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Nesting Activity of Loggerhead Turtles (Caretta caretta) at Göksu Delta, Turkey during 2004 and 2008 nesting seasons

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Abstract. Göksu Delta is one of the most important nesting beaches in Turkey for the endangered loggerhead turtle (*Caretta caretta*). This paper provides information on the nesting activities of loggerhead turtles, the spatial and temporal distribution of nesting, nesting success, nesting density, hatching success, incubation duration and clutch size over two nesting seasons. A total of 902 emergences occurred over two seasons, of which 239 (26.5%) nests were deposited (137 nests in 2004 and 102 nests in 2008) and the overall mean nesting density was 3.4 nests/km. The peak of nesting emergences takes place mainly in June. Of the overall nests, 226 (94.6%) were excavated and 16044 eggs were counted. Of these eggs, 3680 (22.9%) hatchlings emerged and 2695 (73.2% of hatchlings) of them were able to reach the sea. The mean number of eggs per clutch was 71 (range: 15 – 143). The shortest and longest incubation duration in these 2 seasons ranged from 46 to 62 days with a mean of 53 days. The main problems are negatively affecting loggerhead turtle population at Göksu Delta are dense jackal predation both adult and eggs and inundation in nests. The average nesting effort here (mean: 119.5 nests/season) confirms that Göksu Delta is one of the most important nesting sites for loggerhead turtles in Turkey.

Key words: *Caretta caretta,* sea turtle, reproduction, nesting, conservation, Göksu Delta, Turkey.

Introduction

Two endangered sea turtle species, *Caretta caretta*, loggerhead turtles and *Chelonia mydas*, green turtles (IUCN, 2007), nest regularly in the Mediterranean. While the nesting zones of *C. caretta* is widely distributed in the eastern basin of Mediterranean (BRODERICK *et al.*, 2002; MARGARITOULIS *et al.*, 2003), sparse nesting activities were reported from the western basin (LLORENTE *et al.*, 1992; TOMAS *et al.*, 2002; DELAUGUERRE & CESARINI, 2004). In eastern Mediterranean the major nesting grounds for loggerhead turtles, are Greece, Turkey and Cyprus with smaller numbers recorded in Egypt, Libya, Tunisia, Israel, Syria and Lebanon (BRODERICK *et al.*, 2002; NEWBURRY *et al.*, 2002; MARGARITOULIS *et al.*, 2003).

Three species of marine turtle – *C. caretta, C. mydas* and *Dermochelys coriacea* – have been reported from Turkish waters (BARAN & KASPAREK, 1989; BARAN *et al.*, 1998). Only the first two are known to nest on the Turkish coast of the Mediterranean,

whereby green turtle nesting is mostly limited to a few eastern beaches. The first nesting records of *C. caretta* and *C. mydas* from Turkey were by HATAWAY (1972). BAŞOĞLU (1973) and BAŞOĞLU & BARAN (1982) provided information on the carapace plates of *C. caretta* measured in İzmir, Köyceğiz and Fethiye. GELDIAY *et al.* (1982) described marine turtle populations and their protection along the Mediterranean coast of Turkey. BARAN & KASPAREK (1989) conducted the first comprehensive survey of the Turkish Mediterranean coast for turtle nesting sites. Their primary objective was to locate nesting sites and to assess their relative importance. More recently, a series of population studies have been carried out on selected beaches, and problems affecting the turtles there were determined (BARAN *et al.*, 1992; BARAN & TÜRKOZAN, 1996; CANBOLAT, 2004; ERK'AKAN, 1993; ILGAZ & BARAN, 2001; KASKA *et al.*, 2010; SAK & BARAN, 2001; TAŞKIN & BARAN, 2001; TÜRKOZAN & BARAN, 1996; TÜRKOZAN, 2000; TÜRKOZAN & YILMAZ, 2008; YALÇIN-ÖZDILEK, 2007; YERLI, 1990).

A total of 13 beaches were determined to represent the main nesting areas for marine turtles in Turkey (BARAN & KASPAREK, 1989; BARAN *et al.*, 1992; GROOMBRIDGE, 1990). A number of nesting beaches with fewer turtles were also identified (BARAN & KASPAREK, 1989), and four of these were also indicated by Groombridge (1990). Previous studies of sea turtles at Göksu Delta confirmed that this beach is one of the few sites where both loggerhead and green turtles nest in the Mediterranean (PETERS & VERHOWVEN, 1992; PIGGELEN & STRIJBOSCH, 1993; YERLI & DEMIRAYAK, 1996; GLEN *et al.*, 1997; YERLI & CANBOLAT, 1998; AKÇINAR, 2006; CANBOLAT, 2006).

The fundamental goal of the present study was to provide information on the nesting activities of loggerhead turtles, the temporal and spatial distribution of nesting, hatching success, hatchling emergence period, incubation duration and clutch size over two nesting seasons at Göksu Delta, Turkey. Moreover various threats affecting sea turtle populations were discussed.

Material and Methods

The current investigation was carried out over varying periods of the breeding seasons (early June to mid September) – 2004: 01 June to 20 September; 2008: 15 June to 19 September. The nesting records of the May were provided from a local volunteer. The following methodology was utilized: Teams of 2-3 persons conducted night patrols (21:00 – 2:00) and morning patrols (6:00 – 8:00). When the opportunity arose, we counted eggs as they were laid without disturbing the turtle at night patrols. 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. The number of successful nesting attempts can be called nesting success. The nesting success (NS) percentage was calculated with the following formula: NS (%) = [(N)/(N + T)] X 100 where N is the number of nesting emergence, and T is the number of non-nesting emergence. In cases of partial animal predation, the egg chambers and surrounding area were cleared of damaged eggs and covered with moist sand to the original level. Intact eggs were not moved. Damaged eggs and eggshells were counted and reburied elsewhere. In beach sections with known high pressure from land predators (e.g. jackal, *Canis aureus*), a protective metal grating (72x72 cm, mesh size 9 cm) was placed over the eggs at the center of the egg chamber.

During the hatchling emergence season from July to late September, the numbers of hatchling tracks coming from each nest were counted daily, and the numbers of hatchlings reaching the sea were determined by following the tracks. These tracks were then raked to avoid confusing old and new tracks on consecutive days. Those tracks that were interrupted by predator tracks such as jackals or ghost crabs (*Ocypode cursor*) were categorized as "predated". Between 8 and 10 days after the first emergence of hatchlings, nests were excavated. The numbers of remaining hatchlings, empty eggshells,

yolkless eggs and developmentally interrupted eggs (embryo) were counted. These categories were then added up to calculate the total number of eggs in the clutch. The latter two categories were distinguished by their color: shortly after oviposition, those eggs containing embryos turn white as the mucus dries and the embryo takes oxygen. The other eggs do not whiten and tend to remain creamy-white or to become slightly yellowish: when opened they show no sign of development, indicating they were infertile (MILLER, 1985). 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.

For practical fieldwork reasons, the beaches at Göksu Delta were subdivided into 7 subsections: 760-766 subsections. These subsections also partly reflect different beach morphologies and when relevant the results are differentiated according to beach subsection. Göksu Delta is one of the important nesting sites for sea turtles on the Mediterranean shoreline of Turkey (Fig. 1). Göksu Delta (36º17'N-33º39'E), is located at 80 km west of Vilayet Mersin and almost 35 km in length. The beach was divided into 8 subsection beaches by BARAN & KASPAREK (1989). Göksu Delta in Turkey is among the most important nesting grounds for *C. caretta* and the beach is designated as Special Environmental Protection Area (SPA). The importance of this area is enhanced because it is also used as 'Reproduction and Conservation Zone for Water Birds' as well as included in RAMSAR and 1st degree Natural Site. The 767 subsection beach was not included into calculate such as nest density etc because it is not used as nesting zone by sea turtles.

Subsection 760 (10.7 km): starts from the canal in Kum district at the east of Seka paper factory and lies till İncekum cape. This part is an important marine turtle nesting zone (BARAN & KASPAREK, 1989). The first 200 m of the beach consists of pebbles and the remainder fine sand. Secondary constructions are located just behind the beach and this part is being used touristic purposes. Sand junes are started after the entrance gate of private security.

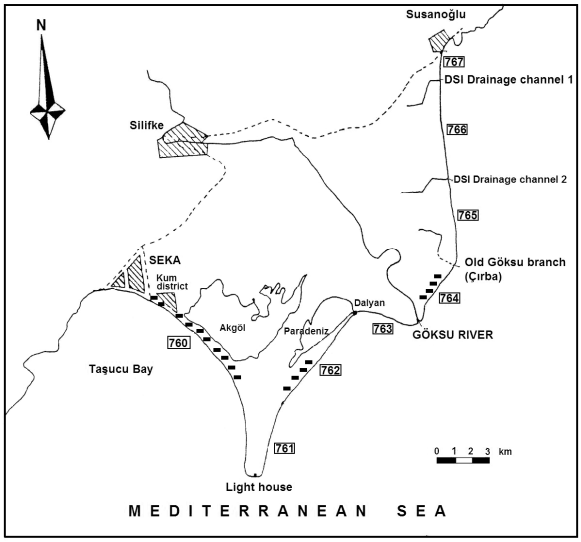

Fig. 1. A sketch map of Göksu Delta showing subsection beaches and spatial distribution of dense nesting sites.

Thorny bushes and herbaceous plants were dominant structure on the dunes. The sea floods during the strong winds constituted small ponds on the beach. In general, this subsection consists of fine sand with scarce vegetation. Subsection 761 (3.5 km): starts from the İnce cape and lies till lighthouse. The altitude of this subsection is almost 0.5 m from the sea level with almost no vegetation. This subsection carries high risk of flood especially during storms. Subsection 762 (5.7 km): starts from light house and lies till Dalyan. The middle point of the beach almost located between the sea and Paradeniz and towards Dalyan a narrowing sand bank is located The sand dunes which lie parallel to the coast either posses almost 1 m elevation or at the sea level. The flood caused the compact sand type and small ponds on the beach towards Dalyan. The sandy plant vegetation starts after light house 15 m away from the coast. Subsection 763 (2.5 km): starts from Dalyan and lies till the mouth of Göksu River. The width of the beach sometimes reaches up to 100 m in some parts. The back of the beach is

covered with sandy vegetation. Subsection 764 (3.5 km): starts from the place where Göksu River reach the sea and ends at the old arm (Cırba district) Göksu River. The width of the beach reaches up to 20 m. Subsection 765 (4.2 km): Situated between Çırba and DSİ canal II. Sand dunes are located at the back of the beach. The hinterland of the beach was covered by wetlands and rice fields. Subsection 766 (4.6 km): starts from DSİ canal II and lies till DSİ canal I of Atayurt daily picnic area. The beach is completely designated as Specially Protected Area. In 760, 764-766 subsection beaches, secondary houses, holiday housing estates, daily picnic sites, pensions, guest house, camping place, desk chairs and umbrellas have been situated. There was no water sport except water bicycle in the area.

Results and Discussion

In total, 902 loggerhead turtle emergences occurred over the two nesting seasons. Of these, 239 (26.5%) resulted in a nest, with the number of nests ranging from 102 to 137 for per year (average number of nests 119.5). MARGARITOULIS *et al.* (2003) stated that average annual number of loggerheads nests throughout the Mediterranean reaches 5031 nests/season, and of these, 1366 nests/season (27.2%) occur in Turkish Mediterranean coasts. According to this value, Göksu Delta represents 2.4% of the total loggerhead nesting in the Mediterranean and 8.7% of the nesting in Turkey. Göksu Delta is thus an important nesting ground for loggerheads and substantially to the Mediterranean loggerhead population. CANBOLAT (2004) reviewed the both loggerhead and green turtle nesting in Turkey, resulted that 500-800 loggerhead turtles nest annually along the beaches of Turkey. He classified the Göksu Delta as a secondary important nesting ground holding 5% of the total nests laid annually on Turkish beaches. The comparative data on nesting and non-nesting activities of loggerhead turtles reported in earlier studies on Göksu Delta are given in Table 1. The second highest number of nesting emergence (137 nests) were recorded in 2004 nesting season over the ten nesting seasons.

Table 1. Previous studies result of nesting (N), non-nesting emergence numbers (NN) and nesting density (ND) at Göksu Delta, Turkey.

Period	N	NN	ND (nests/km)	References
1991 (June - August)	117	384	3.4	PIGGELEN & STRIJBOSCH (1993)
1992 (June – September)	89	271	2.6	PETERS & VERHOWVEN (1992)
1994 (June – September)	36	76	1.0	YERLI & DEMIRAYAK (1996)
1996 (June – August)	36	----	1.0	GLEN *et. al.*, (1997)
1998 (May – September)	94	214	2.7	YERLI & CANBOLAT (1998)
2004 (June – September)	137	393	3.9	THIS STUDY
2005 (June – September)	151	461	4.0	AKÇINAR (2006)
2006 (June – September)	107	149	3.1	CANBOLAT (2006)
2007 (July – September)	122	17	3.5	GÖKDOĞADER (2007)
2008 (June – September)	102	270	2.9	THIS STUDY

Using the assumption that each female nests on average three times in a season every 2-3 years (GROOMBRIDGE, 1990), approximately 40 (1/3 of the average number of nests) loggerheads nest on Göksu Delta. GROOMBRIDGE (1990) estimated 2000 *C. caretta* females nesting annually in the Mediterranean. BRODERICK *et al.* (2002) estimated 2280–2787 loggerhead turtles nesting annually in the Mediterranean using four different methods. Accordingly, almost 1.4-1.8 % of the *C. caretta* population of the Mediterranean nest in this region.

The overall nesting success (number of nests/total number of emergences) for two nesting seasons was 26.5%. The previous

reports at Göksu Delta in different nesting seasons were 23.4% (PIGGELEN & STRIJBOSCH, 1993), 24.7% (PETERS & VERHOWVEN, 1992), 30.5% (YERLI & CANBOLAT, 1998), 24.7% (AKÇINAR, 2006) and 41.8% (CANBOLAT, 2006). Moreover, nesting success at various nesting beaches in the Mediterranean has been reported as 33.7% at Dalyan (TÜRKOZAN & YILMAZ, 2008), 15.6% at Fethiye (TÜRKOZAN, 2000), 48.5% Kızılot (KASKA, 1993), 25.4% at Patara (TAŞKIN & BARAN, 2001), 24.6% at Dalaman (KASKA *et al.*, 2010), 19.4% at northern Karpaz, northern Cyprus (ILGAZ & BARAN, 2001), 25.7% at Laganas Bay, Greece (MARGARITOULIS, 2005) and 40.2% at El-Mansouri, Lebanon (NEWBURRY *et al.*, 2002). The value of nesting success determined over two nesting seasons is similar to other nesting sites in the Mediterranean except data given in CANBOLAT (2006) (for Göksu Delta) and NEWBURRY *et al.* (2002) (for El-Mansouri, Lebanon).

The peak of loggerhead turtle nesting occurred in June (Fig. 2). Of the overall number of nests recorded, 2.9% occurred in May, 59.8% in June, 36.4% in July and 0.8% in August. Temporal distribution of nesting shows that 62.7% of nests at Göksu Delta are completed in May and June as in other nesting beaches of Turkey and northern Cyprus (ILGAZ & BARAN, 2001; SAK & BARAN, 2001; TAŞKIN & BARAN, 2001; TÜRKOZAN & YILMAZ, 2008). However, the main nesting season covers in July and August in nesting beaches of Greece (64.5% of the total nests were completed in July and August at Laganas Bay and Kyparissia Bay, Greece in MARGARITOULIS 2005 and MARGARITOLIS & REES, 2001). We think that this difference could be caused from geographical variation of nesting beaches as

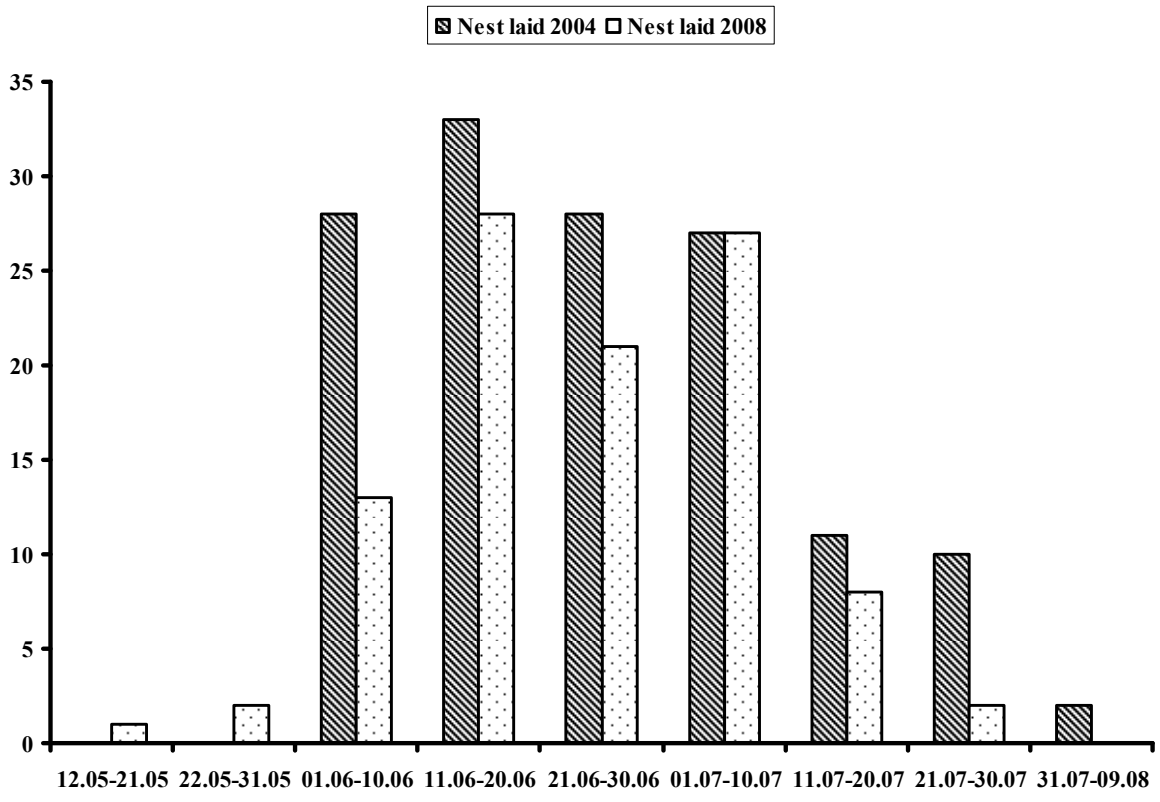

Fig. 2. Temporal distribution of nests during 2004 and 2008 nesting seasons at Göksu Delta.

in stated in MARGARITOLIS & REES (2001).

The overall nesting density was calculated as 3.4 nests/km at Göksu Delta (3.9 nests/km and 2.9 nests/km during the 2004 and 2005 nesting seasons, respectively). The comparative data on nesting density reported in earlier studies on Göksu Delta are given in Table 1. The presently reported value of 3.2 nests/km partly shows similarity with those previously reported

values for Göksu Delta except 1994 and 1996 nesting seasons. Nest densities in the Mediterranean vary widely. ILGAZ & BARAN (2001) reported a value for Dalyan beach of 28.7 nests/km and TAŞKIN & BARAN (2001) gave 7.4 nests/km for Patara beach. SAK & BARAN (2001) recorded 9.1 nests/km on Belek beach. TÜRKOZAN & YILMAZ (2008) found nest density for 47 nests/km over two nesting season at Dalyan beach. The nesting density in Greece was found to be 235.6 nests/km at Laganas Bay, 36.6 nests/km in Rethymnon (Crete), 8.9 nests/km at Chania Bay (MARGARITOULIS, 2000) and 46 nest/km at Kyparissia Bay (MARGARITOULIS & REES, 2001). In Israel, 1.0 nests/km was found by SILBERSTEIN & DMI'EL (1991) while it was 26.4 nests/km at El-Mansouri, Lebanon (NEWBURRY *et al.*, 2002). The nest density of *C. caretta* during two years monitoring period at Göksu Delta is relatively lower than that reported in the literature except Israel in the Mediterranean.

Nesting emergences varied greatly among beach subsections (Table 2). Of all nests, 69.0% concentrated on 760 subsection, 9.6% on 762 subsection, 8.4% on 764 subsection, 5.9% on 765 subsection, 3.8% on 763 subsection, 2.1% on 766 subsection and 1.3% on 761 subsection. The mean nesting densities were 7.7 nests/km for 760 subsection, 2.9 nests/km for 764 subsection, 1.8 nests/km for 763 subsection, 1.7 nests/km for 765 subsection, 0.6 nests/km for 766 subsection and 0.5 nests/km for 761 subsection. The spatial distribution of nests on the beach is given in Fig. 2. As understood from the values, 760 subsection is the most densely used by loggerhead at Göksu Delta as previously mentioned in the literature (PETERS & VERHOEVEN, 1992; PIGGELEN & STRIJBOSCH, 1993; YERLI & DEMIRAYAK, 1996). Most of the nesting and non-nesting emergences of loggerhead were occurred 4th, 5th and 6th km of 760 subsection. Thus, turtle nesting at Göksu Delta was concentrated in only 3 km of the total 34.7 km beach. This site of beach was named as core area by PETERS & VERHOEVEN (1992) for Göksu Delta.

Table 2. The number of nesting emergences, nest ratio (%) and nest density (nests/km) among beach subsection over two nesting seasons. (NN: Number of nesting emergences, NR: Nesting ratio, ND: Nest density)

		760	761	762	763	764	765	766	Total
2004	NN	100	3	14	1	9	8	2	137
	NR (%)	73.0	2.2	10.3	0.7	6.6	5.8	1.5	
	ND (nests/km)	9.3	0.9	2.5	0.4	2.6	1.9	0.4	
2008	NN	65	----	9	8	11	6	3	102
	NR (%)	63.7	----	8.8	7.8	10.8	5.9	2.9	
	ND (nests/km)	6.1	----	1.6	3.2	3.1	1.4	0.7	
Overall	NN	165	3	23	9	20	14	5	239
	NR (%)	69.0	1.3	9.6	3.8	8.4	5.9	2.1	
	ND (nests/km)	7.7	0.5	2.1	1.8	2.9	1.7	0.6	

Of the recorded nests per season, 129 (94.2% of recorded nests) and 97 (95.1%) were excavated and their contents examined in 2004 and 2008, respectively. A total of 16044 eggs were counted from 226 nests, with a mean clutch size of 71.0 eggs over two nesting seasons. The comparison of the total number of eggs, hatchlings and hatchlings reaching to sea with respect to different nesting seasons is given at Göksu Delta in Fig. 3. According to these values the higher hatching success was recorded in 2008 nesting seasons while the lower values was recoded in 2006 nesting seasons. In comparison with other Mediterranean nesting beaches, the hatching success of loggerhead turtles at Göksu Delta was lower than that of loggerhead turtles on Kızılot, Belek (1990–1996), Patara (1990–1996) and Dalyan (1988–1996) beaches in Turkey,

Laganas Bay in Greece and northern Cyprus (BRODERICK & GODLEY, 1996; TÜRKOZAN, 2000; TÜRKOZAN *et al.*, 2003; MARGARITOULIS, 2005; TÜRKOZAN & YILMAZ, 2008). It is clear that hatching success is changed not only nesting beach but also nesting seasons (MARGARITOULIS, 2005). The probable reason for the lower hatching success observed at Göksu Delta was from the high pressure of jackal predation and flooding of the nests as mentioned in previous studies (PETERS & VERHOEVEN, 1992; AKÇINAR, 2006). The hatching success and survival at Göksu Delta is presented in Table 3. According to this values, a total of 3680 hatchlings were emerged (hatching success: 22.9% of total number of eggs), of which 2695 hatchling were able to reach the sea over two nesting seasons. Expressed as a percentage of total egg number, this is equivalent to 16.8%

Table 3. Hatching success and survival at Göksu Delta, Turkey.

	2004		2008		OVERALL	
	N= 129	%	N=97	%	N = 226	%
Total number of eggs	9070		6974		16044	
Depredated eggs	3150	34.7	2532	36.2	5682	35.4
Unhatched eggs	250	2.8	172	2.5	422	2.6
Abnormal eggs	18	0.2	12	0.2	30	0.2
Dead embryos	3862	42.6	2368	34.0	6230	38.8
Hatchlings	1790	19.7	1890	27.1	3680	22.9
Remained in nest	334	18.7	115	6.1	449	12.2
Depredated or died on beach	264	14.7	272	14.4	536	14.6
Reach the sea	1192	66.6	1503	79.5	2695	73.2

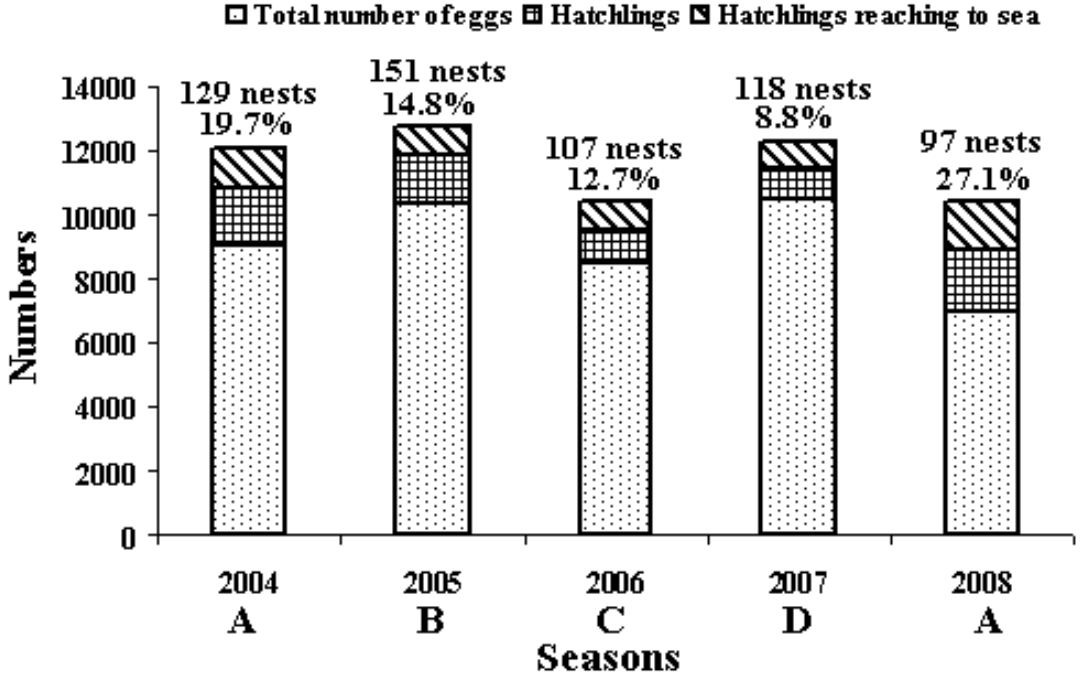

Fig. 3. The comparison of the total number of eggs, hatchlings and hatchlings reaching the sea at Göksu Delta. Percentages above the histograms indicate the mean hatching success according to years [A: This study, B: AKÇINAR (2006), C: CANBOLAT (2006), D: GÖKDOĞADER (2007)].

The mean clutch size at Göksu Delta was 71 eggs (range: 15-143). Mean clutch sizes vary greatly from year to year and from beach to beach. Thus, the 1992 study at Göksu Delta (PETERS & VERHOEVEN, 1992) reported a mean clutch size of 92 eggs. Canbolat (2006) recorded a value of 75 here in 2006. Values from elsewhere in the Mediterranean are 82 (SILBERSTEIN & DMI'EL, 1991) in Israel, 70 in northern Cyprus (BRODERICK & GODLEY, 1996), 117.7 in Greece (MARGARITOULIS, 1988), 64.7-64.3 in Egypt (CAMPELL *et al.,* 2001), 72.7 in Lebanon (NEWBURRY *et al.,* 2002) 76 in Dalyan (TÜRKOZAN & YILMAZ, 2008), 80.1 in Patara (TAŞKIN & BARAN, 2001) and 79 eggs (KASKA *et al.,* 2010). Outside of the Mediterranean, mean clutch sizes vary from between 101 to 126 eggs for the loggerhead turtles (HIRTH, 1980). Clutch size at Göksu Delta was lower than those documented in Greece (MARGARITOULIS,1988), Israel (SILBERSTEIN & DMI'EL, 1991) and Patara (TAŞKIN & BARAN, 2001) but is partly similar to Lebanon (Newburry *et al.* 2002) and Dalyan (TÜRKOZAN & YILMAZ, 2008). According to TIWARI & BJORNDAL (2000) there is a correlation between clutch size and latitude. MARGARITOULIS (2005) noted that variation in clutch size among nesting colonies of loggerhead in Greece, Cyprus and Turkey is probably results of body size difference.

In this study, the mean incubation periods were 52 (n= 23, range=46-61±3.26) and 54 (n= 17, range=48-62±3.79) days during the years 2004 and 2008 respectively. The shortest and longest incubation period in these 2 seasons ranged from 46 to 62 days with a mean of 53 days. In the previous studies, the mean incubation periods were reported as 57 (PIGGELEN & STRIJBOSCH, 1993), 55 (PETERS & VERHOEVEN, 1992), 52 (AKÇINAR, 2006) and 52 (CANBOLAT, 2006) days at Göksu Delta. GODLEY *et. al.,* (2001) derived field pivotal incubation duration for loggerheads turtles as 59.2 days. Upon this value, sex ratios on Göksu Delta are highly biased toward females in all years. MARGARITOULIS (1988) quotes a mean of 55.5 days in Greece, whereas CAMPELL *et al.* (2001) cite 48.1-53.5 days along the Mediterranean coast of Egypt. SILBERSTEIN & DMI'EL (1991) quote 54 days in Israel, whereas BRODERICK & GODLEY (1996) cite 48 days in northern Cyprus. MARGARITOULIS (2005) recorded incubation duration as 55.2 days at Laganas Bay, Greece. The mean incubation duration was ERK'AKAN (1993) cited 59.3 days on Dalyan beach, Turkey, whereas TÜRKOZAN & YILMAZ (2008) reported this value for 52.3 days for 2004 and 2005 nesting seasons. TÜRKOZAN (2000) give a mean of 56 and 49.8 days at Fethiye and Kızılot beaches, respectively. ILGAZ & BARAN (2001) give a mean of 51.8 and 52.4 days at northern Karpaz. According to KASKA *et al.* (2010), the mean incubate period is 49 days on Dalaman beach over the seven nesting seasons. Incubation period ranges between 48-58 days at Akrotiri Peninsula, Cyprus (MACLEAN *et al.,* 1998). The general range of incubation periods for sea turtle nests worldwide is quoted in the literature as 50-70 days (HIRTH, 1980). It is clear that there are substantial differences among the nesting beaches of loggerhead turtles in terms of incubation duration.

Early studies show that canids such as fox (*Vulpes vulpes*), jackal (*Canis aureus*) and feral dog are the main predators both hatchlings and eggs for loggerhead turtles in different nesting sites in the Mediterranean (MARGARITOULIS, 1988; MACDONALD *et al.,* 1994; BRODERICK & GODLEY, 1996). Previous studies show that jackal is the main predator at Göksu Delta (PETERS & VERHOEVEN, 1992; YERLI & DEMIRAYAK, 1996). Of the recorded nest, 33.9% were predated by jackal at Göksu Delta during 2004 and 2008 nesting seasons. A total of 5682 (35.4%) eggs were destroyed by jackals. The percentage of hatchlings depredated or died on the beach to the total number of eggs is 3.3%. The jackal predation was very intensive on 760-763 subsection beaches. The predation was occurred as soon as egg laying and nests were totally depredated.

During two nesting seasons, a total of 25 adult loggerhead turtles were killed by jackal (*Canis aureatus*). Of the killed adults, 66.7% were found on 760 subsections. The jackal predation on adults is most dense in June and July (93.3%). Furthermore, a total

of 10 loggerhead females washed ashore over two nesting seasons. One of the adverse effects on the beach was occurred during the stormy weather by flooding the nests. Of the recorded nests, 34.3% (82 nests) was flooded due to high tide line and 6230 eggs (38.8%) were not able to complete their embryonic development. According to ÖZDEMIR *et al.* (2008), embryonic mortality rate of loggerhead turtles is higher at Göksu Delta than at Fethiye beach. They also stated that lower slope at Göksu Delta is most important factors on higher value of embryonic mortality.

Protecting nests against predation with metal gratings is one of the effective conservation tools (YERLI *et al.*, 1997; TÜRKOZAN, 2000; TÜRKOZAN & YILMAZ, 2008). Throughout two breeding seasons, a total of 68 nests were protected against jackal predation by means of metal gratings (72X72) with a mesh opening of 9 cm was placed over the eggs (20 cm deep from the sand surface) centered around the egg chamber on 760 beach subsection. These gratings were very effective against jackal predation. Nevertheless 2 were totally depredated by jackals. These predations were resulted from the removal of metal gratings by the people before predation.

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