 156 nests on the beaches in 1994 was 12,926 (Table 3). Of these, 5.1% were depredated, 22.3% were spoiled or unfertilized, 4.1% had delayed

Table 2. Distribution of emergences (incl. nests) in each section of Fethiye Beach and their percentages.

	Calis	Yaniklar	Akgöl	Total
Total emergence	83	261	95	439
Number of nests	37	99	22	158
Nest ratio (%)	44.58	37.93	23.16	35.99
Length of beach (km)	2.2	4.8	1	8
Nest density	16.8	20.6	22	19.8

Table 3. Natural hatching success and survival on Fethiye Beach in 1994.

	n	Percent
Total number of eggs	12,926	
Predator destruction	659	5.1
Spoiled or unfertilized eggs	2884	22.3
Undeveloped (embryo)	524	4.1
Abnormal eggs	21	0.2
Hatchlings	8838	68.4
Remained in nest (% of hatchlings)	326	3.7
Predated or died on beach (% of hatchlings)	2559	29.0
Reached the sea (% of hatchlings)	5953	67.4
Reached the sea (% of total eggs)		46.1

development, 0.2% were abnormal, and 68.4% (8838) hatched. Of the hatchlings, 3.7% remained in the nest, 29.0% died or were depredated on the beach, and 67.4% were able to reach the sea. The total number of hatchlings reaching the sea as a percentage of the total number of eggs was 46.1%. In Kiparissia Bay, Greece, Margaritoulis (1988) reported hatching success of 54.9% in nests not depredated. The percentage of hatchlings at Fethiye that did not reach the sea is partially affected by the natural structure of Yaniklar Beach, which includes areas of large pebbles. Some turtles on that beach nest in soft sand mixed with large pebbles, making it difficult for those hatchlings to emerge from the nest chamber (Table 3).

Clutch size in the 156 nests examined was 82.9 (range 42–203). The total number of eggs with respect to month were 3218 (24.9%) in May, 6742 (52.1%) in June, 2831 (21.9%) in July, and 135 (1.1%) in August. Mean clutch sizes and ranges elsewhere in the Mediterranean have been reported as 82.0 (55–149) in Israel (Silberstein and Dmi'el, 1991), 61.0 (24–105) in northern Cyprus (Broderick and Godley, 1994), 117.7 in Greece (Margaritoulis, 1987), 75.7 in Dalyan, Turkey (Canbolat, 1991), and 95.0 in Patara, Turkey (Baran et al., 1992).

Incubation periods on Calis Beach averaged 53.5 days in 16 nests, on Yaniklar Beach 56.0 days in 47 nests, and on Akgöl Beach 53.3 days in 12 nests, for an overall mean incubation period of 55.0 days. Incubation periods elsewhere in the Mediterranean have been reported as 54.0 days in Israel (Silberstein and Dmi'el, 1991), 47.9 in northern Cyprus (Broderick and Godley, 1994), 55.0 in Greece (Margaritoulis, 1987), and 59.1 in Dalyan, Turkey (Canbolat, 1991).

Five nests (375 eggs) were transplanted and incubated in beach hatcheries. The hatching success of these nests was 65.1% (244 hatchlings). The nests and hatchlings of Fethiye Beach face different threats, and 659 eggs and 486 hatchlings were destroyed for different reasons. These causes are discussed below in regard to the separate beach sections.

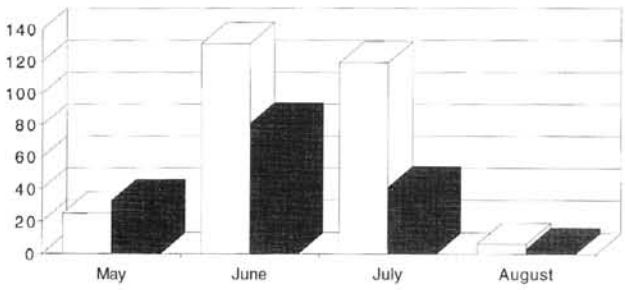

Figure 3. Distribution of numbers of nests and non-nesting emergences of *Caretta caretta* with respect to months.

Calis Beach has numerous human settlement units behind the beach. For that reason, one of the principal factors on the beach is human activities. To reduce this impact wire cages were placed to protect nests. In spite of this, people wanted to see hatchlings and take photographs. This negatively affected the vulnerable hatchlings. Loose dogs destroyed or ate 33 hatchlings. One hatchling was found on the road run over by a vehicle. The use of speed boats and fishing boats also affected hatchlings. One adult female carcass was found on the beach, possibly killed in a collision with a boat.

Fox predation is the most harmful effect on Yaniklar Beach, where 524 eggs and 50 hatchlings were destroyed by foxes. The existence of Coleoptera larvae destroying eggs in the nests has previously been noted by Baran and Türkozan (1994). These larvae destroyed 73 eggs. Bird predation destroyed 46 hatchlings. Exposure and dehydration in strong sunlight caused 28 hatchlings to die. Sand mining is an important factor that is destroying the natural structure of the beach (see Fig. 3). Tourist development is also having an effect in the area. A bar built on Yaniklar Beach causes sand compression in the area, and the lights of a coastal camping site cause disorientation for hatchlings.

Crabs were noted to be predators on two hatchlings on Akgöl Beach. Also in this section, people occasionally removed our nest marker sticks. In such situations, finding the nests again was sometimes quite difficult.

The number of nests in the 1994 breeding season was 33.9% higher than in the 1993 season (Table 4). As a result, the number of eggs deposited on the beach, numbers of hatchlings, and hatchlings reaching the sea all increased by a significant percentage. The number of hatchlings that were able to reach the sea was increased 78.4% in comparison with the previous year.

When the subsection beaches are compared between years, Calis Beach showed a significant productivity increase in 1994, with the number of tracks increased 3.5 times and nests 5 times the 1993 totals. In the same years there was no increase in the number of nests on Akgöl Beach and a small increase of 16% on Yaniklar Beach.

We noted the presence of two other turtle species in the area of Fethiye Beach. Several juvenile green turtles, *Chelonia mydas*, approximately 30 cm in carapace length, were seen at Yaniklar Beach. Three were caught by fishermen in nets and then released. We are of the opinion that this area represents a feeding ground for juvenile *C. mydas*.

Table 4. Number of nests, eggs, and hatchlings of *Caretta caretta* with respect to year on Fethiye Beach. Data from 1993 from Baran and Türkozan (1994).

	1993	1994	Percent Gain
Number of nests	118	158	33.9
Hatchling producing nests	102	153	50.0
Number of eggs	8772	12,926	47.4
Hatchlings reaching the sea	3337	5953	78.4

In addition, an African softshell turtle, *Trionyx triunguis*, was seen in the canal next to Calistepe in 1993, and another in Fethiye harbor. Thus, the existence of this species which occurs further west at Dalaman (Atatür, 1979) (Fig. 1) was recorded for the first time in this area.

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Stomach Contents of Commercially Harvested Adult Alligator Snapping Turtles, *Macroclemys temminckii*

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Studies of diet can provide insight into the behavior and habitat selection of a species. Individual growth rates, health, movement patterns, habitat preferences, and longevity are some factors that are strongly influenced by diet. For rare or declining species, diet data may be important for developing effective management strategies and identifying changes in natural systems.

The alligator snapping turtle, *Macroclemys temminckii*, is the largest freshwater turtle in North America (Ernst et al., 1994) and is confined to drainage systems along the Gulf Coast of the United States (Pritchard, 1989). It ranges west to the San Antonio River in Texas, east to the Suwannee River in Florida, and north in the Mississippi River system to central Illinois (Lovich, 1993). *Macroclemys* has historically been an important part of the culture and cuisine of the southeastern United States and is a common inhabitant of its wetlands. Exploitation of the meat of *Macroclemys* has caused a steep population decline in recent times (Pritchard, 1989; Ernst et al., 1994; Sloan and Lovich, 1995) and the species is currently a candidate for protection under the US Federal Endangered Species Act.

Habitats occupied by *Macroclemys* are usually highly productive, rich in organic matter, and possess a great diversity of potential food items. Habitats occupied by adults include freshwater lakes, rivers, canals, bayous, swamps with permanent water, and brackish coastal areas (Jackson and Ross, 1971; George, 1987; Sloan and Taylor, 1987; Dundee and Rossman, 1989).

A wide variety of food items have been identified from the stomachs of *Macroclemys*. Faunal components of the diet include many species of fish, salamanders (including *Siren* and *Amphiuma*), snakes, turtles, small alligators, crayfish, freshwater mussels, snails, ducks, and mammals. Vegetable matter includes spider lily seeds, acorns, tupelo fruit, palmetto berries, wild grapes, pawpaws, Spanish moss, and briar roots (Allen and Neill, 1950; Redmond, 1979; George,