Turtle activity monitoring project within north-east Tobago

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Introduction

Tobago, a small island located in the Caribbean which lies between 11°8′ and 11°30′ north and 61°5′ and 60°28′ west, is an important nesting site for three of the seven marine turtle species found globally. Females of the leatherback sea turtle (*Dermochelys coriacea*), the hawksbill sea turtle (*Eretmochelys imbricata*) and the green sea turtle (*Chelonia mydas*) come ashore between the months of April and September to lay their eggs at night (Dow *et al.* 2007). Global population declines in all three species have led the IUCN to classify the leatherback as Vulnerable, the green as Endangered, and the hawksbill as Critically Endangered. These declines can be attributed to terrestrial and marine habitat destruction, poaching for consumption and trade, climate change, pollution and fishery bycatch (Mortimer *et al*. 2007; Seminoff 2004; Wallace *et al.* 2013). Monitoring of marine turtle populations is necessary in order to assess the impact of these threats and to identify any population changes.

The most reliable method of monitoring trends in sea turtle populations is long-term population assessments conducted at nesting beaches (Bjorndal 1995), where returning individuals can be identified by tag numbers. A minimum standard for data collection in these capture - mark - recapture studies has been defined by the State of the World's Sea Turtles (SWOT) partnership, allowing comparison among sites globally (SWOT Scientific Advisory Board 2011). Unfortunately long-term monitoring can be difficult due to the life history of sea turtles: long lifespans, late sexual maturity, two to three year gaps in female breeding seasons, and the fact that laying females are the only demographic which is relatively accessible for monitoring. Recently, developments in genetic tools have shown the potential to address these issues, identifying population structure, population connectivity and biological parameters in nesting females such as age and reproductive maturity (Komoroske *et al.* 2017).

As not all beaches within the north-east of Tobago are accessible for monitoring, the results of comprehensive monitoring of 'index' beaches can be inferred to the broader local population, as recommended by SWOT (SWOT Scientific Advisory Board 2011). The two index beaches in this study

were Hermitage and Cambleton (Fig. 1). These two index beaches host high numbers of nesting hawksbill turtles each year with occasional nesting of leatherback and green sea turtles recorded. In addition to the index beaches, hawksbills nest on a large number of smaller beaches mainly on the leeward coast of northern Tobago, while leatherbacks predominate on the large sandy beaches of the south (Reid 2008; Walker & Gibson 2015; Walker *et al*. 2015).

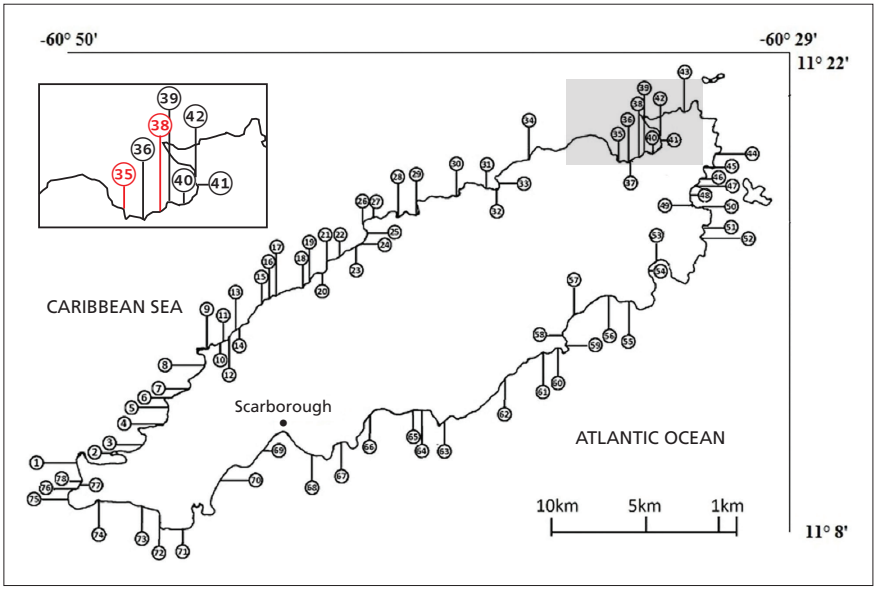

Fig. 1. Map of Tobago and hawksbill nesting beaches. Adapted from Walker *et al.* (2015). Hermitage Bay number 35. Cambleton Bay number 38.

The University of Glasgow Tobago Expedition has been collecting and collating nesting turtle data since 2012, working with the local NGO North East Sea Turtles (NEST) on the two index beaches. The aim of the long-term turtle monitoring in north-east Tobago is to identify every laying turtle on both index beaches, and collect data on the nesting behaviour and on their physiology. In this paper, we present nesting data for 2016, and compare them to data from 2012-2015, drawn from Tobago Expedition reports. Standardised methodology was used for the entire 2012-2016 period.

Methods

Study sites: The study sites were two beaches on the Caribbean side of the north-east of Tobago, Cambleton and Hermitage Bay. Cambleton is a sandy bay, accessed only by foot through a steep rainforest trail, or by boat. There is no nearby settlement or light pollution. Cambleton has a length of 105m, mean width 24.6m ± 14.8 SD; slope 26 degrees. There is a river which runs through one end of the beach, which varies with rainfall. Hermitage is a rocky shore which can be accessed by a dirt track connected to a road, or by boat. It has more human activity due to the track, but rarely significant light or noise pollution. There is a very small settlement nearby, and fishermen on the beach at times. There is a boat hut and multiple small motorboats at the back of the beach. Hermitage has a length of 151m, mean width 20.6m ± 6.7 SD, mean slope 26 degrees.

Patrol protocols: Teams of three expedition members and one NEST member patrolled the beaches at Cambleton and Hermitage for the entirety of the expedition (11-week period from early June to mid-August 2016). The nesting season for hawksbills in Tobago lasts from early May to early/mid-October (Walker & Gibson 2015). The precise dates of the expedition varied between years, but not by more than a week. Turtle nesting data are compared between years on the basis of date, rather than number of weeks into the expedition. Foot patrols were carried out every 30 minutes from 19:00 to 03:00 to ensure that nesting females were encountered prior to the laying phase of the nesting process. If a turtle was present on the beach at 03:00h the team would stay until she had returned to sea (Fig. 2). It was not feasible for the team members to patrol past 03.00h every night, so the data set is limited to turtles which laid or were present on the beach up to 03.00h. Each patrol surveyed the entire length of the beach. When a turtle or signs of turtle activity were seen, the time and activity observed were recorded.

Data collection: Discrimination of nesting behavioural phases was according to Burns *et al*. (2015), with a total of eight phases being defined:

1. APPROACH: The animal's movement from ocean to upper beach;
2. PROSPECTING: Movement within a feasible nesting area of the upper beach prior to selecting a nesting site;
3. BODY-PITTING: Preparation of the nest site for excavation; it should be noted that body pitting may occur but then rejection of the nest site and movement to another potential site;
4. DIGGING: Excavation of the clutch chamber through the use of the turtle's rear flippers;

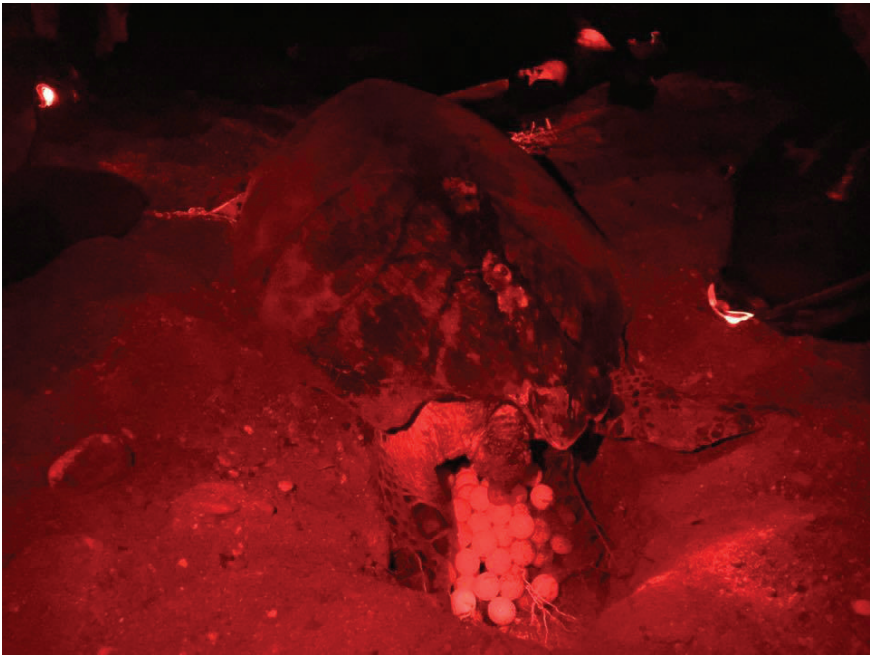

Fig. 2. Hawksbill turtle nesting at Cambleton Beach, seen under red torch. Photo by Isabel Byrne.

5. LAYING: Deposition of eggs into the clutch chamber;
6. COVERING: Turtle covers deposited eggs with previously excavated sand;
7. CAMOUFLAGE / DECOY: Rear flippers are used to pat down loose sand and excess sand is 'scattered' to presumably create the illusion of uninterrupted sand cover;
8. RETURN: The nesting females return to the sea from nesting site.

Night vision cameras were used to track the activity of a turtle in the lead-up to her laying phase. Data were collected once the turtle was confirmed laying. If not tagged, a 681 Inconel tag (WIDECAST Marine Turtle Tagging Centre) with a unique number was applied to each of the front flippers (hawksbills) and the rear flippers (leatherbacks). If the turtle had been previously tagged, the tag number was noted to identify returning individuals. Biometric (Curved Carapace Length and Curved Carapace Width), nesting, observational and physiological data were collected. If a turtle came to the beach but failed to deposit a clutch of eggs her activity was noted as a 'false crawl'. Occasionally turtles were not seen on patrols due to the rocky substrate, which meant that tracks were difficult to discern. Usually these turtles would be heard thrashing sand on later patrols.

Fig. 3. Eggs in process of relocation. Photo by Isabel Byrne.

If a turtle began to dig in an area of the beach within the tideline, or likely to be flooded by other means, we relocated the nest to a more suitable area of the beach. A new nest hole with similar dimensions to the one dug by the turtle was excavated, and the eggs were collected and transferred quickly and with much care and caution to the new nest (Fig. 3). The GPS coordinates for the new nest were recorded.

In addition, a trajectory map of the turtle's movements relative to the location of her covered nest was recorded for the 'decoy' stage for as many turtles as possible. The nest location was noted in relation to the sea, and the pathways the turtle moved from the nest while presenting decoying behaviour, flicking large amounts of sand with her front flippers over the nest and the surrounding area, were measured and drawn.

In addition to our nightly patrols on the two index beaches, we carried out a few morning checks of some other beaches to look for any signs of poaching.

Results

Number of tracks: A total of 72 nesting activities were recorded for hawksbill turtles on Cambleton, and 111 on Hermitage. A total of two nesting activities were recorded for leatherback turtles on Cambleton, and none for

Hermitage (Table 1). These records are in line with what has been recorded over the previous four seasons, with a slight drop in leatherback numbers on Cambleton (Figs 4 & 5).

Table 1. Nesting events on Hermitage and Cambleton beaches.

Beach	Hawksbill Confirmed lay	Hawksbill False crawl	Leatherback Confirmed lay	Leatherback False crawl
Hermitage	79	32	0	0
Cambleton	58	14	1	1

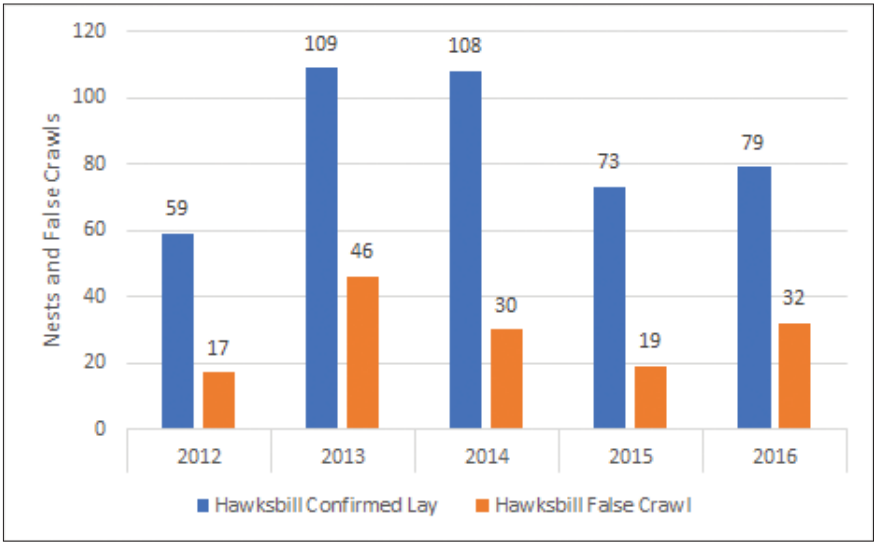

Fig. 4. The numbers of hawksbill confirmed lays and false crawls on Hermitage from 2012 to 2016.

Nesting activity: Ninety-five of the 132 hawksbill turtles which laid nests on Cambleton or Hermitage in 2016 were returning turtles which had been tagged during previous seasons. The remaining 37 turtles were newly tagged by team members. Turtles were not checked for tags on 54 occasions as the turtle false crawled or was sighted after laying, as the only phase at which team members could check tags was the laying phase. The highest frequency of hawksbill nesting in 2016 was seen in the three weeks from the 27th of June - 17th of July (Figs 6 & 7).

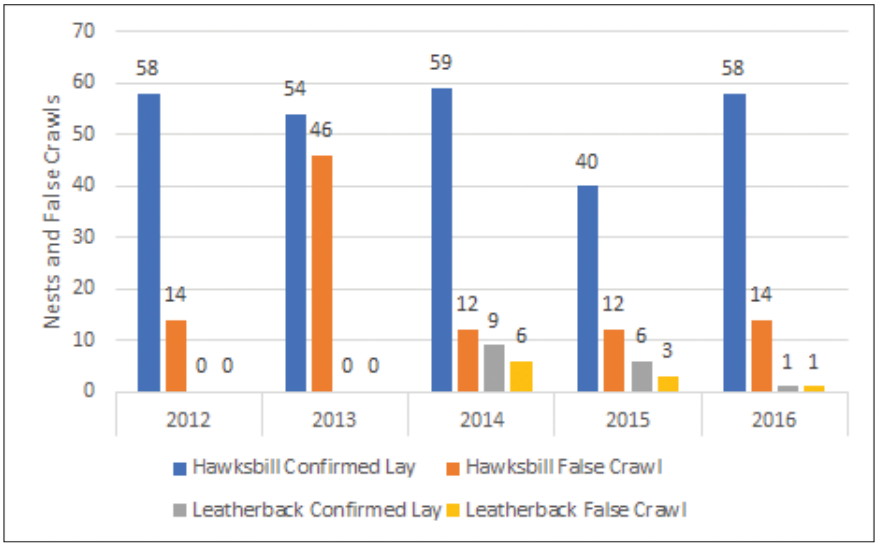

Fig. 5. The numbers of hawksbill and leatherback confirmed lays and false crawls on Cambleton from 2012 to 2016.

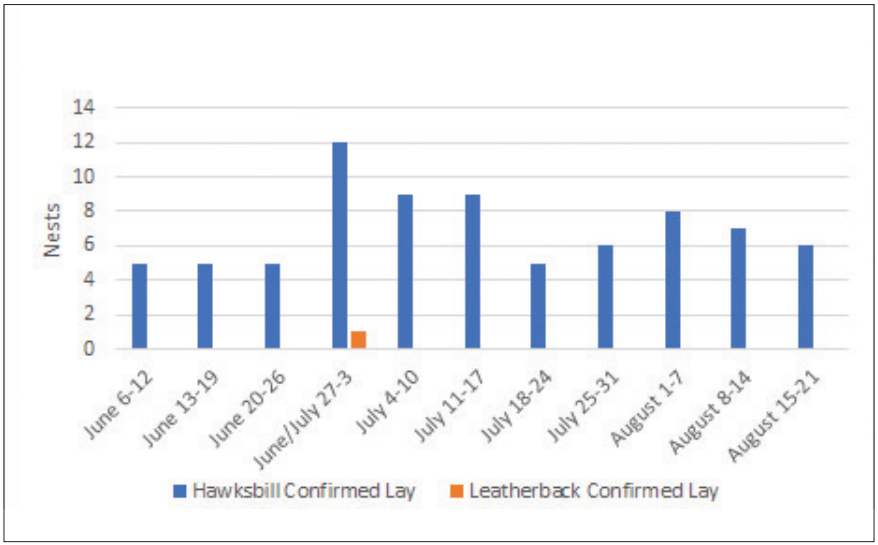

Fig. 6. Week-by-week bar chart showing the number of confirmed hawksbill and leatherback lays on Cambleton in 2016.

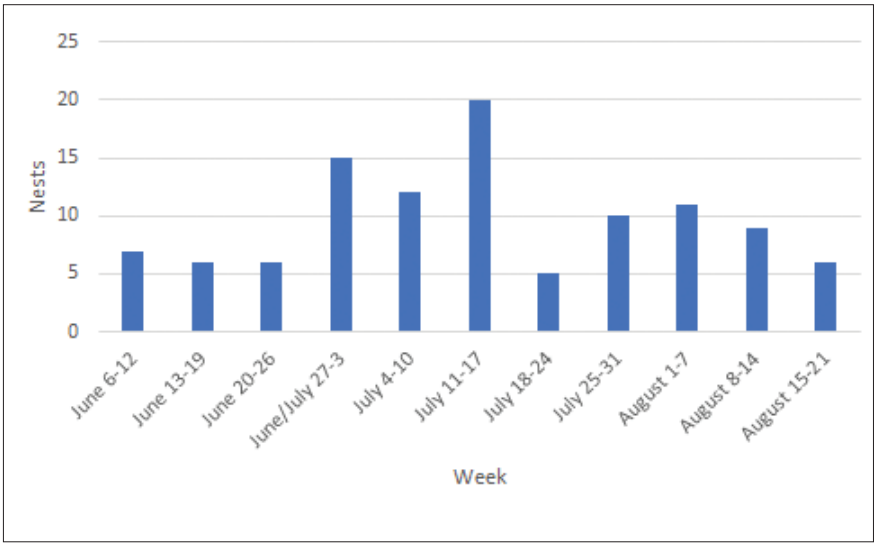

Fig. 7. Week-by-week bar chart showing the number of confirmed hawksbill lays on Hermitage in 2016.

Observed clutch frequency (OCF): We recorded 137 nesting hawksbill turtles (79 Hermitage, 58 Cambleton). Of these, 17 returned to lay a second clutch; 16 returned and laid three clutches. This gives us an observed clutch frequency of 1.36OCF = (104 +34 +48)/137 = 1.36.

Internesting intervals: The range of inter-nesting intervals recorded was 13 - 34 days. However, intervals >22 days are assumed to represent missed nests (Beggs *et al.* 2007). In order to account for these missed nests, we applied a correction factor to the inter-nesting intervals, resulting in a mean inter-nesting interval of 15.5+/-1.3 SD days (n=33).

Nest re-locations: In 2016, 5.8% (n=8) of hawksbill nests required re-location.

Turtles recorded on both beaches: Of the 33 returning turtles, five (15.2%) nested on both Cambleton and Hermitage.

Poaching: No poaching events or attempts were reported on either Hermitage or Cambleton for the duration of the 2016 expedition.

Discussion

Nesting activity: Hawksbills can nest at any time of the year in the eastern Caribbean (Beggs *et al.* 2007), but peak nesting activity occurs June to August. University of Glasgow nesting data collection occurs during the same period of the peak season each year. The most recent five-year assessment of hawksbill nesting female abundance published by the National Marine Fisheries Service (NMFS) and US Fish and Wildlife Service (FWS) identifies both important increases and decreases in population trends within the Caribbean. However, as historic trends >20 years ago found all recorded hawksbill populations in decline, the presence of increasing populations shows promising results. In particular, increased nesting has occurred within the Caribbean rookeries known to be comprehensively monitored (US Fish and Wildlife Service, 2007).

While it is difficult to predict any future trends of increase or decrease in numbers from the five years of data gathered by University of Glasgow Expeditions, a lack of any decline at the index beaches is a hopeful sign. With continued data collection in Tobago over the coming years, and continued tagging effort, general trends will become discernible and have robust statistical power.

Cambleton experienced higher confirmed lays rate than Hermitage in 2016. Accessibility by land may be a potential factor in this difference, as there is no developed pathway to the beach. This lack of on-foot accessibility most likely contributes to the higher confirmed lay success rate, as turtles are less likely to be disturbed during the nesting process. Conversely, Hermitage is much more accessible by land, thus has more human activity with potential to disturb nesting hawksbills. The beach has a small side road that leads to a main road approximately 200m from the beach, allowing access for a range of motor vehicles, but is farther away from Charlotteville (approx. 2.8km).

There was considerably less leatherback activity recorded on Cambleton in 2016 (n=1 false crawls, n=1 nest) compared to 2015 (n=6, n=12) and 2014 (n=6, n=9). The reasons for this are unknown. It may simply be down to the fact that there were more females which were due back to nest over the past two years compared to 2016. It would not be wise to take any one year's data as an indication of a population trend for Caribbean nesting leatherbacks, due to the difficulty of attaining long-term population data.

Our inter-nesting intervals reflect similar findings for hawksbills in this region (Walcott *et al.* 2012) and our measure of nest beach infidelity (15.2%) is similar to that found in Barbados. Our result is likely to be an underestimate given that our interval data included 16 missed nests. Because of the intensive nature of our monitoring effort at Cambleton and Hermitage, it is likely that many of the missed nests occurred at other beaches. Of the 10 beaches (numbers 34-43) identified by Walker *et al*. (2015) around northeast Tobago, only one was found to have no recorded hawksbill nests, so

several other suitable beaches are available in the Hermitage-Cambleton area. Our index beaches were chosen by NEST, based on their accessibility by land, safety, and their high turtle nesting incidence. Since these index beaches were chosen, surveys have shown that some less easily accessible beaches in the area support significant numbers of nesting hawksbills (Walker *et al.* 2015).

Turtle poaching: During the ten weeks of the expedition, no poaching activity was reported on either of the index beaches. On a daytime check of L'Anse Fourmi Bay, a beach where hawksbill poaching is common, at least five hawksbill carapaces were found, which was recorded as evidence of poaching and was reported by NEST. L'Anse Fourmi Bay is currently too dangerous as a site for the expedition and NEST to be comfortable sending members for nightly patrols. The finding of these carapaces confirms that turtle poaching is still prevalent in north-east Tobago, less than 10km from Cambleton and Hermitage and is a strong indication that the presence of the members of the expedition, alongside members of NEST, is vital to prevent poaching on the index beaches.

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