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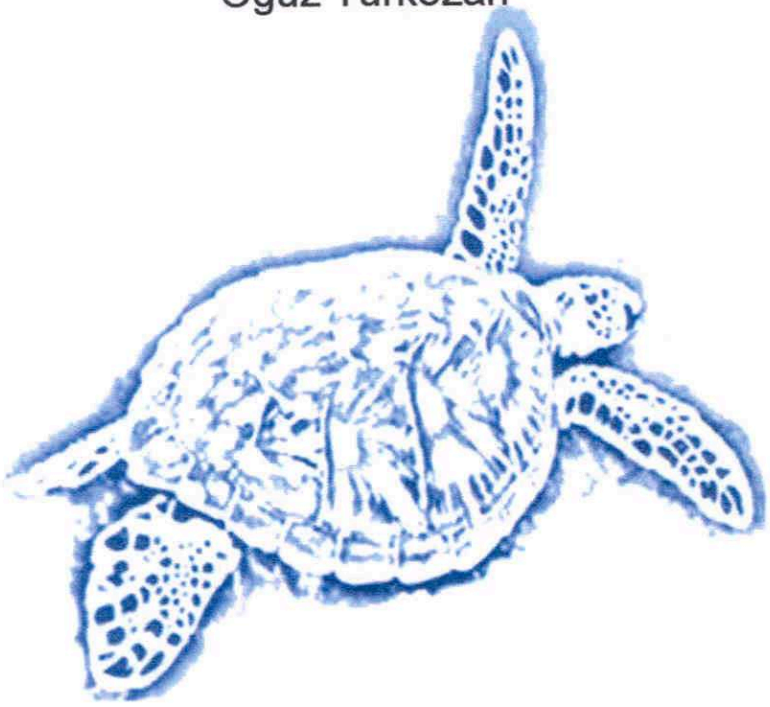

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THE NESTING POPULATION AND SPATIAL DISTRIBUTION OF LOGGERHEAD SEA TURTLES NESTS ON DALAMAN BEACH, TURKEY

Yakup KASKA, Eyup BASKALE, Yusuf KATILMIS and Rasit URHAN

Pamukkale University, Faculty of Arts and Science, Department of Biology, Denizli, Turkey

INTRODUCTION

Sea turtles are one of the examples for a species diminishing in numbers due to degradation of the living and nesting habitats, incidental catches and pollution. Two species of marine turtle, *Chelonia mydas* (green turtle) and *Caretta caretta* (loggerhead turtle), are known to nest in the Mediterranean (Groombridge 1990). The nesting sites of sea turtles are being heavily used and destroyed by people especially during the last 25-30 years. The major nesting beaches identified for *C. caretta* were in Greece and Turkey, with smaller numbers recorded in Cyprus, Libya, Egypt, Syria, Tunisia, Israel and Italy (Broderick et al. 2002).

Dalaman beach is one of 13 key Turkish nesting sites for loggerhead turtles. Assessing the population size of sea turtles is a difficult task, particularly in those species that occupy different habitats during their life cycle and migrate large distances (Broderick et al. 2002). In 1988, a total of 69 nests, 73 nests in 1997 and 69 nests in 1998 were recorded (Baran and Kasparek 1989, Yerli and Demirayak 1996, Yerli and Canbolat 1998). We aimed to find out the population size of the sea turtles nesting on Dalaman beach, which was not investigated previously on a continuous basis.

MATERIALS AND METHODS

Dalaman beach is approximately 10.3 km in length and was examined during the breeding seasons of 2002-4. The beach consists of four subsections. The first subsection, 1.8 km in length, starts from Sarigerme hill and extends to the mouth of Sarisu stream. Behind this zone, there are three big tourist hotels (Aldiana, Magic Life, and Iber), and there are also water-sports facilities on the beach. Sun beds and umbrellas cover nearly the entire beach. The second subsection, 1.9 km in length, starts from Sarisu stream and extends to Dalaman River. There is a large wetland with small creeks behind the beach. There is also a camping site and a small restaurant near Sarisu stream. The third subsection is located between the Dalaman and Tersakan rivers. The length of this subsection is approximately 4.5 km. The Dalaman International Airport, a wetland, and agricultural fields are located behind the beach. The last subsection starts from Tersakan River and extends to Hodul hill. This beach has mainly beach rocks, therefore, not many turtle activities occur on this zone.

The beaches were measured with a tape measure and marked with numbered wooden posts at 500 m intervals, running parallel to the beach. This was to allow accurate positioning of turtle activity and egg chamber by measuring to nearby posts. The nest was recorded when a track led to an area of disturbed sand where digging and covering had occurred. All the nests were left in situ. False crawls were recorded in one of two ways: when some digging in the sand, if only slight, 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 went back to the sea. Species identification was possible using the criteria of track and nest pit morphology (Groombridge 1990). The beaches were patrolled from 21.00 to 02.00 and early in the morning from 06.00 to 11.00, to record any turtle activity.

All the activities from the previous night were accepted and evaluated as the next day's activity. The positions of the nests were also recorded by GPS. Depending on the number of volunteers available, daily night and morning patrols were provided by three groups consisting of 2-3 people on each beach. Half of the in situ nests, under threat from land predators such as foxes (*Vulpes vulpes*), were screened with a metal grid (72 x 72 cm) with a mesh opening of 9 cm placed over the nest at a depth of 20 cm from the surface over the center of the egg chamber. During night patrols, each encountered turtle - following oviposition or while returning to the water – was measured and tagged with monel tags on the right front flipper. Carapace lengths and widths (straight), from nuchal notch to caudal tip and widest point of carapace, were measured, in cm, using wooden callipers. During morning patrols, the shape and pattern of tracks were noted and those tracks that resulted in nests were marked. The nest locations were confirmed with probes and then marked. Tracks with no nests were counted as non-nesting emergences. Some nests were considered to be threatened by tidal inundation. These nests that were within 7 m of the sea were relocated further inland on the beach. Relocation of the nests always occurred within the first 24 hours after laying. The incubation period was calculated from the length of the time from oviposition to first hatchling emergence.

During the hatching season, the tracks of each hatchling coming from control nests were counted, and thus, the total numbers of hatchlings reaching the sea were determined. When tracks were interrupted by tracks of predators such as foxes, dogs, birds, or crabs, we assumed that the hatchlings were destroyed by those predators. All destroyed hatchlings and eggshells were also counted, and disposed of elsewhere. All undamaged eggs were replaced in their original nests after predation. After 8 or 10 days from the first emergence of the hatchlings, nests were opened, and checked for the number of retained hatchlings, empty eggshells, undeveloped eggs, and dead-in-egg embryos. Undeveloped eggs and dead embryos were identified according to Kaska and Downie (1999). 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 depredated embryos (PE). Also, hatching success rate (HSR) was calculated as: HSR=Ee/(Ee+Ue + DiEE+PE)*100. Hatching success was the percentage of eggs that produced hatchlings. This was ascertained by counting hatched eggshells (fragmented eggshells were pieced together to represent one egg). Incubation duration was defined as the number of days from the date of egg deposition to the date of first hatching.

RESULTS AND DISCUSSION

During this study, a total of 39 animals were measured and 37 new females tagged. We were able to tag 11 females in 2002, 8 in 2003 and 19 in 2004. Only one of them was tagged previously on Fethiye beach in 1993. We found one stranded dead animal.

During the entire study period, a total of 1293 loggerhead turtle emergences were found on Dalaman beach and only 325 (25%) of them resulted in nests (Table 1). The peak nesting seasons were June and July. This result is parallel to the general pattern of nesting success in the Mediterranean (Groombridge 1990). The majority of nests were concentrated between 10 and 45 meters from sea, but non-nesting emergences were irregularly distributed up to 60 meters from sea. The majority of the nests (91 %) were found between 10 and 35 meters. These patterns were almost the same for all years. From the total data, it emerges that one of four emergences resulted in a nest on Dalaman beach. Nonetheless there was no nesting on the first 1.5 km zone, the nesting success was very low (10-15 %) in some regions (i.e., at 5.5; 6; 7 and 7.5 kms) and very high (nearly 50%) in some regions (at 2.5 and 3.5 kms). The distribution and

fate of the nests together with hatching success were investigated and the locations of nests were marked on maps together with beach-back structures. The reasons of the dense nests and low nesting zones were investigated. The sand blockage of breakwater, beach rocks, photo pollutions from hotels and airport and water sports were found to be the main reasons for low nesting percentages.

		May	June	July	August	Total
2002	Nests	7	60	33	3	103
	Tracks	15	91	135	5	245
	Total emergences	22	151	168	8	348
	Nesting success rate (%)	32	40	20	38	30
2003	Nests	8	54	43	7	112
	Tracks	6	136	171	35	348
	Total emergences	14	190	214	42	460
	Nesting success rate (%)	57	28	20	17	24
2004	Nests	1	56	46	7	110
	Tracks	4	174	152	45	375
	Total emergences	5	230	198	52	485
	Nesting success rate (%)	20	24	23	13	23
Total	Nests	16	170	122	17	325
	Tracks	25	401	458	85	968
	Total emergences	41	571	580	102	1,293
	Nesting success rate (%)	39	30	21	17	25

Tab. 1. The number of emergences and their nesting success on Dalaman beach

The mean incubation period of these nests was 48 days (max: 62, min: 42). The hatching success was 65 % in the first year and this increased to 71 and 78 % in the second and third years, by relocating and screening the nests. The numbers of nests relocated were 6, 15 and 21 and the numbers of nests screened were 54, 45 and 60 for the years of 2002, 2003 and 2004 respectively. The main reasons for the low hatching success were nest predation and embryonic mortalities due to different reasons. The fates of the eggs during the study period are presented in Table 2. The majority (26 %) of the dead embryos were found at the early stages (6-16). These mortalities were compared according to the levels of presence in nest chamber as top, middle and bottom. There were statistically significant differences between stages 17 and 30 of dead embryos at different levels (x^2=63, 17, df =26, P<0.001). The embryonic mortalities were higher at the middle levels (45 %) and decreased towards to the bottom (35%) and top (20 %) levels. The embryonic mortalities were slightly higher at late stages embryos (after stage of 25) in all nests. The hatching and emergence success were higher in relocated nests and there were also less embryonic mortalities in relocated nests.

The heaviest impacts from invertebrates on loggerhead turtle nests were from *Pimelia sp.* (Tenebrionidae, Coleoptera). 24 (36.3 %) out of 66 randomly selected loggerhead hatched nests in 2002 and 20 (33.89%) out of 59 randomly selected nests in 2003 were affected by these larvae. *Pimelia* sp larval damage was recorded in 188 (10.6 %) out of 1773 eggs and only in 2 (0.28 %) hatchlings in 2002 and in 159 (9.8%) out of 1622 eggs in 2003. As this can be seen from these results, these insects primarily damage eggs and dead hatchlings and should not be taken as primarily predators for live hatchlings but may be accepted as decomposers of dead hatchlings and eggs.

	2002	2003	2004	Total
Nests	103	112	110	325
Numbers of predated nests	33	49	8	90
Unfertilized eggs	419	176	137	732
Dead embryos	1,337	662	1,364	3,363
Predated eggs	888	1,564	473	2,925
Total eggs	7,526	8,159	8,833	24,045
Hatchlings	4,882	5,757	6,859	17,498
Numbers of hatchlings reaching sea	4,682	5,656	6,739	17,077
Hatchlings predated by foxes	39	18	18	75
Hatchlings predated by crabs	22	15	16	53
Hatchlings predated by birds	1	3	6	10
Wrong direction-photo pollution	14	11	15	40
Hard surface	92	29	35	156
Plant root	12	5	5	22
Nests with stone (pebble)	20	20	25	65
Total dead embryos	200	101	120	421

Tab. 2. The fates of the eggs on Dalaman beach during the years of 2002-4

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