



Strandings of loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) sea turtles along the eastern Mediterranean coast of Turkey

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Data on strandings of dead loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) turtles were collected from the eastern Mediterranean coast of Turkey during the nesting seasons between 2002 and 2009. A total of 276 strandings were recorded (142 *C. caretta* and 128 *C. mydas*). The curved carapace length (CCL) of *C. caretta* ranged from 12.6–85 cm (mean 63.50±1.06 cm). The CCL of *C. mydas* ranged from 20–93 cm with a mean of 40.97±1.41 cm. 2.4% and 31.7% of the loggerheads were oceanic stage small juveniles (≤30 cm CCL) and adults (≥70 cm CCL), respectively. Of the green turtles, 33.3% (≤31.5 cm CCL) and 4.6% (≥85 cm CCL) were small juveniles and adults, respectively. The source populations of these turtles could become identified with genetic mixed stock analysis.

Key words: *Caretta caretta*, *Chelonia mydas*, Mediterranean, strandings, Turkey

INTRODUCTION

Data on strandings provide key information about life stages, seasonal distributions and geographic ranges of marine turtles (Hart et al., 2006; Chaloupka et al., 2008; Casale et al., 2010). Strandings offer a source of biological material for population studies such as age determination from skeletochronology (Zug et al., 2002), tissue samples for toxicity (Storelli et al., 2005), parasite loads and general health (Deem et al., 2009), tissue for stable isotope analysis (Godley et al., 1998a), and material for genetic analysis (Türkozan & Yılmaz, 2010). Strandings can also provide preliminary information for conservation planning and management, such as the location of rehabilitation centres. Furthermore, adequate measures based on stranding records can be taken if the causes of injuries or deaths are mostly fishery-related (Panagopoulos et al., 2003; Snover et al., 2007; Tomás et al., 2008).

The main nesting grounds of loggerhead turtles (*Caretta caretta*) in the Mediterranean are Greece, Turkey, Cyprus and Libya, with smaller numbers in Lebanon, Egypt, Syria and Italy. For green turtles (*Chelonia mydas*), Turkey, Cyprus and Syria are the main nesting sites with smaller numbers in Lebanon, Israel and Egypt. In the entire Mediterranean, the number of loggerhead and green turtle nests are estimated as

>7,200 and 1,500, respectively (Casale & Margaritoulis, 2010). Due to fisheries, over 132,000 incidental captures occur annually, with over 44,000 of them resulting in death (Casale, 2011). In Turkey, an average of 2,145 (29.8% of the Mediterranean population) and 1,252 nests (83.5% of the Mediterranean population) are estimated annually for loggerhead and green turtles, respectively. The eastern coast is the most important nesting ground for green turtles in the Mediterranean (Kasperek et al., 2001), and the site is also used by loggerhead sea turtles on a smaller scale (Türkozan & Kaska, 2010).

Little is known about the oceanic and neritic habitats of marine turtles in the Turkish Mediterranean, with the habitats of juveniles during winter as well as their foraging grounds not being clearly defined. Based on stranding data, Kasperek & Baran (1989) reported that immature green turtles stayed more or less around their birthplace, while loggerhead turtles migrate further distances. İskenderun Bay (Oruç, 2001) and the Samandağ coast (Yalçın-Özdilek & Aureggi, 2006) have been suggested as areas for juvenile development for both species, and the coast of Fethiye was suggested to be a feeding ground for juvenile green turtles (Türkozan & Durmuş, 2000). More recently, an unusual stranding of a green turtle 90 cm in total length was reported from the Turkish Black Sea coast (Öztürk et al., 2011). Unfortunately, no stranding network exists in Turkey and therefore systematic

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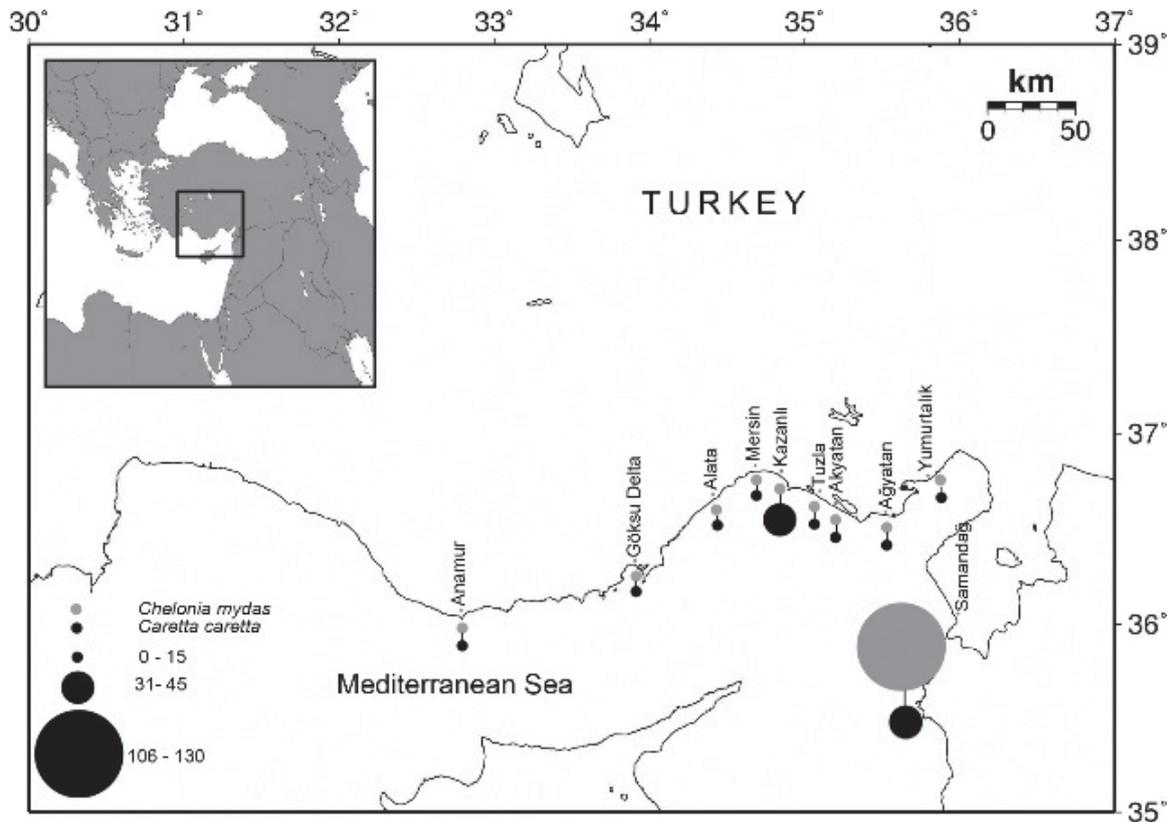


Fig. 1. Study area: the upper left corner shows the location of study area in the Mediterranean. Grey circles represent green turtles (*Chelonia mydas*) and black circles represent loggerhead turtles (*Caretta caretta*). The size of circles represents the number of strandings found on each beach.

information about strandings is largely limited to data collected during nesting seasons. In this paper we collate a comprehensive data set of sea turtle strandings on the eastern Mediterranean coast of Turkey for the first time.

METHODS

Data about strandings were collected during the nesting seasons from the beaches of Anamur, Göksu Delta, Alata, Mersin, Kazanlı, Tuzla, Akyatan, Ağyatan, Yumurtalık (2005–2009) as well as Samandağ (2002–2009). Beaches were monitored daily with roughly equal effort. Stranded turtles were identified to species (when possible), and straight carapace length and width (SCL, SCW) and curved carapace length and width (CCL, CCW) were measured (Bolten, 1999). We were not able to perform necropsies in order to detect the cause of deaths.

Loggerhead turtles ≤ 30 cm CCL were assumed to be less than four years old, corresponding to an oceanic stage (following Casale et al., 2010). The smallest nesting

loggerhead females recorded in Turkey had a CCL of 62–71 cm (Türkozan, 2000; Türkozan & Yılmaz, 2008). Therefore, individuals ≥ 70 cm were considered adults (see also Casale et al., 2005). For green turtles, such data are not available from the Mediterranean. The smallest green turtle reported along the U.S Atlantic coast ranged between 19.2 cm (Goshe et al., 2010) and 29.5 cm SCL (Mendonça, 1981). Since SCL is not available in our study, the equation of $SCL = 0.94 * (CCL) - 0.0515$ (Goshe et al., 2010) was used to convert SCL to CCL. Therefore, we used ≤ 31.5 cm CCL to define the oceanic stage, and ≥ 85 cm to define the adult stage.

RESULTS

A total of 276 stranded dead turtles were found along the eastern Mediterranean coast of Turkey (Fig. 2). Of these, 142 (51%) were *C. caretta*, and 128 (46.7%) were *C. mydas*; 6 carcasses that were unidentified species were also recorded.

Table 1. Descriptive statistics of strandings recorded along the eastern Mediterranean coast of Turkey.

	<i>Caretta caretta</i>			<i>Chelonia mydas</i>		
	<i>n</i>	Mean±SE	Range	<i>n</i>	Mean±SE	Range
Curved carapace length (CCL)	123	63.50±1.06	12.6–85	123	40.97±1.41	20–93
Curved carapace width (CCW)	124	58.52±0.93	12.5–80	124	37.68±1.38	19.5–96
Straight carapace length (SCL)	77	59.26±1.27	12.5–79	18	48.98±5.16	18.5–82
Straight carapace width (SCW)	78	47.88±1.02	10.7–68	17	38.91±3.93	16.5–66

Table 2. Distribution and density of stranding records along the eastern Mediterranean coast of Turkey. Mersin is a harbour and therefore beach length was not given. Since monitoring was not continuous in space and time turtle densities should be regarded with caution.

Region	Length of beach (km)	<i>Caretta caretta</i> (n)	<i>Chelonia mydas</i> (n)	Turtles km ⁻¹
Anamur	12.7	-	1	1
Göksu Delta	25.6	9	-	0.35
Alata	3	3	2	1.66
Kazanlı	4.5	45	3	10.6
Mersin	-	10	3	
Tuzla	25	8	-	0.32
Akyatan	22	11	2	0.59
Ağyatan	8.5	12	-	1.41
Yumurtalık	6	1	-	0.16
Samandağ	14.2	43	117	11.27

The CCL of *C. caretta* ranged between 12.6 and 85 cm, with a mean of 63.50±1.06 cm. CCL of *C. mydas* ranged from 20 to 93 cm, with a mean of 40.97±1.41 cm (Table 1). The *C. caretta* strandings were mainly from Kazanlı and Samandağ beaches, while the *C. mydas* were mainly from Samandağ (Table 2). Samandağ beach comprised the highest number of the strandings for both species (60.1% in total, Fig. 3). The spatial distribution of the stranding records and density (Turtles km⁻¹) is shown in Table 3. For *C. caretta*, 2.4% and 31.7% were juveniles and adults, respectively; the corresponding values for *C. mydas* are 33.3% and 4.6%. The remainder of the strandings were neritic juveniles and sub-adults.

Excluding the 2002–2004 data from Samandağ, a total of 192 turtles (131 *C. caretta* and 61 *C. mydas*) were recorded, with 38.4 mean annual strandings (26.2 and 12.2. mean annual strandings for *C. caretta* and *C. mydas*, respectively). There was no significant difference in mean size among years in *C. mydas*, and significant differences in *C. caretta* ($F=3,20, p<0.05$). The loggerhead turtles in 2006 were significantly larger than those recorded in 2008.

Eighty-one of the strandings (67 *C. mydas*, 9 *C. caretta* and 5 unknown) were found on Samandağ beach alone during 2002–2004, with 27.3 strandings annually. Of the overall strandings, 166 (60.1%) were from Samandağ, consisting of 43 *C. caretta*, 117 *C. mydas* and 6 unidentified turtles.

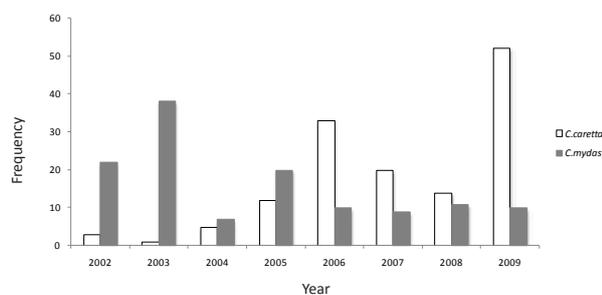


Fig. 2. The frequency of *C. caretta* and *C. mydas* strandings on the eastern Mediterranean coast of Turkey between 2002 and 2009.

DISCUSSION

The eastern Mediterranean coast of Turkey is the most important nesting ground for *C. mydas* in the Mediterranean (Kasperek et al., 2001; Türkozan & Kaska, 2010), with *C. caretta* also nesting in smaller numbers (Türkozan & Kaska, 2010). The majority of strandings reported in the present study were loggerhead turtles (except Anamur and Samandağ, Table 2), coinciding with the fact that they occur on almost all recorded nesting beaches in Turkey. The majority of *C. caretta* strandings were from Kazanlı and Samandağ, which are also main *C. mydas* nesting beaches. In Kazanlı, 60% of strandings had a CCL of 61–81 cm without any records <51 cm, meaning

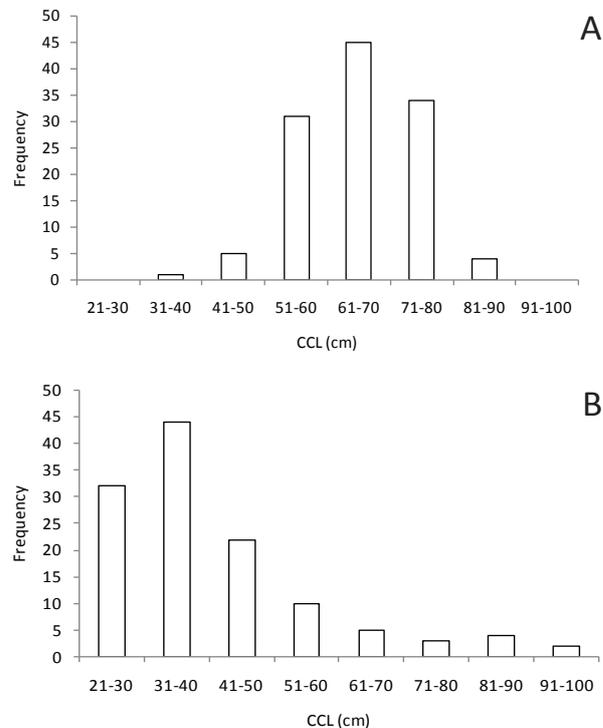


Fig. 3. The size frequency distribution of marine turtle strandings on the eastern Mediterranean coast of Turkey (A: *Caretta caretta*; B: *Chelonia mydas*).

Table 3. Size statistics (CCL in cm) per beach (from west to east) of loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) sea turtles.

Region	<i>Caretta caretta</i>					<i>Chelonia mydas</i>				
	<i>n</i>	mean±SE:	Range	≤30 cm	≥70 cm	<i>n</i>	mean±SE:	Range	≤31.5 cm	≥85 cm
Anamur	1	-	-	-	-	1	-	-	-	-
Göksu Delta	7	68.29±4.89	50–84	-	71.4%	-	-	-	-	-
Alata	2	44.5±12.5	32–57	-	-	2	50.5±3.5	47–54	-	-
Kazanlı	37	66.78±1.25	51–83	-	37.8%	1	-	-	-	-
Mersin	9	69.11±1.99	62–76	-	44.4%	3	33.33±3.81	27.5–40.5	33.3%	-
Tuzla	7	66.07±2.89	53–74	-	42.9%	-	-	-	-	-
Akyatan	10	50.76±6.38	12.6–74	20%	10%	2	86.5	86.5–86.5	-	100%
Ağyatan	12	62.17±2.57	44.5–72	-	25%	-	-	-	-	-
Yumurtalık	1	-	-	-	-	-	-	-	-	-
Samandağ	38	62.24±1.87	13.5–85	2.6%	23.7%	115	40.29±1.39	20–93	34.8%	2.6%

that strandings represent mainly adults and sub-adults. The situation was similar in Samandağ (CCL>41 cm), where *C. mydas* strandings were limited to six beaches (Table 2).

The earlier data from Samandağ beach (2002–2004) are characterized by roughly equal strandings between loggerhead and green turtles (51% and 46.7%, respectively). Between 2005 and 2009, however, 68.2% of strandings were loggerhead turtles compared to 31.8% of green turtles, in line with the fact that *C. caretta* is the most common marine turtle in the Mediterranean (Broderick et al., 2002). The stranding records of Samandağ constituted 60.1% of the overall stranding records, which might be due to sea surface currents from South to North (Hecht et al., 1988) accumulating strandings of turtles which originated from Syria, Lebanon and Israel. This is in line with high amounts of litter washed onto this beach (Özdilek et al., 2006).

Only 39 (31.7%) of the 123 measured loggerhead turtles were adults (CCL>70 cm), which are important for the reproductive output of populations (Crowder et al., 1995; Lewison & Crowder, 2007). Small oceanic juveniles constituted 2.4% of strandings, with the remainder being neritic juveniles and sub-adults, similar to what was reported by Kasperek & Baran (1989). Of the 123 green turtles measured, 33.3% and 4.6% were small juveniles and adults, respectively. The remainder of strandings were neritic juveniles and sub-adults, in line with was previous reports (Kasperek & Baran, 1989; Başoğlu & Baran, 1982; Peters & Verhoeven, 1992; Özdilek-Yalçın & Aureggi, 2006).

The ratio between *C. caretta* and *C. mydas* differs between sea records and strandings, for which more loggerhead turtles are recorded. In 1995, trawler boats reported 160 green turtles and 26 loggerhead turtles in Iskenderun Bay, followed by 306 green turtles and 116 loggerhead turtles in the trawling season 1996–1997 (Oruç, 2001); 82% of the captured green turtles and 61% of the captured loggerhead turtles had CCL values between 31 and 60 cm (Oruç et al., 1997). Oruç (2001) suggested that the eastern Mediterranean coast is

frequented by juveniles, but stranded individuals could be of a different origin.

The present study is not able to provide information about the cause of turtle mortalities, although evidence suggests a high frequency of head trauma in Samandağ (Bektaş Sönmez, personal communication), possibly related to fishing activities. Godley et al. (1998b) estimated that fisheries in Turkey catch 2.5 turtles/boat/year, with 10% of turtles being dead at the point of capture. Small vessels (<12 m) using set nets and demersal or pelagic long lines are thought to cause high numbers of incidental or intentional deaths of turtles, with a total of 9,400 turtles estimated to be caught annually in Turkey (Casale, 2010). The genetic determination of source populations of stranded turtles, therefore, is a high priority for further investigations.

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REFERENCES

- Başoğlu, M. & Baran, İ. (1982). Anadolu sahillerinden toplanan deniz kaplumbağası materyeli üzerinde kısa bir rapor. *Doğa Bilim Dergisi* (Temel Bilimler) 6, 69–71.
- Bolten, A.B. (1999). Techniques for measuring turtles. In: Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. & Donnelly (Eds.) *Research and Management Techniques for the Conservation of Sea Turtles*. IUCN Marine Turtle Specialist Group Publication No: 4, pp. 110–114.
- Broderick A.C., Glen, F., Godley, B.J. & Hays, G.C. (2002). Estimating the number of Green and Loggerhead Turtles nesting annually in the Mediterranean. *Oryx* 36, 1–9
- Casale P., Freggi D., Basso R. & Argano R. (2005). Size at male maturity, sexing methods and adult sex ratio in loggerhead turtles (*Caretta caretta*) from Italian waters investigated

- through tail measurements. *Herpetological Journal* 15, 145–148.
- Casale P., Affronte M., Insacco G., Freggi D., Vallini C., Pino d'Astore P., Basso R., Paolillo G., Abbate G. & Argano R. (2010). Sea turtle strandings reveal high anthropogenic mortality in Italian waters. *Aquatic Conservation: Marine and Freshwater Ecosystems* 20, 611–620.
- Casale, P., & Margaritoulis, D. (2010). Sea turtles in the Mediterranean: distribution, threats and conservation priorities. IUCN, Gland, Switzerland.
- Casale, P. (2011). Sea turtle by-catch in the Mediterranean. *Fish and Fisheries* 12, 299–316.
- Chaloupka, M., Work, T. M., Balazs, G.H., Murakawa, S.K.K. & Morris, R. (2008). Cause-specific temporal and spatial trends in green sea turtle strandings in the Hawaiian Archipelago. *Marine Biology* 154, 887–898.
- Crowder, L.B., Hopkins-Murphy, S.R. & Royle, A. (1995). Effects of turtle excluder devices (TEDs) on loggerhead sea turtle strandings with implications for conservation. *Copeia* 1995, 773–779.
- Deem, S.L., Noton, T.M., Mitchell, M., Segars, A., Alleman, A.R., Cray, C., Popenka, R.H., Dodd, M. & Karesh, W.B. (2009). Comparison of blood values in foraging, nesting and stranded loggerhead turtles (*Caretta caretta*) along the coast of Georgia, USA. *Journal of Wildlife Diseases* 45, 41–56.
- Godley, B.J., Thompson, D.R., Waldron, S. & Furness, R.W. (1998a). The trophic status of marine turtles as determined by stable isotope analysis. *Marine Ecology Progress Series* 166, 277–284.
- Godley, B.J., Gücü, A.C., Broderick, A.C., Furness, R.W. & Solomon, S.E. (1998b). Interaction between marine turtles and artisanal fisheries in the eastern Mediterranean: a probable cause for concern? *Zoology in the Middle East* 16, 49–64.
- Goshe, L.R., Avens, L., Scharf, F.S. & Southwood, A.L. (2010). Estimation of age at maturation and growth of Atlantic green turtles (*Chelonia mydas*) using skeletochronology. *Marine Biology* 157, 1725–1740.
- Hart, K.M., Mooreside, P. & Crowder, L.B. (2006). Interpreting the spatio-temporal patterns of sea turtle strandings: Going with flow. *Biological Conservation* 129, 283–290.
- Hecht A., Pinardi N. & Robinson A.R. (1988). Currents, Water Masses, Eddies and Jets in the Mediterranean Levantine Basin. *Journal of Physical Oceanography* 18, 1320–1353.
- Kasperek, M. & Baran, I. (1989). On the whereabouts of immature sea turtles (*Caretta caretta* and *Chelonia mydas*) in the eastern Mediterranean. *Zoology in the Middle East* 3, 31–36.
- Kasperek, M., Godley, B.J. & Broderick, A.C. (2001). Nesting of the green turtle, *Chelonia mydas*, in the Mediterranean: a review of status and conservation needs. *Zoology in the Middle East* 24, 45–74.
- Lewis, R.L. & Crowder, L.B. (2007). Putting longline bycatch of sea turtles into perspective. *Conservation Biology* 21, 79–86.
- Mendonça, M.T. (1981). Comparative growth rates of wild immature *Chelonia mydas* and *Caretta caretta* in Florida. *Journal of Herpetology* 15, 447–451.
- Oruç, A. Demirayak, F. & Şat, G. (1997). Doğu Akdeniz'de troll balıkçılığı ve deniz kaplumbağları üzerine etkisi. Final Report 30 pp. Doğal Hayatı Koruma Derneği.
- Oruç, A. (2001). Trawl fisheries in the eastern Mediterranean and their impact on marine turtles. *Zoology in the Middle East* 24, 119–125.
- Özdilek, H.G., Yalçın-Özdilek, S., Ozaner, F.S., & Sönmez, B. (2006). Impact of accumulated beach litter on *Chelonia mydas* L. 1758 (green turtle) hatchlings of the Samandağ coast, Hatay, Turkey. *Fresenius Environmental Bulletin* 15, 95–103
- Öztürk, B., Tonay, A.M., Akkaya, A., Öztürk, A.A. & Dede, A. (2011). Stranding of a green turtle, *Chelonia mydas* (Linnaeus, 1758), in the Turkish Black Sea. *Zoology in the Middle East* 52, 115–117.
- Panagopoulos, D., Sofouli, E., Teneketsiz, K. & Margaritoulis, M. (2003). Stranding data as an indicator of fisheries induced mortality of sea turtles in Greece. In: Margaritoulis D. and Demetropoulos A (eds) Proc 1st Mediterranean Conference Marine Turtles pp. 202–206.
- Peters, A. & Verhoeven, K.J.F. (1992). Breeding success of the loggerhead, *Caretta caretta*, and the green turtle, *Chelonia mydas*, in the Göksu Delta, Turkey. Rapport 310 Department of Animal Ecology University of Nijmegen, The Netherlands 26 pp.
- Snover, M.L., Avens, L. & Hohn, A.A. (2007). Back-calculating length from skeletal growth marks in loggerhead sea turtles, *Caretta caretta*, *Endangered Species Research* 3, 95–104.
- Storelli, M.M., Storelli, A., D'Adabbo, R., Marano, C., Bruno, R. & Marcotrigiano, G. O. (2005). Trace elements in loggerhead turtles (*Caretta caretta*) from the eastern Mediterranean Sea: overview and evaluation. *Environmental Pollution*, 135, 163–170.
- Tomás, J., Gozalbes, P., Raga, J.A. & Godley, B.J. (2008). Bycatch of loggerhead sea turtles: insights from 14 years of stranding data. *Endangered Species Research* 5, 161–169.
- Türkozan, O. (2000). Reproductive ecology of the loggerhead turtle, *Caretta caretta*, on Fethiye and Kızılot beaches, Turkey. *Chelonian Conservation and Biology* 3, 686–692.
- Türkozan, O. & Durmuş, H. (2000). A feeding ground for juvenile green turtles, *Chelonia mydas*, on the western coast of Turkey. *British Herpetological Society Bulletin* 71, 1–5.
- Türkozan, O. & Yılmaz, C. (2008). Loggerhead Turtles, *Caretta caretta*, at Dalyan Beach, Turkey: Nesting activity (2004–2005) and 19 year abundance trend (1987–2005). *Chelonian Conservation and Biology* 7, 178–187.
- Türkozan, O. & Kaska, Y. (2010). Turkey. In Casale, P and Margaritoulis D. (Eds) Sea Turtles in the Mediterranean: distribution, threats and conservation priorities, 257–293 pp. IUCN/SSC Marine Turtle Specialist Group, Gland, Switzerland
- Türkozan, O. & Yılmaz, C. (2010). Post-hatchling loggerhead sea turtles, *Caretta caretta* from the eastern Mediterranean. *Marine Turtle Newsletter* 128, 24–25
- Yalçın-Özdilek, Ş. & Aureggi, M. (2006). Strandings of juvenile green turtles at Samandağ, Turkey. *Chelonian Conservation and Biology* 5, 152–154.
- Zug, G., Wetherall, J., Balazs, G., Parker, D. & Murakawa, S. (2002). Age and growth in Hawaiian green sea turtles (*Chelonia mydas*): an analysis based on skeletochronology. *Fisheries Bulletin* 100, 117–127.

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