Satellite tracking of a Green Turtle, *Chelonia mydas*, from Syria further highlights importance of North Africa for Mediterranean turtles

by Alan F. Rees, Mohammad Jony, Dimitris Margaritoulis and Brendan J. Godley

Abstract. In 2006, we tracked a single Green Turtle after nesting Latakia, providing the first evidence of foraging grounds and migratory routes from this rookery which is one of the most important nesting areas in the Mediterranean. Tracking lasted 95 days during which time the turtle migrated southward (minimum average speed = 0.9 km/h) and then westward (minimum average speed = 1.6 km/h), following the coast. The turtle settled in the Bay of As Sallum, western Egypt where it remained in neritic, coastal waters for the final 26 days of transmissions. These results, when combined with findings from Cyprus, Turkey and Greece, further highlight the importance of the North African coast for foraging adult turtles and the need for effective conservation measures to be adopted there.

Key words. Egypt, Syria, Mediterranean, conservation, sea turtle, foraging grounds, migration, North Africa.

Introduction

The Green Turtle, *Chelonia mydas*, population in the Mediterranean has been demonstrated to be relatively discrete from those in the wider Atlantic (BOWEN et al. 1992, ENCALADA et al. 1996). Nesting occurs only in the eastern basin, mainly in Turkey and Cyprus (KASPAREK et al. 2001). The population at monitored beaches was estimated to range between 339 and 360 females nesting annually (BRODERICK et al. 2002), indicating the endangered status of this subpopulation. Recently in Syria – where only Loggerheads (*Caretta caretta*) were previously known to nest (KASPAREK 1995) – a regionally important Green Turtle nesting population was discovered, at Latakia, with an estimated 31-35 individual turtles nesting in 2004. This site is likely the ninth largest nesting aggregation in the Mediterranean Sea (REES et al. 2008).

Using satellite telemetry, GODLEY et al. (2002) elucidated migration routes and foraging grounds for Green Turtles that had nested on Cyprus. Turtles promptly departed the nesting area after making their final nests and the majority migrated south, to overwinter off the North African coast. All five turtles that migrated south travelled through Egyptian coastal waters; four moved into coastal waters of Libya and the transmissions from one turtle ceased abruptly, with the last locations in Egypt. The turtles that were tracked for extended periods at their foraging grounds maintained distinct home ranges in neritic waters (GODLEY et al. 2002). Subsequent studies have shown that Green Turtles display high levels of fidelity to their foraging grounds, having followed similar routes to reach there from the nesting areas, with the turtles moving to deeper water and remaining more sedentary during the winter period (BRODERICK et al. 2007).

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Methods

Here we set out to complement an ongoing flipper tagging programme (REES et al. 2005) by tracking one Green Turtle via satellite telemetry, to obtain information about its migratory route and foraging area destination. We attached a Kiwisat 101 satellite tag to the carapace of a Green Turtle at Latakia (35.452°N, 35.863°E) after nesting on 8 July 2006 (Fig. 1). The transmitter was adhered to the highest point on the carapace (2nd vertebral scute) using Araldite AW2101, 2-part epoxy (see GODLEY et al. 2002 for details). Data collection, management and mapping were undertaken using the Satellite Tracking and Analysis Tool (STAT; COYNE & GODLEY 2005).

Location data were generated and downloaded from the Argos system, with levels of accuracy to each given location. Three location classes (LCs; 3, 2 & 1) have an approximate error to within 1 km and a further three classes (0, A & B) have no assigned error (CLS 2008) but may still produce usable locations (HAYS et al. 2001). The route was constructed from Argos LCs 3,2,1,0&A with a filtering regime of: speed <5 km/h, topography <1m altitude, interval >12 hours between locations and turning angle of >25°. An additional 5 position fixes from LC B, which complied with the filtering protocol, were included at the later part of the track to supplement extended periods with no other position fixes. Following this regime, data points were generated for 46 days.

Results and discussion

The turtle was tracked for a total of 95 days. Locations were obtained on a total of 46 separate days, with fixes were near daily for the first 44 days and intermittent thereafter.

The turtle immediately departed the nesting area in a southerly direction after nesting. The turtle's migration occurred primarily in coastal waters and as such, it passed through territorial waters of all geopolitical units *en route* (i.e. Lebanon, Israel and the Gaza Strip), before reaching the Bay of As Sallum in Egypt (Fig. 2a) at some point between 23 August and 16 September.

For the initial 5 days, the turtle travelled up to 38 km from shore through waters up to 1800m deep, at approximately 2.1 km/h which compares well to the 2.8 km/h reported for open sea crossing by Godley et al. (2002). For the subsequent 39 days it swam through waters that averaged only 38.8 m deep (SD 54.7, 3.7-228.6 m, N=40 locations) and 4.7 km (SD 4.9, 0-18km, N=40 locations) from the coast.

Average minimum speed between locations was 0.9 km/h (SD 0.6, 0.1-1.9 km/h, N=16) for the southward leg of the coastal migration following the open sea crossing. Between 19 and 22 July, whilst in the coastal waters of Israel, average minimum swim speed was less than 0.12 km/h, when intensive foraging or resting is assumed to have occurred (Fig. 2a&b). The mean minimum speed of the westward migration along the Egyptian coast was 1.6 km/h (SD 0.5, 0.8-2.7, N=24; Fig. 2a&b). This compares well with the 1.7 km/h found by GODLEY et al. (2002) for migrations along Turkish and North African coastal waters by turtles from Cyprus.

It is interesting to note that, except for the first five days, the turtle migrated in coastal, neritic waters where it could feed *ad hoc,* rather than taking a more direct route to its final destination that would have taken it through deep oceanic water in which benthic feeding would be impossible (GODLEY et al. 2002). An alternative reason for adopting a coastal migration is that navigation is more straightforward compared to the open sea (HAYS et al. 2002).

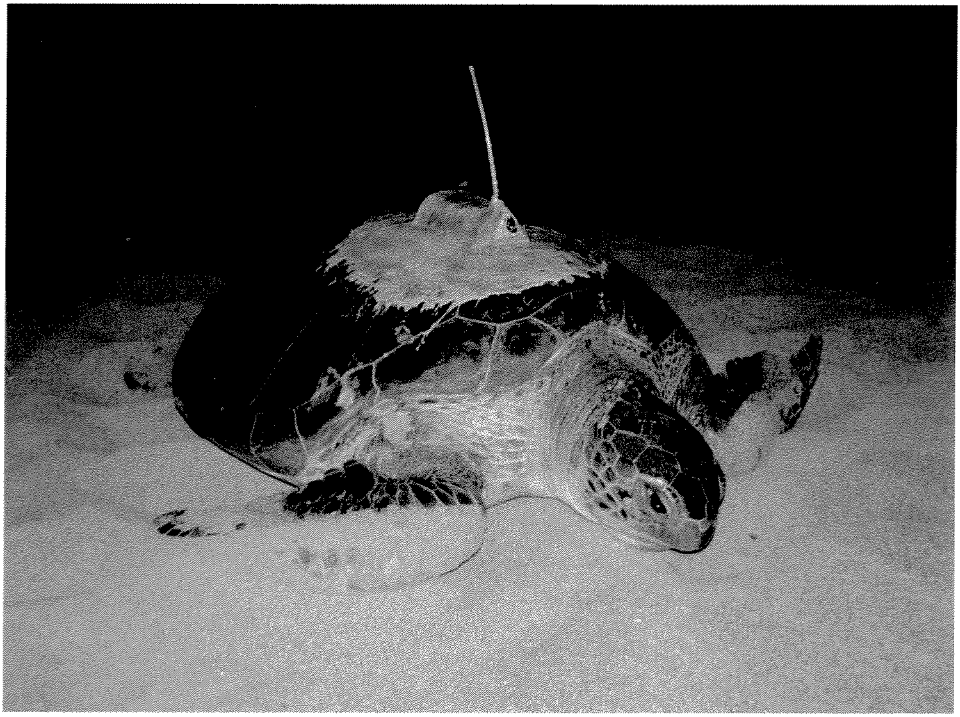

Fig. 1. Nesting Green Turtle returning to the sea near Latakia, equipped with a Kiwisat 101 satellite transmitter.

The final, intermittent, locations placed the turtle for 26 days in one area, in neritic waters, within 16 km of the Egyptian coast (Fig. 2c), indicating it had at least temporarily become resident in a foraging area likely centred within the 50 m isobath.

Post-nesting migrations of this kind, i.e. pelagic crossings with additional coastal movements to neritic foraging grounds (type A1; GODLEY et al. 2008) are the kind, at least in part, exhibited by all Green Turtle populations tracked so far (GODLEY et al. 2008). It appears that adult Green Turtles are indeed obligate benthic feeders in the Mediterranean with all individuals tracked to date foraging in neritic waters, although recent evidence indicates this is not the case for all Green Turtles tracked elsewhere (HATASE et al. 2006, SEMINOFF et al. 2008).

Conservation implications

Although the present study examines the movements of only a single individual, the information presented here when combined with other Green Turtle studies from Cyprus (BRODERICK et al. 2007) and Turkey (GODLEY et al., unpublished data) and Loggerhead data from Cyprus and Greece (GODLEY et al. 2003, BRODERICK et al. 2007, ZBINDEN et al. 2007) indicates that North African waters host critically important foraging grounds for the both

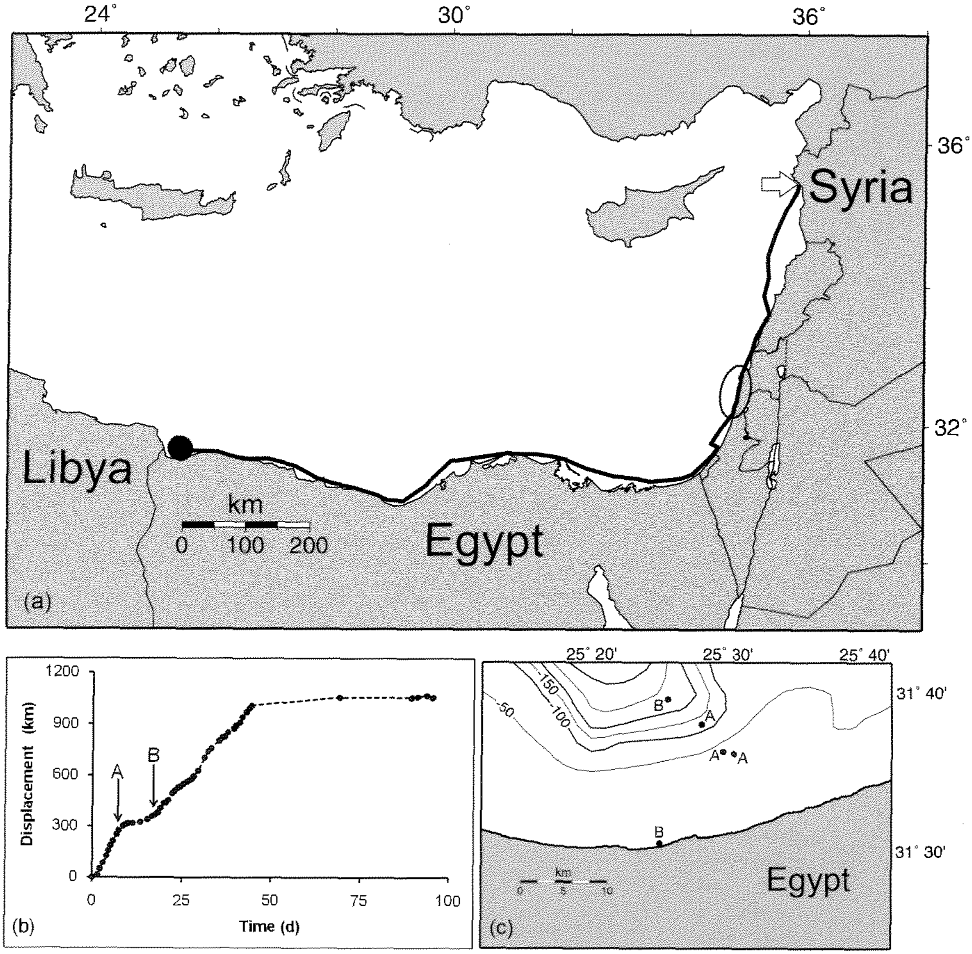

Fig. 2. (a) Migration route of a Green Turtle from nesting area in Syria to its foraging ground in Egypt. Arrow indicates start position; open oval indicates location of reduced migratory speed and a probable foraging site. Filled circle indicates end-point of the migration and location of the turtle for at least the final 26 days of transmitter activity. (b) Displacement plot indicating open sea (left of arrow labelled A) and coastal movements and presumed foraging activity (between arrows A and B). Slope of line is indicative of speed. (c) Turtle locations obtained from the foraging ground at end of migration and transmitter activity. Lines and numbers are isobaths in metres.

species of Mediterranean turtle. Only breeding individuals migrate north to the nesting areas in the spring and return again in autumn. This comprises a relatively small proportion of an adult turtle's life (several months in every 2–4 years; MILLER 1997) hence a substantial proportion of the sea turtle populations remain in North African waters year-round. The process of migration for most of the tracked animals (above) involved significant periods of movements in coastal neritic areas. These movements would make them vulnerable to artisanal and commercial fisheries interaction (GODLEY et al. 1998, ORUÇ 2001) and, specifically in the case of Egypt, direct take (NADA 2001) thus impacting on individual survivorship and population sustainability. Conservation of Green Turtles and marine turtles in general, in the Mediterranean – which has historically centred on nesting beaches – must also focus on foraging grounds to be fully effective.

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