ARTICLES

WHERE DO THEY GO? SATELLITE TRACKING OF NESTING TURTLES IN SRI LANKA

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INTRODUCTION

Five species of turtle nest on Sri Lanka's beaches. Green (*Chelonia mydas*) and olive ridley turtles (*Lepidochelys olivacea*) are the most frequently encountered, with occasional nesting by hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) turtles also recorded (Kapurusinghe, 2006).

To date, two satellite telemetry studies on turtles have been conducted in Sri Lanka. The first involved a collaboration between the Marine Conservation Society (MCS), the Turtle Conservation Project, and the Government's Department of Wildlife Conservation (DWC) (Richardson *et al*., 2013). This study deployed satellite tags on ten nesting green turtles at the Rekawa Sanctuary, near Tangalle on the south coast, in 2006 and 2007.

The second study was a collaboration between the Wildlife Institute of India (WII) and DWC in 2010, and deployed satellite tags on four nesting olive ridley turtles and one nesting green turtle at Bundala, Rekawa, and Kosgoda turtle rookeries on the south and west coasts (Sivakumar *et al*., 2010). This study is yet to be fully published, and therefore this review only summarises the project tracking data as described in Sivakumar *et al*. (2010).

SATELLITE TAGGING OF GREEN TURTLES NESTING AT REKAWA

Richardson *et al*. (2013) aimed to identify inter-nesting habitat, migration corridors and residence locations of a population of green turtles nesting within the Rekawa Sanctuary, the largest green turtle rookery on the southern coast of Sri Lanka (Figure 1). Sirtrack Kiwisat 101 satellite transmitters were attached to adult female green turtles (Table 1) after they had nested on Rekawa beach in July and August 2006 (n=6), and June 2007 (n=4), and the turtles' subsequent movements were tracked and mapped by STAT (Coyne & Godley, 2005). The turtles

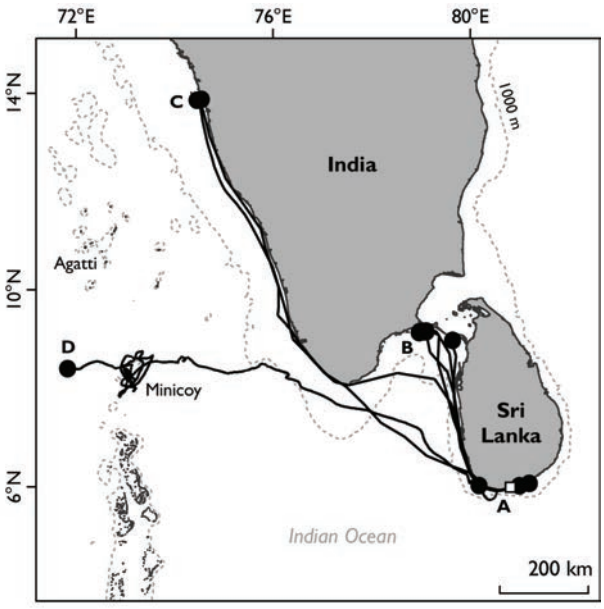

Figure 1. Migrations of 10 green turtles satellite tagged in the study by Richardson *et al*. (2013) at Rekawa Sanctuary (white square) to four geographic areas, A, Southern Sri Lanka (n = 3 turtles), B, Gulf of Mannar (n = 4 turtles), C, Karnataka (n = 2 turtles) and D, Lakshwadeep Islands (n = 1 turtle). Agatti Island is also shown.

exhibited behavioural plasticity within the population.

Inter-nesting behaviour

While one green turtle started its post-nesting migration immediately after tagging, six turtles spent their inter-nesting periods proximate to Rekawa beach before nesting again at Rekawa (Figure 2). The other three turtles repeatedly travelled to respective and separate coastal locations at Usangoda, Bundala, and Habbaraduwa, all within 60km distance from Rekawa, to spend their inter-nesting periods before returning to Rekawa to lay subsequent clutches (Figure 2).

Table 1. Summary of biometric and tracking information for the 10 female green turtles fitted with satellite transmitters at the Rekawa Turtle Sanctuary (RS), Sri Lanka (Richardson *et al*., 2013).

Turtle ID #	CCL (cm)	Date tagged (dd.mm.yy)	Inter-nesting location(s)	Foraging site name and jurisdiction	Straight line distance between Rekawa and foraging centroid (km)	Days tracked (days at residence site)
Movement Pattern Type A1 (after Godley *et al*., 2008)						
1	117.5	30.07.06	Not known - turtle began post-nesting migration after tagging.	Gulf of Mannar, India	415	145 (136)
2	110.1	02.08.06	Proximate to RS	Gulf of Mannar, India	409	64 (46)
3	106.3	06.08.06	Proximate to RS	Gulf of Mannar, India	403	97 (51)
4	107.5	19.06.07	Proximate to RS	Gulf of Mannar, Sri Lanka	350	62 (32)
5	101.2	07.08.06	Proximate to RS	Karnataka, India	No centroid (last LC 'A' transmitted from Shirali Island, 1128 km from RS).	169 (56)
6	109.9	18.06.07	Proximate to RS	Karnataka, India	1128	126 (48)
Movement Pattern Type A3 (after Godley *et al*., 2008)						
7	95.0	03.08.06	Habbaraduwa	Habbaraduwa, Sri Lanka	60	61 (29)
8	97.1	16.06.07	Bundala	Bundala, Sri Lanka	38	172 (92)
9	90.1	17.06.07	Ussangoda	Ussangoda, Sri Lanka	16	69 (24)
Movement Pattern Type B (after Godley *et al*., 2008)						
10	92.8	08.08.06	Proximate to RS	Minicoy, India	898	140 (42)

Post-nesting migrations

After laying their last clutch of eggs at Rekawa, the green turtles exhibited multiple migration patterns as described by Godley *et al.* (2008) (Figure 1). The turtles that spent inter-nesting periods at the coastal locations away from Rekawa returned to their respective inter-nesting sites, where they remained until transmissions ceased. This relatively proximate residence to the nesting beach of these 'resident breeders' is described as movement pattern A3 by Godley *et al.* (2008).

The other green turtles exhibited two other movement patterns. Six turtles migrated away from Rekawa once they had laid their last clutch of eggs, travelling northwards in coastal waters, and corresponding with movement pattern A1 described by Godley *et al.* (2008) (Figure 1). Two of these turtles eventually settled at a site close to Shirali Island in coastal waters of Karnataka, India. Four of these turtles settled at sites in the Gulf of Mannar, with three of these turtles settling in the Gulf of Mannar National Park off the coast of Tamil Nadu. It is interesting to note that the only green turtle in the Sivakumar *et al.* (2010) study, tagged after nesting at Bundala in February 2010, also exhibited this movement pattern and also finally settled in the Gulf of Mannar National Park.

One green turtle exhibited movement pattern B described by Godley *et al.* (2008) when it migrated away

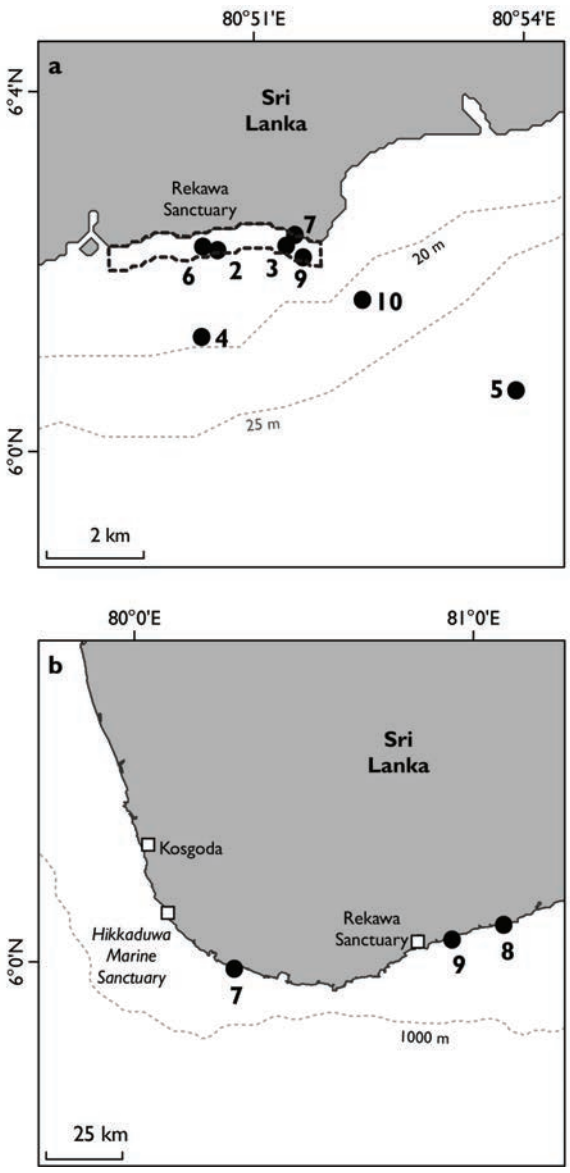

Figure 2. Inter-nesting centroids calculated for the nine turtles that nested at Rekawa after they were fitted with a satellite tag (numbers represent turtles in Table 1) in the study by Richardson *et al*. (2013), a, for turtles remaining proximate to Rekawa Sanctuary, b, inter-nesting and foraging site centroids calculated for the resident breeder turtles identified in this study.

from Sri Lanka through pelagic waters and travelled to Minicoy Atoll in the Lakshwadeep Islands (Figure 1). The turtle remained close to Minicoy for 39 days, constantly performing looping movements around the atoll, and up to 65km distance before returning back to the atoll. The tags transmissions ceased when the turtle was 135km away from Minicoy, after having travelled due west from the atoll for 3 days, perhaps migrating into the Arabian Sea.

SATELLITE TAGGING OF OLIVE RIDLEY TURTLES NESTING AT REKAWA AND BUNDALA

Sivakumar *et al*. (2010) describe the tracks of four female olive ridley turtles tagged after nesting in February 2010, and up to the 30th of June 2010 when the tags were still transmitting (tag make not specified). Two turtles were tagged at Bundala, one tagged at Kosgoda and one tagged at Rekawa. After nesting, two of these turtles (tagged in Bundala and Kosgoda) travelled to open oceanic habitats to the south west of Sri Lanka and were there in June 2010. One turtle (tagged in Bundala) migrated north-west to the Gulf of Mannar Park, where it appeared to settle in April 2010, and was still there in June 2010. The other turtle (tagged in Rekawa) travelled westwards to the Maldives, arriving in April 2010, before heading north and settling offshore of Kerala, India in May 2010. It was still there in June 2010.

DISCUSSION

The findings of these studies highlight the disparate nature of habitats that nesting green and olive ridley turtle populations in Sri Lanka depend on. The Rekawa green turtle population uses inter-nesting habitat proximate to Rekawa, as well as other inshore sites along Sri Lanka's southern coast. These sites also serve as resident foraging habitat for these turtles. The population uses important migration routes through the coastal waters of India and Sri Lanka, and some turtles share foraging sites far away from Sri Lanka in India's waters. Coastal fisheries incur turtle bycatch in both India and Sri Lanka (Kapurusinghe, 2006; Rajagopalan, 2006) and, therefore, more research is required to determine whether or not this bycatch poses a significant threat to Sri Lanka's nesting turtle populations. The study also highlighted the importance of protecting key foraging habitat for marine turtles, with the rich habitats in the Gulf of Mannar National Park being of particular significance to Sri Lanka's green turtle nesting population, and possibly olive ridley turtle populations. It is also of interest to note that Sri Lanka and the Lakshwadeep Islands share a green turtle population, and this has been corroborated through flipper tag return data from Agatti Island, another Lakshawdeep Island (see Richardson *et al*., 2013). Atolls in the Lakshwadeep Islands have experienced increases in the number of foraging juvenile green turtles aggregating in atoll lagoons in the recent years causing conflict with local fishers (Lal *et al*., 2010). Further research is required to determine whether turtle conservation efforts in Sri Lanka over the last 20 years (Ekanayake, 2002) may be linked to this phenomenon.

These studies represent the first ever satellite telemetry

studies on Sri Lanka's turtles, but should not be the last. The results pose more questions than they answer. Researchers in Sri Lanka, India and elsewhere are encouraged to develop partnerships and share resources to develop more telemetry and genetics studies on the countries' turtle populations. These should aim to fully determine the ecology, range and behaviours of these populations with a view to better informing future conservation efforts.

ACKNOWLEDGEMENTS

These figures are from Richardson *et al*. (2013) and I encourage anyone interested in a better understanding of this paper to visit www.seaturtle.org/mtrg/pubs/. I thank my co-authors for their invaluable contributions to that paper, and for the numerous Turtle Conservation Project staff and volunteers for supporting the tracking project. I also thank Dr BC Choudhury for sending me a copy of the note by Sivakumar *et al*. (2010).

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TRACKING LEATHERBACK TURTLES FROM LITTLE ANDAMAN ISLAND

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INTRODUCTION

Leatherback nesting in India is currently restricted to the Andaman and Nicobar Islands (Andrews *et al*., 2006). A long-term monitoring programme was established in 2008 at Little Andaman Island, and two index beaches, South and West Bay (Figure 1) were chosen to study the recovery of leatherback turtles after the earthquake and tsunami of December 2004 (Swaminathan *et al*., 2011, 2017). Over the years, the objectives evolved to include monitoring of leatherback nesting at the index beaches through a capture-recapture programme. The data indicate that leatherback nesting on Little Andaman Island has recovered substantially after the 2004 tsunami and seems stable with some fluctuations (Swaminathan *et al*., 2017). One of the components of the project was to identify the post-nesting migratory routes of leatherback turtles nesting in this region. For the first time in India, leatherback turtles were tagged with satellite transmitters to understand their migratory routes and foraging sites (Namboothri *et al*., 2012).