

Nesting of the Green Turtle, *Chelonia mydas*, in the Mediterranean: a review of status and conservation needs

by Max Kasperek, Brendan J. Godley and Annette C. Broderick

Abstract. The status of the Green Turtle, *Chelonia mydas*, nesting population in the Mediterranean is reviewed on the basis of literature records and unpublished data. It is estimated that 350 to 1750 clutches are laid per year, from which an annual nesting population of 115 to 580 females can be estimated. 99% of all recorded nesting occurs in Cyprus and in Turkey, with the remainder being found in the Lebanon, Israel and Egypt. Interannual fluctuations in the number of nests follows a relatively synchronous pattern across the region. 78% of all nests are concentrated at five key sites, three of them in Turkey (Akyatan, Kazanlı, Samandağ) and two in northern Cyprus (North Karpaz, Alagadi). As well as making the nesting population vulnerable, this concentration allows the focussing of conservation efforts. The existing threats to the nesting sites are described in detail; they are multifold, and include destruction of nesting habitat for tourism and agriculture, beach erosion and pollution. By-catch of turtles in fisheries, direct exploitation, nest predation, and global warming pose additional threats. Despite extensive turtle research in the Mediterranean, our knowledge of the size of the Green Turtle population and population dynamics are still insufficient. Increased consistent monitoring in tandem with conservation management is needed.

Kurzfassung. Auf der Basis von Literaturdaten und unveröffentlichten Berichten wird die Nistpopulation der Suppenschildkröte, *Chelonia mydas*, im Mittelmeer dargestellt. Die Anzahl der alljährlich abgelegten Gelege wird auf 350 bis 1750 geschätzt, woraus sich eine Nistpopulation von 115 bis 580 von Weibchen ableiten lässt. 99% aller Nester sind auf Zypern und in der Türkei konzentriert, der Rest ist auf den Libanon, Israel und Ägypten verteilt. Die alljährliche Fluktuation der Anzahl der Nester folgt in der gesamten Region einem ziemlich synchronen Muster. 78% aller Nester sind auf fünf Niststrände verteilt, von denen drei in der Türkei (Akyatan, Kazanlı, Samandağ) und zwei im nördlichen Zypern (Nord-Karpaz, Alagadi) liegen. Diese Konzentration macht die Population einerseits empfindlich gegenüber Bedrohungen, doch erlaubt sie auch die Konzentration von Schutzbemühungen. Die Bedrohungen der Niststrände sind im Detail beschrieben; sie sind vielfältig, und umfassen die Zerstörung von Nistgebieten durch Tourismus und Landwirtschaft, Stranderosion und Verschmutzung. Der Beifang von Suppenschildkröten in Fischnetzen, die gezielte Ausbeutung, Nestplünderung und die globale Erderwärmung stellen zusätzliche Bedrohungen dar. Trotz der intensiven Forschungen an Meeresschildkröten im Mittelmeer ist unser Wissen über die Populationsgröße und die Populationsdynamik der Suppenschildkröte ungenügend. Es werden vor allem standardisierte Monitoring-Daten im Verein mit einem Populationsmanagement benötigt.

Key words. Population assessment, marine turtle, threats, Turkey, Cyprus, Israel, Middle East.

Introduction

The Green Turtle, *Chelonia mydas*, is globally endangered, and the Mediterranean subpopulation has recently been classed as critically endangered (IUCN 2000). Genetic data suggest that the population in the Mediterranean is relatively discrete from that of the wider Atlantic

(BOWEN et al. 1992, ENCALADA et al. 1996). Past commercial exploitation for food exports (1930–1983) led to a massive decline in its breeding stocks in the Mediterranean (SELLA 1982). This situation has worsened in recent years as a result of loss or deterioration of nesting beaches, adverse pressure from incidental catch in marine fisheries (particularly trawling) and marine pollution (CORBETT 1989, GROOMBRIDGE 1990, HUTCHINSON & SIMMONDS 1992, MEDASSET 2000).

Nesting in the Mediterranean appears always to have been confined to the Levantine Basin, with recent records of nesting in Turkey, Lebanon, Israel, Egypt and Cyprus. There are no indications that Green Turtles have ever nested in the central and western parts of the Mediterranean, even in the seminal reviews of the regional biology of the species by GELLDAY et al. (1981) and SELLA (1982) Although these first reviews did not give great detail of the distribution or population size, they did indicate that large numbers had once nested in southern Turkey and Israel, and that they had already considerably declined. Once preliminary monitoring was underway, CORBETT (1989) and then GROOMBRIDGE (1990) estimated that in the Mediterranean as a whole, the population could number as few as 300–400 nesting females per year.

To help update our knowledge of Green Turtles in the Mediterranean, we attempt to review the magnitude of the nesting of this species and review the conservation status and threats experienced. For this purpose, we review a wide body of literature, including many unpublished reports and results solicited by direct communication with colleagues working in the region.

Nesting population: distribution and numbers

Nesting in Turkey

The first comprehensive marine turtle survey was carried out along the Turkish coast in 1988 on behalf of the World Wide Fund for Nature (BARAN & KASPAREK 1989). Green Turtles have been reported nesting at 12 sites along the Turkish coastline (Fig. 7).

Dalyan (36°46'N 28°36'E – 36°47'N 28°38'E)

There are anecdotal reports of Green Turtles nesting at Dalyan beach, a well-known nesting site of the Loggerhead Turtle, *Caretta caretta*. However, none of these reports have yet been substantiated (KASPAREK 1990).

Patara (36°20'N 29°14'E – 36°15'N 29°19'E)

IN 2000, ERDOĞAN et al. (2001) identified two Green Turtle nests among those of the Loggerhead Turtle. Patara represents the westernmost substantiated site for Green Turtle nesting in the Mediterranean.

Kumluca (36°18'N 30°09'E – 36°16'N 30°22'E)

Seven Green Turtle nests were recorded in 1994 (YERLI & DEMIRAYAK 1996), however YERLI et al. (1998) found no evidence of nesting by this species in a comprehensive survey carried out in 1998. Kumluca is also a Loggerhead Turtle nesting site, and it is thought that Green Turtle nests may have been overlooked among those of Loggerhead Turtles.

Belek (36°51'N 30.55'E – 36°50'N 31°10'E)

Low numbers of Green Turtle nesting at Belek were mentioned by GELDIAY et al. (1981) and GELDIAY (1987). During a 1988 survey, no nests of this species were located, but the area was found to be one of Turkey's major areas for nesting Loggerhead Turtles (BARAN & KASPAREK 1989). Four Green Turtle nests were recorded in each of 1994 (YERLI & DEMIRAYAK 1996) and 1998 (YERLI & CANBOLAT 1998a, 1998c, YERLI et al. 1998). In 2000, three nests were recorded within the "Belek Specially Protected Area" and five between Aksu River and Acisu (CANBOLAT 2000a, b).

Side-Kızılot area (36°46'N 31°23'E – 36°42'N 31°34'E)

GELDIAY et al. (1981) mentioned Green Turtle nesting at Side-Niğit beach in 1979. In 1988, Green Turtle nesting was confirmed (BARAN & KASPAREK 1989). No Green Turtle nests were recorded during a 1994 survey (YERLI & DEMIRAYAK 1996) but one nest was recorded in 1998 (YERLI et al. 1998).

Alanya area (36°33'N 32°00'E – 36°27' 32°07'E))

GELDIAY et al. (1981) and GELDIAY & KORAY (1982) mentioned Green Turtle nesting at beaches around Alanya, without giving details on the locality and no more recent records have been reported.

Göksu Delta (36°19'N 33°54'E – 36°18'N 34°02'E)

No signs of Green Turtle nesting were recorded during incomplete or sporadic monitoring surveys in 1988, 1993 and 1994 (BARAN & KASPAREK 1989, YERLI & DEMIRAYAK 1996), but more complete surveys in 1991, 1992, 1996, 1998 all revealed nesting (Tab. 1).

Tab. 1. Number of Green Turtle nests recorded during the full season surveys of the Göksu Delta. References: (a) VAN PIGGELEN (1991;1993); (b) PETERS & VERHOVEN (1992); (c) GLEN et al. (1997); (d) YERLI & CANBOLAT (1998a). n.k. = not known.

	1991	1992	1996	1998
survey period (approx. no. of days)	90	n.k.	6 surveys over 54 days	90
no. of nests	20	14	3	12
Data source	a	b	c	d

Kazanlı (36°49'N 34°44'E – 36°49'N 34°47'E)

Green Turtle nesting at this site was first mentioned by GELDIAY & KORAY (1982) and its regional importance was highlighted in a 1988 survey (BARAN & KASPAREK 1989). In 1988 a total of 152 nests was recorded with 95 of these being on a 0.6 km stretch of beach (beach K3, see Fig. 1) leading to a nesting density in K3 of 158 nests/km, which is unusually high in the Mediterranean. Monitoring in subsequent years has been incomplete (Tab. 2), but has confirmed the key importance of this site (SMART & COLEY 1990, YERLI & CANBOLAT

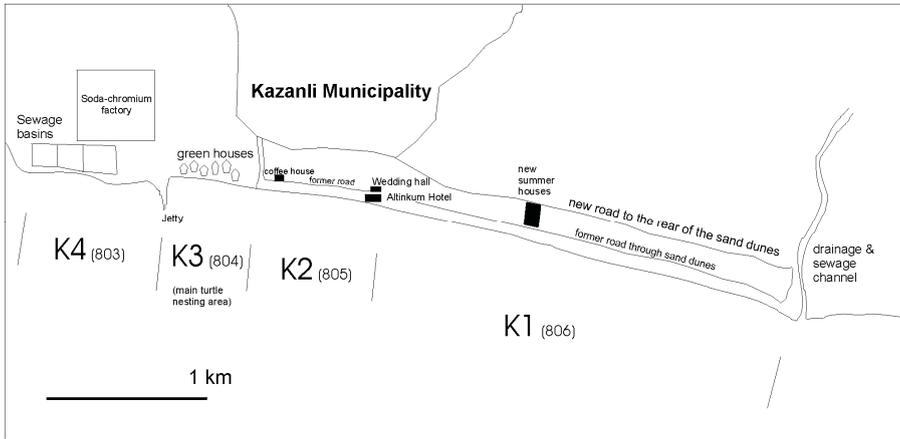


Fig. 1. Nesting beach at Kazanlı, Turkey. The map shows the beach sections K1-K4 used in various studies plus the numbering of of beach sectors according to BARAN & KASPAREK (1989). Some of the greenhouses were removed in 2000 and 2001.

Tab. 2. Summary of information on Green Turtle nesting from Kazanlı, Turkey. The table gives the approximate number of days over which the survey extended within the nesting season, and the number of nests found. Only the 1994 and 1996 surveys can be considered complete estimates. Data sources: (a) BARAN & KASPAREK (1989), BARAN et al. (1991); (b) SMART & COLEY (1990), COLEY & SMART (1992); (c) DURMUŞ (1998); (d) YERLI & DEMIRAYAK (1996); (e) YERLI & CANBOLAT (1998b); (f) DEMIRAYAK (2000), ALTAN & KASPAREK (2000).

	1988	1990	1993	1994	1996	2000
survey period (approx. no. of days)	69	41	>50	92	95	5
no. of nests	152	74	176	216	128	111
Data source	a	b	c	c, d	e	f

1998b). Due to the profound degradation of the site (see below), it was assumed by DEMIRAYAK (1999, 2000) that the beach had effectively been lost as a breeding site. However, partial surveys in 2000 (ALTAN & KASPAREK 2000) demonstrated that this was not the case, confirming the continued importance of this site and in particular beach section K3.

Tuzla beach (36°43'N 34°54'E – 36°41'N 35°07'E)

YERLI & CANBOLAT (1998b) reported eight Green Turtle nests on the beach between Tuzla and the mouth of the Seyhan River in 1996.

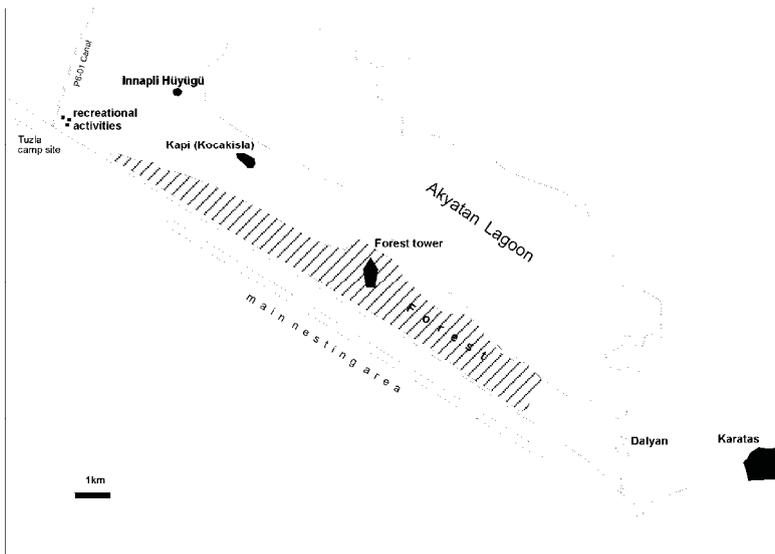


Fig. 2. Green Turtle, *Chelonia mydas*, nesting beach at Akyatan, Turkey.

Akyatan (36°41'N 35°05'E – 36°33'N 35°19'E)

Green Turtle nesting at this site was first mentioned by GELDIAY & KORAY (1982). Surveys in 1988 revealed that this was the single most important nesting site for Green Turtles in the Mediterranean with a total of 108 nests being recorded despite only occasional surveying (BARAN & KASPAREK 1989). Additional occasional monitoring was carried out in 1991 (WHITEMORE 1991) and surveying of 13 km of the site was carried out in 1992 (MACDONALD & BROWN 1992). From 1994–1998, although there have been variations in methodology, there has been monitoring which has resulted in an estimate for each season (Tab. 3). All data have confirmed the regional importance of this site. The results of surveys from 1999–2000 are unfortunately not yet available.

Tab. 3. Summary of nesting information from Akyatan. The table gives the approximate number of days over which the survey extended within the nesting season, and the number of nests found. Data sources: (a) BARAN & KASPAREK (1989); (b) WHITEMORE (1991); (c) MACDONALD & BROWN (1992b); (d) AUREGGI et al. (2000); (e) GEROSA et al. (1995a, b); (f) GEROSA et al. (1995c); (g) GEROSA et al. (1996); (h) GEROSA et al. (1997); (i) AUREGGI et al. (2000). For 1996, 179 nests have been accepted according to AUREGGI et al. (2000), although GEROSA et al. (1996, 1998) detail 231 nests for that season. nk: not known.

	1988	1991	1992	1994	1995	1996	1997	1998
survey period (approx. no. of days)	7	3	n.k	81	74	84	85	n.k
no. of nests	108	210	120	496	504	179	231	735
Data source	a	b	c, d	d, e	d, f	d, g	d, h	i



Fig. 3. Green Turtle, *Chelonia mydas*, nesting beach at Samandağ in Turkey near the border with Syria.

Ağyatan and Yelkoma beaches (36°35'N 35°28'E – 36°35'N 35°34'E)

GELDIAY & KORAY (1982) reported the occurrence of Green Turtles at Yumurtalık, including nesting at “Yumurtalık beach”. These reports are somewhat vague, in particular as the beaches in the immediate vicinity of Yumurtalık are not very suitable for turtle nesting. Thus the reports may refer to the Ağyatan and Yelkoma beaches to the south of Yumurtalık where six nests, presumed to be of Green Turtles, were found in 1988 (BARAN & KASPAREK 1989). YERLI & CANBOLAT (1998b) recorded four nests at Ağyatan and two nests at Yelkoma beach in 1996. Occasional turtle nesting was recorded at the “University Camp” to the south of Yumurtalık, but not since the early 1990's (KASPAREK, unpubl.).

Samandağ (36°07'N 35°55' E – 36°01'N 35°58'E)

A single nesting Green Turtle was recorded in 1982 (cited by BARAN & KASPAREK 1989). In June/July 1988, a total of 33 nests was recorded (BARAN & KASPAREK 1989). Continuous surveying over the entire nesting period was carried out in 1994, and concentrated on Şeyhıdır beach, which has the highest nesting density, recording a total of 126 nests (DURMUŞ 1998, cf. YERLI & DEMIRAYAK 1996 who report a smaller number of nests). In 1996, a total of 44 nests was recorded (YERLI & CANBOLAT 1998b) and 21 nests were recorded in August 1999 (DEMIRAYAK 1999).

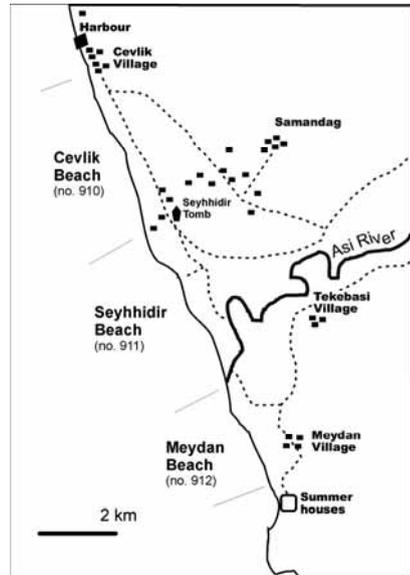


Fig. 4. Green Turtle nesting beach at Samandağ, Turkey. Beach numbering according to BARAN & KASPAREK (1989).

Nesting in Syria

Although subject to limited monitoring in 1991 (KASPAREK 1995), the coastline of Syria appears only to support only low density nesting of Loggerhead Turtles. However, nesting by Green Turtles cannot be ruled out as most tracks were rather old and obliterated by wind, or covered with litter which made species identification impossible in many cases (KASPAREK 1995).

Nesting in Lebanon

Green Turtle nesting in southern Lebanon was confirmed in summer 2000 (press release by Medasset on 6.4.2001). Details on location and numbers are not known; a survey is planned for summer 2001.

Nesting in the Gaza Strip

The Gaza Strip has apparently never been surveyed for marine turtle nesting.

Nesting in Israel

Nesting in Israel occurs in low numbers in most years (Tab. 4). Nesting occurs at different localities in different years e.g. all nests in 1999 were laid close to the town of Hadera (45 km N of Tel Aviv); the nests of the year 2000 were near the town of Ashgelon (45 km S of Tel Aviv) and near Netanya (32 km N of Tel Aviv) (KULLER, pers. comm.).

Tab. 4. Number of Green Turtle, *Chelonia mydas*, nests recorded in Israel. Data sources: KULLER (1998, 1999, and pers. comm.).

	1993	1994	1995	1996	1997	1998	1999	2000
no. of nests	0	8	1	0	2	13	8	8

Nesting in Egypt

The coast between Alexandria and El Salum at the border with Libya was surveyed in 1993 (KASPAREK 1993a, 1993b), and the Nile delta and northern Sinai (and again the coast between Alexandria and El Salum) in 1998–2000 (CAMPBELL et al. 2000, 2001, CLARKE et al. 2000a, 2000b). Whereas no Green Turtle nests were found in the Nile delta and the area between Alexandria and El Salum, between Rafah and Port Said in Northern Sinai one nest was identified in 1998; none were found in 1999, and 3 were recorded in 2000.

Nesting in the Central and Western Mediterranean

Despite surveying throughout the Mediterranean, Green Turtle nesting has not been confirmed in Central and Western parts. This is particularly noteworthy for Greece, Libya and Tunisia, where Loggerhead Turtles nest in significant numbers (e.g. MARGARITOU LIS 2000, LAURENT et al. 1995, LAURENT et al. 1999).

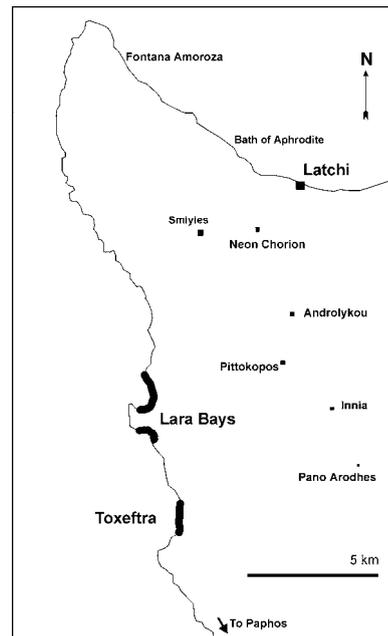


Fig. 5. Akamas Peninsula, Cyprus. The map shows the two main nesting areas for Green Turtles, i.e. Lara Bay and Toxeftra Bay.

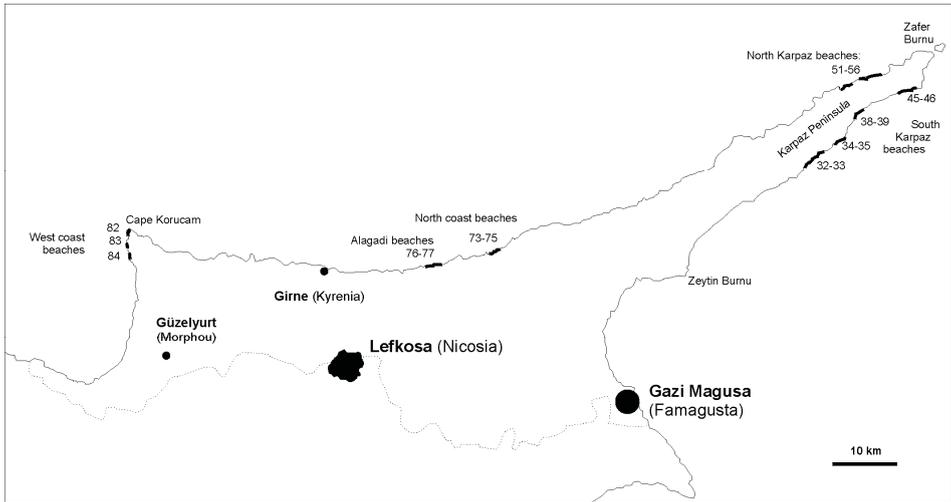


Fig. 6. Nesting beaches used by the Green Turtle, *Chelonia mydas*, in northern Cyprus. Beach numbers follow BRODERICK & GODLEY (1993).

Nesting in Cyprus

Akamas Peninsula (Cyprus)

A small number of Green Turtles nest around the Akamas Peninsula, notably in the Lara area. Beaches in the Lara region include Toxeftra (ca. 1.0 km) and Lara south, central and north beaches (3.0 km in total). Nesting occurs also occasionally at Ayiie Phanentes (1.5 km), but numbers are not significant. The Green Turtle population has been estimated to comprise 100 individuals (DEMETROPOULOS & HADJICHRISTOPHOROU 1987) with 95 individual females having been tagged over the years (DEMETROPOULOS & HADJICHRISTOPHOROU 1995, 2000). GROOMBRIDGE (1990) concluded that on average some 25 females (with approx. 75 nests per season) nest in the Akamas Peninsula each season.

South-western coast

Small numbers of Green Turtles (1-2 nests per year) nest in Episkopi Bay. Nesting was also recorded north of Paphos in 1976/1977, but nesting has ceased there due to intensive human use (DEMETROPOULOS & HADJICHRISTOPHOROU 2000).

Ayia Napa

Small numbers of Green Turtles were found nesting at Ayia Napa in 1976/1977, but nesting has ceased because of the intensive use of the beach for tourism (DEMETROPOULOS & HADJICHRISTOPHOROU 2000).

Tab. 5. Spatial and temporal patterns of Green Turtle nests in northern Cyprus (1993–2000) for study sites see Fig. 6. n.m. = not monitored. Sources of data: (a) BRODERICK & GODLEY (1993); (b) GODLEY & BRODERICK (1994); (c) BRODERICK & GODLEY (1995); (d) GODLEY & KELLY (1996); (e) BRODERICK et al. (1997); (f) GODLEY et al. (1998); (g) BRODERICK et al. (1999); (h) GLEN et al. (2000). Data from 1992 were omitted (incomplete survey, GODLEY & BRODERICK 1992). Beach nos. as per BRODERICK & GODLEY (1993), see Fig. 6.

beach area	Beach nos.	1993	1994	1995	1996	1997	1998	1999	2000
West Coast	82	42	28	33	16	18	21	20	43
	83/84	23	52	15	7	11	18	12	42
Alagadi	76/77	50	68	64	8	13	111	8	82
	73-75	9	27	15	3	23	21	18	23
North Karpaz	51-56	95	133	104	38	44	167	69	179
South Karpaz	45/46	21	57	13	11	19	23	15	34
	38/39	24	31	15	28	12	29	22	n.m.
	34/35	8	12	21	9	3	25	5	n.m.
	32/33	6	7	10	5	1	14	0	n.m.
Sum	–	278	415	290	125	144	429	169	>403
% annual total	–	86.9	90.0	81.0	92.6	92.3	93.9	84.9	n.a.
Source		a	b	c	d	e	f	g	h

Northern Cyprus

The numerous beaches and coves of northern Cyprus have been subject to detailed annual monitoring studies since 1992. These sites are the ones from where the longest time series of monitoring data are available: complete surveys of all major nesting beaches have been undertaken over eight seasons (1993–2000), and all beaches monitored for seven seasons (1993–1999). The methodology of survey has been previously described (BRODERICK & GODLEY 1996). Nesting of Green Turtles is centred in four main areas (west coast, north coast and the north and south coasts of the Karpaz peninsula; Tab. 5, Fig. 6). Tab. 5 shows that 9 sites account for between 81.0 and 93.9% of all nesting for this species and that numbers at all sites greatly fluctuate from year to year, with the lowest annual total being 135, and the highest 461 nests.

Population size and distribution

Our present knowledge reviewed above does not allow us to precisely assess the number of nesting female Green Turtles in the Mediterranean. Even for some of the main nesting beaches, data are scant, and the high inter-annual fluctuation in nesting numbers makes comparison among the various nesting areas difficult.

Given that the annual number of clutches laid in the Mediterranean varies roughly between 350 and 1750 per annum, an approximate estimate of 115–580 females per season can be generated by dividing the number of nests by a factor of 3, the estimated mean number of nests laid per female in any season (see e.g. GROOMBRIDGE 1990).

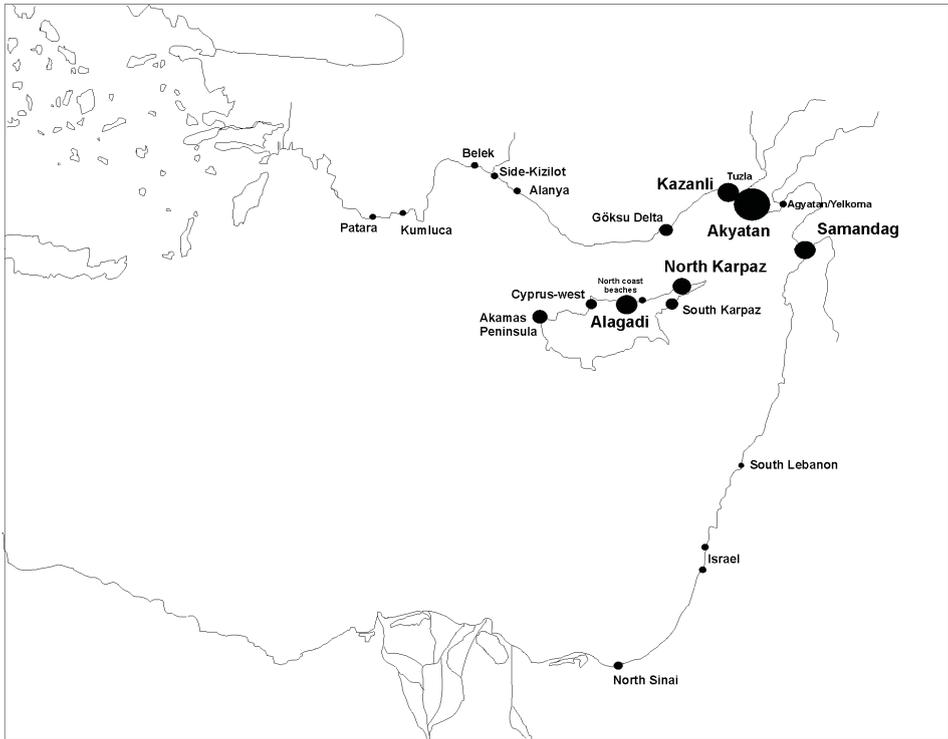


Fig. 7. Nesting distribution of the Green Turtle, *Chelonia mydas*, in the Mediterranean. The size of the dots represents the approximate number of nests laid (larger dots represent more important nesting areas).

The present nesting distribution is largely confined to Turkey and Cyprus, with less significant nesting also occurring along the Levantine coast (Lebanon, Israel, Egypt). Nesting in Syria cannot be ruled out. The coastlines of Lebanon and the Gaza Strip are the only parts of the eastern Mediterranean which have not as yet been systematically surveyed for turtle nesting. Following the discovery of Green Turtle nesting in the Lebanon in 2000, a comprehensive survey will be carried out as a high priority in 2001, as a joint project by MEDASSET, RAC/SPA and the Lebanese authorities. In order to identify conservation priorities for Mediterranean Green Turtle nesting areas, they are classified according to the maximum number of nests recorded in any year: beaches with a maximum of over 100 nests per season are regarded as nesting areas of major importance, beaches with 10 to 100 nests per season as nesting areas of moderate importance, and those with less than 10 nests per season as nesting areas of minor importance. As the highest number of nests recorded in one year have been used for this classification, the beaches qualify for one of the three categories even if these thresholds are not reached every year. Nesting beaches are defined for this purpose as “protectable” units, i.e. areas which can be treated as a unit not only from a physiogeographical point of view, but which would also allow protection of the areas under a single area-approach.

Tab. 6. Overview of the nesting status of the Green Turtle in the Mediterranean. The nesting areas are divided into major nesting areas, moderate nesting areas, and minor nesting areas (for definitions see text), based on the maximum number of nests per season. Beach numbers for sites in northern Cyprus follow Fig. 6 (see BRODERICK & GODLEY 1993 for details). SIT Areas are protected areas in Turkey which are under the auspices of the Ministry of Culture.

1. Most important nesting areas for the Green Turtle in the Mediterranean

Beach name	Beach length (km)	max. no. of nests	max. nest density (nests/km)	notes on protective status
Akyatan	21.7	735	33.8	Permanent Wildlife Reserve, Ramsar Site (lagoon), Natural SIT (areas adjacent to the nesting beach)
Kazanlı	5.4	216	40.0	No protective status
North Karpaz (beach nos. 51-56)	3.1	179	57.7	No protective status
Samandağ	10.3	113	10.9	No protective status; partly restricted access (border with Syria)
Alagadi (beach nos. 76-77)	2.0	111	55.5	Specially Protected Area

2. Nesting areas of moderate importance

Beach name	Beach length (km)	max. no. of nests	max. nest density (nest/km)	Notes on protective status
Akamas Peninsula (5 beaches)	5.5	approx. 75	13.6	Protected area (turtle reserve) since 1989
Göksu Delta	36.1	20	0.6	Specially Protected Area, Wildlife Protection Area, Ramsar Site (lagoons)
West Coast: beach no. 82	0.3	43	143.3	No protective status
West Coast: beach nos. 83-84	2.1	52	24.7	No protective status
North Coast: beach nos. 73-75	1.3	27	20.7	No protective status
South Karpaz: beach nos. 45-46	4.0	57	14.2	No protective status
South Karpaz: beach nos. 38-39	1.2	31	25.8	No protective status
South Karpaz: (beach nos. 34-35)	0.8	25	31.3	No protective status
South Karpaz: beach nos. 32-33	0.5	14	28.0	No protective status

3. Discrete nesting areas of minor importance

beach name	beach length (km)	max. no. of nests	max. nest density (nests/km)	Notes on protective status
Israel (3 areas)	n.a.	13	n.a.	No protective status
Tuzla	20.0	8	0.4	Permanent Wildlife Reserve

Kumluca (Tab. 6, cont.)	20.5	7	0.3	No protective status
Belek	21.8	4	0.2	A sand spit of the Acisu River has been designated Specially Protected Area
Ağyatan and Yelkoma beaches	31.5	4	0.1	Yumurtalık Nature Reserve and Natural SIT.
Northern Sinai	n.a.	3	n.a.	Partly within Zaranik Protected Area (Biosphere Reserve)
Patara	11.8	2	0.2	Specially Protected Area, SIT Area
Side-Kızılot area	16.2	2	0.1	No protective status.
Lebanon	n.a.	1	n.a.	No protective status.

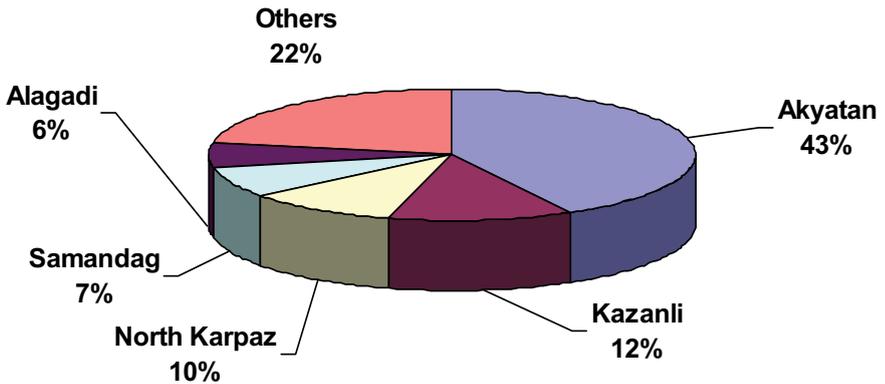


Fig. 8. Relative annual contribution in number of Green Turtle nests for the eastern Mediterranean. Average annual values are shown.

Significant numbers of Green Turtles are only found in Turkey and Cyprus. Although nesting occurs also along the Levantine coast (Lebanon, Israel, Egypt), these make up less than 1% of the Mediterranean nesting population. Turkey holds two thirds of the Mediterranean Green Turtle nests, and Cyprus one third (Fig. 8). 78% of all Mediterranean Green Turtle nests are concentrated at the five most important nesting sites. Akyatan is by far the single most important nesting beach (42% of the Mediterranean population) This beach is followed by Kazanlı and Samandağ. Other Turkish beaches are only of minor importance for Green Turtle nesting. In Cyprus, nesting is distributed over many beaches and small coves. The single most important nesting ground is the site in the North Karpaz (beaches 51-56; Tab. 5), harbouring approx. 10% of the Mediterranean population, followed by Alagadi,

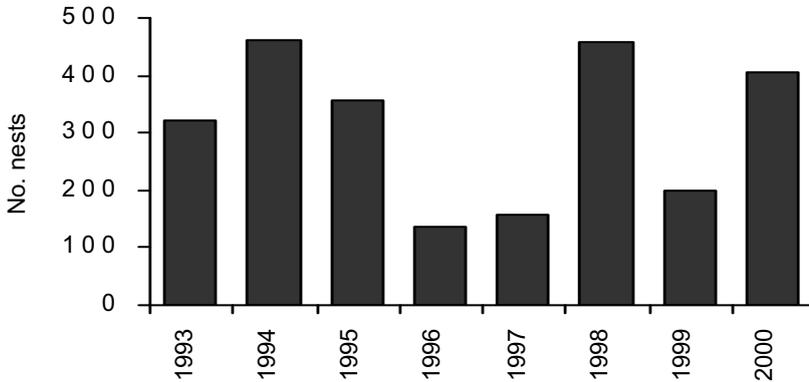


Fig. 9. Annual number of Green Turtle nests recorded in northern Cyprus between 1993 and 2000 (the period when complete and systematic surveys of the major nesting beaches were undertaken). For data sources see Tab. 5.

with approx. 6% (beaches 76-77; Tab 5). The available data do not allow to fully assess the importance of the beaches of the Akamas Peninsula and to compare them with other beaches due to the lack of annual nesting data, but it is thought that the Green Turtle nesting population there is important.

Annual fluctuation of nesting numbers and detecting trends in population size

The number of Green Turtle nests on single nesting beaches vary greatly from year to year. Long-term monitoring data are available only from northern Cyprus, Akyatan in Turkey and the beaches of Israel. The annual total of nests has ranged between 135 and 461 nests in northern Cyprus (see Tab. 5), 179 and 735 in the seasons of complete monitoring at Akyatan (see Tab. 3) and between 0 and 13 nests in Israel (see Tab. 4). This profound interannual variation is infitting with that found in Green Turtles nesting in other regions (LIMPUS & NICHOLLS 1988) and is thought to be the result of highly variable remigration intervals driven by variation in the quality in the Green Turtle's herbivorous diet (BRODERICK et al. 2001). When plotting the annual number of nests as a proportion of recorded maximum for different sites in northern Cyprus (Fig. 10a), it can be seen that fluctuations are relatively similar for all sites. This suggests that low nest numbers in one area are not balanced by high nest numbers in other areas. Data regarding many other sites in the Mediterranean are too fragmentary to undertake a similar exercise, however the limited data from Akyatan, Gökusu Delta and Israel show similar patterns of variation in the magnitude of numbers of nests recorded as found in northern Cyprus (Fig. 10b). The annual fluctuations of Green Turtle nesting thus apparently follow a general pattern in the entire Mediterranean. This suggests that nesting females in this region may form mixed stocks in foraging grounds and/or that most foraging grounds for this population experience similar conditions.

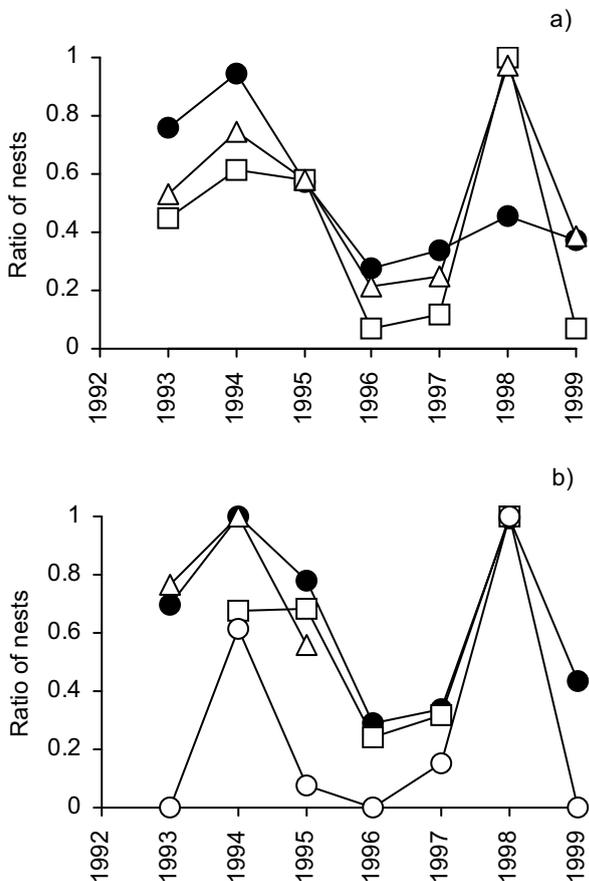


Fig. 10. Relative annual nesting activity by green turtles in the eastern Mediterranean (scaled as proportion of maximum for each site): a) at different sites in northern Cyprus: Alagadi (squares), North Karpaz (triangles), and on the west coast (circles). b) at different sites in the eastern Mediterranean: northern Cyprus (filled circles), Akyatan (squares), Gökusu Delta (triangles) and Israel (open circles). For sources of data see Tabs. 1, 3, 4 and 5.

The available data do not yet allow us to discern any trend in population size. The high inter-annual variation in nesting number also shows the limited value of single-season assessments and the need for ongoing monitoring of key sites. Survey data from only one season may be sufficient to identify nesting beaches, but they do not give a reliable picture of the importance of a nesting area within a regional context.



Fig. 11. Turtle shells offered as souvenirs in Taşucu, Turkey, in 1988. This trade plays no longer a significant role. Photograph: Max KASPAREK.

Threats

In addition to the degradation of nesting habitats, there are a number of perceived general threats to the Mediterranean Green Turtle population for which quantitative data are generally lacking.

Incidental capture in fisheries and direct exploitation

Many Green Turtles are caught annually as fishery-bycatch in the eastern Mediterranean. ORUÇ et al. (1997), GODLEY et al. (1998a, b), and ORUÇ (2001) showed that the numbers involved are significant and are a cause for concern. The overall mortality rate of captured turtles is still unknown. Trawling takes place very close offshore of some of the most important turtle nesting beaches, and may have significant impacts in terms of mortality, disturbance and destruction of habitats. This is true in particular for Kazanlı, Akyatan and Göksu Delta.



Fig. 12. Marine turtle found on the beach of Samandağ, Turkey, in June 2001. It apparently drowned in a fishing net. Note the dark incisions at the throat. Photograph: Ismail ZUBARI.

Green Turtles are also subject to direct exploitation in Egypt by fishermen who, although may capture turtles incidentally, sell them for human consumption (KASPAREK 1993b, NADA 2001).

Predation

Nest predation by the Red Fox (*Vulpes vulpes*), Golden Jackal (*Canis aureus*; except in Cyprus) and domestic/feral dogs (*Canis familiaris*) is widespread at Green Turtle nesting sites in Cyprus (DEMETROPOULOS & HADJICHRISTOPHOROU 1989, 2000, BRODERICK et al 1996), Turkey (e.g. VAN PIGGELEN 1991, BROWN & MACDONALD 1995, AUREGGI et al 1999) and Israel (KULLER 1999). Nest loss rates have been described as up to 70% in Cyprus (DEMETROPOULOS & HADJICHRISTOPHOROU 1989) and 68% at Akyatan (BROWN & MACDONALD 1995). These levels have mandated protective measures which have involved translocation to hatcheries (DEMETROPOULOS & HADJICHRISTOPHOROU 1989, KULLER 1999) and *in situ* nest screening (DEMETROPOULOS & HADJICHRISTOPHOROU 1989, 2000, BRODERICK & GODLEY 1996) which although time and labour-intensive have been shown to reduce predation and increase hatchling production substantially. In Akamas beaches, 0-6 Green Turtle nests are – in addition to a significantly higher number of Loggerhead Turtle nests – translocated per



Fig. 13. The environment of Kazanlı, one of the most important Green Turtle nesting areas in the Mediterranean, is heavily polluted by a soda-chromium factory which regularly discharges chemical substances into the sea. The photograph shows a discharge canal leading to the sea. Photograph: Max KASPAREK.

year. It is difficult to know what natural levels of predation would be if the population was larger. Current high levels may be the result of domestic/feral animals, natural predators such as the Red Fox being present at unnaturally high levels as a result of human detritus in the vicinity of nesting sites (BROWN & MACDONALD 1995). Until such times as the Mediterranean Green Turtle population has a more favourable conservation status, textensive nest protection measures are justified in particular at the main nesting sites (Akyatan, Cyprus) where roughly two thirds of all unprotected nests are predated.

Pollution

The eastern Mediterranean is subject to high levels of pollution with marine debris, much of which is washed up on nesting beaches (below). This is in particular true for the nesting beaches at Cyprus, Samandağ (Turkey) and Egypt. Although the eastern Mediterranean is highly contaminated with litter, this does not necessarily mean that turtles are exposed to high levels of all environmental contaminants. In studies of Green Turtle tissues and eggs it was found that levels of heavy metals (Hg, Cd and Pb; GODLEY et al. 1999) and concentra-

tions of individual chlorobiphenyls and organochlorine pesticides (MCKENZIE et al. 1999) were very low (cf. also KASKA & FURNESS 2001). However, it is thought that litter may provide shelter for Ghost Crabs (*Ocypode cursor*), and thus indirectly may increase mortality among hatchlings (SMITH et al. 1998).

A soda-chromium factory close to the nesting beach at Kazanlı regularly discharges chemical substances into the sea, including highly toxic chromium (VI) compounds. There is one documented case of discharge from 6 March, 2001 (UMWELTBÜRO WOLF 2001), but the scope of the pollution and the impact on Green Turtle populations has not yet been fully assessed. Another spill of chemical substances happened on 12 July, 2001. However, more than 15 dead Green Turtles, together with Loggerhead Turtles and Nile Soft-shelled Turtles (*Trionyx triunguis*), were washed onto the shore of Kazanlı between June and September 2001, and the previous discharge of toxic chromium (VI) is thought to be at least one of the reasons for it (M. KASPAREK).

Global warming

Due to temperature dependent sex determination and likely skews in natural sex ratios of hatchling production towards female (BRODERICK et al 2000, CASALE et al. 2000), an emerging threat is that of rapid global environmental change and resultant warming which could alter the thermal characteristics of sand on turtle nesting beaches resulting in the reduction or cessation of male hatchling production. This could threaten the survival of Mediterranean Green Turtle populations in the long term.

Degradation of nesting habitats

A summary of these threats and their likely severity is given in Tab. 7 for all major and moderate nesting sites. In addition a detailed description for each of the major nesting areas is given below. Some of the sites are summarised under single headings (e.g. northern Cyprus).

Akyatan

The Akyatan beach is relatively remote, but nevertheless has a number of environmental problems: Local tourism occurs during the summer months at both ends of the beach. In particular around Tuzla several thousand tents are found during the summer months, in addition to some permanent buildings. The area where the tourists are concentrated is of minor importance for turtle nesting, but there is a permanent threat that these facilities will increase and extend over the main nesting beach. As on other eastern Mediterranean beaches, there is much sea-borne litter washed ashore, and this is not cleaned even during the nesting season. Tractors are not prevented from driving over some of the most sensitive nesting zones. Fishing (trawling) and pollution (high level of agrochemicals assumed to be present in the sea) are factors that may affect turtles in the sea in front of the nesting beach, although concrete information is absent. Nest predation is high.

Akyatan beach is protected as a Permanent Wildlife Reserve. The lagoon has been designated a Ramsar Site, and there is a "Natural SIT" (protected areas category under the auspices of the Turkish Ministry of Culture), which however does not include the nesting beach.



Fig. 14. Beach section K3 of Kazanlı, Turkey: through beach erosion and the agricultural use of the sand dunes (green houses), the beach has almost been completely lost (photograph: M. KASPAREK).

Tab. 7. Summary assessment of the threats at Green Turtle nesting sites in the eastern Mediterranean. The table covers only those sites which are either major nesting beaches or where nesting takes place in moderate, but significant numbers. Three dots means “very serious threat”, two dots “medium impact”, and one dot “minor threat”. For the beach numbers for sites in northern Cyprus see Fig. 6.

Site	Develop- ment	Pollution	Sand extraction	Beach erosion	Other human disturbance	Nest predation
Major nesting						
Akyatan		•			•	•••
Kazanlı	•••	•••		•••	•••	•
N. Karpaz: (51-56)		••			•	••
Samandıĝ	•••	•••	••	•••	•	
Alagadi: (76-77)	•	•	••	••		••
Moderate nesting						
Göksu	•		•		•	
Akamas	•				•	
West Coast: (82)		•				••
West Coast: (83-84)		•	•			••
North Coast: (73-75)	••	•			••	••
S. Karpaz: (45-46)	••				••	••
S. Karpaz: (38/39)						••
S. Karpaz: (34/35)						••
S. Karpaz: (32/33)						••

Göksu Delta

In the past, large parts of the sand dunes especially those next to Akgöl, have been lost through sand extraction. Although now prohibited, extraction still occurs. The paper mill located at Taşucu has an outlet into the sea at the southernmost tip of the delta, and discharges untreated or partially treated sewage into the sea. Solid wastes including plastic materials have been found even on the remote beaches of the delta area, which may have been seaborne or carried down the Göksu River (cf. YERLİ & DEMIRAYAK 1996). Light pollution by the town of Taşucu and summer homes as well as from highway sections close to the shore affect the breeding grounds. The entire Göksu Delta was declared a “Specially Protected Area” in 1990. Akgöl and Paradeniz lagoons are, in addition, “Wildlife Protection Areas”. In 1994, the Göksu Delta was listed by the Turkish Government under the Ramsar Convention.

Kazanlı

Kazanlı faces a large number of threats that have different effects on the various beach sections (cf. Fig. 1). The environmental problems can be summarised as follows:

Beach erosion: Roughly one metre of beach width is lost every year, resulting in narrowing or complete loss of some parts of the beach (particularly parts of beach section K3 where the highest nesting density is found). The construction of a jetty at the near-by soda-chrome factory in the 1980’s and early 1990’s has been identified as the main reason for beach erosion. The misuse of sand dunes (agricultural use, particularly construction of greenhouses) also contributes significantly to the continuous loss of land. Other factors include the construction of a jetty at Mersin harbour, water works at streams around Kazanlı beach resulting in a lower input of sediments, and sand extraction for construction purposes (KUZUCUOĞLU et al. 1994, DEMIRAYAK 1999).

Agricultural use of sand dunes: Large parts of the sand dunes are being used for agriculture, and greenhouses have been constructed within the dunes for cultivating fruit and vegetables (e.g. watermelons and peppers). The greenhouses extend almost to the seaward limit of the dunes. Efforts have been undertaken since 2000 to remove the greenhouses with the aim of eventually rehabilitating the dunes. However, many greenhouses were still present during the 2001 nesting season .

Housing: There is a new building complex under construction on beach section K1, which is expected to be ready in 2001. Disturbance and light pollution are expected.

Light pollution: There is much light pollution particularly from the soda-chrome factory in the hinterland, from the settlement of Kazanlı, and from some tourist installations on the beach (coffee houses, tea gardens, hotel).

Water pollution: The Municipality of Kazanlı has no canalisation and no sewage treatment system. Sewage is collected and discharged directly into the sea. The soda-chrome factory has been recorded discharging highly toxic sewage into the sea. Although deoxidation basins exist, they are not sufficient to avoid serious chemical pollution of the environment. LANGEVELD & SARIGÜL (1988) previously reported 416 mg chromium per kg soil, which exceeds by far the upper limits set in European countries. Also highly toxic chromium(VI)-compounds are released into the sea on a regular basis (see also above). The soda-chromium factory also releases substances which produces white sodium-sediments covering both the sea bottom and the carapaces of Green Turtles nesting there (DEMIRAYAK 2000).

Fishing: The shallow sea in front of the beach is subject to intensive fishing, including illegal bottom trawling (see above).



Fig. 15. Beach erosion threatens not only the Green Turtle nesting beach at Kazanlı, Turkey, but also the foundations of a hotel which has been built close to the shore line.

Disturbance: The area of the Municipality of Kazanlı extends very close to the beach. The beach is much frequented by people for swimming, fishing and other recreational activities both by day and by night.

Waste: The beach is highly polluted with litter, in particular plastics. This is both sea-borne and from land-based sources. Despite collection of waste from the beach it becomes polluted again within short periods.

Whereas practically all these serious environmental problems have existed and have been known to the conservation community at least since 1988 (BARAN & KASPAREK 1989), all attempts to improve the situation have thus far failed. The first significant achievements were made in 1999/2000, when a new local administration at Kazanlı started to remove the greenhouses from the sand dunes, destroyed some buildings on beach section K1, removed the coastal road in K1 and K2, and started a local awareness campaign. Further plans foresee the complete removal of the greenhouses, the rehabilitation of the sand dunes, the destruction of the jetty, light screening, and the reduction of the level of chemical pollution originating by the nearby factory (ALTAN & KASPAREK 2000). The area has no official protection status.

Samandağ

The biggest problem at this site is the illegal extraction of sand from the nesting beach. As this has given rise to beach erosion of between 3 and 14 metres per year in the past, regula-

tions on sand extraction were effectively implemented in recent years, and sand extraction has largely ceased. However, there is still illegal extraction, albeit on a smaller scale, and even commissioned by the Municipality of Samandağ (Kasperek). Although there are several tourist installations including hotels and holiday houses, tourism is still at a moderate level, and more or less confined to the northern end of the beach. Nevertheless, there is some light pollution from these buildings. Huge amounts of garbage cover the beach, the majority of which is sea-borne (DEMIRAYAK 1999, YERLI & DEMIRAYAK 1996, MEDASSET 2000). There is also pollution from discharge of untreated or insufficiently treated sewage. Other threats include the construction of roads and the disposal of rubble on the beach (SAMANDAĞ ÇEVRE KORUMA VE TURİZM DERNEĞİ, pers. comm.).

Akamas Peninsula (Cyprus)

In 1976 a project was conceived to help the marine turtles of Cyprus. Two years later, in 1978, the project was launched by the Fisheries Department. It includes a seasonal station and a hatchery at Lara. The Cyprus government finances the project. Late in 1980, it received WORLD WIDE FUND FOR NATURE support for three years, as an IUCN/WWF project. More recently it has also received assistance from the European Union as a MEDSPA Project (HADJICHRISTOPHOROU & DEMETROPOULOS 1998, 2000). The main turtle beaches at Lara/Toxeftra are protected by legislation. There are however, imminent threats to the Akamas Peninsula, including the extension of the tourist zone about 4 km along the north coast and a large tourist development on the north coast within the state forest.

Northern Cyprus

Threats to marine turtles in northern Cyprus have been reviewed previously (BRODERICK & GODLEY 1996, GODLEY et al. 1996). Most of northern Cyprus is relatively undeveloped and most beaches in the Karpaz Peninsula and on the west coast are not accessible by paved roads. However, coastal development is increasing and will bring with it increased risk of sand extraction and light pollution which can affect Green Turtle hatchlings (IRWIN et al. 1998). Predation by foxes and feral dogs presents a considerable threat (GODLEY et al. 1996, KINSELLA et al., 1998). Crabs are abundant, but are thought to have no significant impact on turtle populations (SMITH et al. 1998). Beach litter is very severe on some beaches, but not a significant problem for marine turtles (HOBSON et al., 1998, MELLANBY et al. 1998).

Under local legislation Alagadi beach has been declared a Specially Protected Area. This means that it is closed to all but accompanied turtle watches and researchers from 8 p.m. to 8 a.m. throughout the nesting and hatching season. This is rigorously controlled by the local Department of Environment. By day, many hundreds and sometimes several thousand people visit the beach. Vehicular traffic on the beach is prohibited and people are marshalled to sit below a line of markers that delineate the nesting zone. The beach is cleaned regularly and the only major problems in the area are illegal sand extraction and erosion. Erosion is resulting from sand extraction and the creation of vehicular access points in the early 1990's in addition to foot traffic. The Specially Protected Area currently does not have the resources or infrastructure to deal with these problems. Beaches 45-46 on the south Karpaz are within a proposed national park, and core North Karpaz nesting beaches (51-56) are within another proposed Specially Protected Area. It is necessary that swift development of protective legislation for key sites be undertaken concomitantly with the rehabilitation of nesting beaches where necessary.

Conclusions

The annual number of Green Turtle nests in the eastern Mediterranean varies roughly between 350 and 1750 nests, leading to an estimate of 115–580 mature females nesting each year. 78% of these are concentrated at five key sites. Although the restriction of the nesting of species to a handful of key areas makes the species vulnerable, the breeding grounds for more than three quarters of the Mediterranean nesting population could be safe-guarded through the protection of only a handful of beaches.

The population size is extremely low, and factors which may not exert significant effects on larger populations may become decisive for the survival of the species in the Mediterranean. These factors refer mainly to human impact, but include also natural predation e.g. by foxes and jackals. All important nesting beaches are situated in Turkey and in Cyprus. However, the migration routes and wintering areas for adults thus far described include Cyprus, Israel, Egypt, Libya and Turkey (as determined from the post-nesting satellite tracking of 6 females from northern Cyprus; GODLEY et al., in press). It is essential that more be discovered about the migration routes and foraging grounds of adults and juveniles within the region.

An Action Plan for ensuring the survival of Mediterranean turtles has been prepared by the Regional Activity Centre for Specially Protected Areas (RAC-SPA) under the Mediterranean Action Plan of UNEP (RAC/SPA s.a.). Other international efforts include activities in the frame of the Council of Europe: Marine Turtles and their habitats have received much attention from the Standing Committee of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) in the last 12 years. A number of recommendations have been issued concerning Green Turtles. A file is already opened concerning the Akamas Peninsula. The recommendations made for the Turkish beaches of Kazanlı, Samandığ and Yumurtalık Bay are pertinent, but are not enforced (cf. e.g. document T-PVS (2000)) 59 of the Council of Europe).

Taking the deep interest in marine turtles by the scientific community into account, our knowledge in population size and dynamics of Green Turtles in the Mediterranean is as yet insufficient. It is recommended that ongoing monitoring be undertaken at all major nesting sites simultaneously with urgent conservation and lobbying for protective status for these key breeding sites. In addition, there is a need to standardize methodologies and implement quality control in data collection and reporting. Thus far, long-term monitoring data are only available from northern Cyprus, but are largely absent for the main nesting beaches in Turkey. It should be noted that available data are often difficult to compare due to differences in methodology and duration of surveying. In addition data are not circulated promptly. For monitoring results to be translated into practical conservation efforts, they should be made widely available with less delay. Gaps in this respect are in particular evident for Akyatan nesting beach and for Akamas Peninsula. In order to overcome these general problems the establishment of a clearing-house has been proposed to help to better co-ordinate the various on-going activities and to develop synergies among the various concerned parties (KASPAREK 2001).

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Authors' addresses: Dr. Max Kasparek, Mönchhofstr. 16, 69120 Heidelberg, Germany. – Dr. Brendan J. Godley and Dr. Annette C. Broderick, Marine Turtle Research Group, School of Biological Sciences, University of Wales Swansea, Swansea SA2 8PP, UK. – E-mail contacts: Kasparek@t-online.de, mtn@mtrg.u-net.com.