



**SEA TURTLE ECOLOGY IN BIOT
November-December 2019 Research Expedition Report.**



Nicole Esteban & Jacques-Olivier Laloë



Executive summary

This scientific expedition to Diego Garcia, British Indian Ocean Territory (BIOT), in November-December 2019 brought together a research team of sea turtle scientists from Swansea University (United Kingdom) and Deakin University (Australia). The team spent 22 days on Diego Garcia. This research was part of the Bertarelli Programme of Marine Science and is part of a four-year research program.

The research expedition was timed to coincide with the start of the hawksbill turtle nesting season on Diego Garcia. The objectives were:

- 1) to attach satellite tags to adult hawksbill turtles and track their movements within and outside of BIOT
- 2) to monitor sea turtle nesting activities on Diego Garcia and improve adult population size estimates
- 3) to count immature turtles at Turtle Cove using an Unmanned Aerial Vehicle (i.e. a quadcopter) and observe their foraging behaviour
- 4) to assess the impact of microplastics on sand temperatures and incubating sea turtle eggs
- 5) to perform maintenance duties on monitoring equipment deployed year-round on Diego Garcia (i.e. remote camera traps and temperature loggers)

In addition, the scientific team gave two public talks about sea turtle conservation and research in BIOT and posted updates of the expedition on Twitter (#BIOTscience; @BIOTscience) and on the Facebook group *Chagos Turtles* (345 members).

Preliminary results:

18 satellite tags were successfully deployed on nesting adult hawksbill turtles. The turtle tracks show that the Great Chagos Bank is a key foraging site for adult hawksbill turtles, with many turtles migrating >100 km to reach their foraging grounds. The information gained from this research will inform on the ecology and conservation of hawksbill and green sea turtles in BIOT. Results will feed into the Biodiversity Action Plans and Conservation Management planning in BIOT.

The trip's extensive success was made possible through the incredible support provided by the British Forces BIOT, the United States Navy, the US Air Force and Contractors. A total of 136 volunteers helped with the research.

Participants: Nicole Esteban¹ & Jacques-Olivier Laloë²

¹Swansea University, College of Science, Singleton Park, Swansea, SA2 8PP, Wales;

²Deakin University, School of Life and Environmental Sciences, PO Box 423, Warrnambool, Victoria 3280, Australia.

Dates: 26 November to 17 December 2019.

Cover photo: The science team celebrates after deploying the 18th satellite tag of the expedition on an adult hawksbill on Diego Garcia (note the camera trap deployed on the tree in the background).

INTRODUCTION

With support from the Bertarelli Foundation, scientists from Swansea University (Dr Nicole Esteban) and Deakin University (Dr Jacques-Olivier Laloë) visited the British Indian Ocean Territory (BIOT) between 26 November and 17-December 2019. This research expanded on previous sea turtle conservation and research work in BIOT and continues the conservation research programme following recent sea turtle expeditions to BIOT in 2012, 2014, 2015, 2016, 2017, 2018 and 2019.

At the start of the expedition a presentation highlighting sea turtle research in BIOT (Fig. 1) was given in the Chapel. After the presentation volunteers could sign up to assist with the various research activities planned during the research visit (see Objectives below). All volunteers were required to sign the approved Guidelines before assisting with turtle research. 72 volunteers signed up to assist with the planned research activities during the 20 work days on Diego Garcia. Halfway through the expedition a second presentation was given at the FilMau Club for people who could not attend the first presentation. A further 12 volunteers signed up to assist with the planned research. Additional volunteers signed up during the expedition.



Figure 1. Two talks were given during the expedition to present sea turtle conservation and research in BIOT. The talks were advertised with flyers circulated on various Facebook groups and internal mailing systems. The talks attracted an audience of 72 people in the Chapel and 25 people in the FilMau Club. Expedition objectives were outlined and the talks finished with a volunteer sign-up.

This research expedition was part of the ongoing four-year sea turtle ecology programme to explore the importance of the BIOT Marine Protected Area (MPA) for sea turtles. It expands upon previous research conducted over the last eight years in BIOT. The expedition focused on the following five objectives:

Objective 1: To record sea turtle movements within and outside of BIOT by attaching FastLoc GPS satellite tags to adult hawksbill turtles. To achieve this we used tried-and-tested methods from previous research expeditions to Diego Garcia and the outer islands.

Objective 2: To improve adult sea turtle population size estimates by monitoring nesting activities. To achieve this we carried out daily track surveys on an index beach that has received regular monitoring since 1996.

Objective 3: To survey the turtle population in the lagoon and make behavioural observations. To achieve this we flew an Unmanned Aerial Vehicle (UAV) over immature sea turtles foraging within Turtle Cove and filmed their behaviour.

Objective 4: To assess the effect microplastics have on sand temperatures and incubating eggs. To achieve this we recorded sand temperatures at nest depth in experimental plots with varying levels of plastic contaminations.

Objective 5: To service all equipment used for the year-round remote monitoring. To achieve this we checked all the equipment (i.e. remote camera traps and temperature loggers) deployed during a previous research expedition, downloaded data locally, and replaced batteries and memory cards when necessary.

METHODOLOGY

Objective 1: To record sea turtle movements within and outside of BIOT by attaching FastLoc GPS satellite tags to adult hawksbill turtles.

Beach patrols were carried out daily to find nesting hawksbill turtles. We attached FastLoc GPS model WC SPLASH10 satellite tags to turtles we encountered (Figure 2) using methods that were proven successful on adult green sea turtles during previous research expeditions to Diego Garcia. Tracking these turtles will allow us to identify key habitat and migratory routes used by the turtles within and outside of BIOT. These results will feed into efforts to designate new conservation areas as well as reinforce the value of current conservation areas for this species.



Figure 2. An example of a satellite tag attachment to a hawksbill turtle on Diego Garcia, December 2018. We surveyed turtle nesting beaches on Diego Garcia to locate nesting female hawksbills. Turtles were placed in a wooden box after nesting to allow quick attachment of the satellite tags. Tags were attached using quick-setting epoxy and were then painted with anti-fouling paint. Attachment of the tag takes approximately two hours after which time the turtle returns to the sea. The turtle's location is acquired through the GPS satellite network and is relayed to us via the Argos satellite network. Tags typically work for 1-2 years after which they fall off the turtle.

Objective 2: To improve adult sea turtle population size estimates by monitoring of nesting activities.

Since 2006, with the assistance of Nestor Guzman and other personnel of the Natural and Cultural Resources Program NAVFACFE PWD Environmental, we monitor sea turtle nesting activity along a 1.75 km-long Index Beach located on the south east coast of Diego Garcia by counting turtle tracks twice per month throughout the year. During this expedition

we conducted daily surveys of the index beach to improve our estimates of hawksbill and green sea turtle population sizes.

Objective 3: To survey the turtle population in the lagoon and make behavioural observation.

We monitored hawksbill and green turtles in the lagoon using a quadcopter UAV (USA Autel Robotics EVO) fitted with a high-resolution camera. We used the same methodology that was successfully trialled in Diego Garcia in November 2018. In short, a series of five parallel 1 km survey transects were carried out at in 3 zones (Turtle Cove, mid lagoon, north lagoon) around the island. Replicates at key sites were done over three days. Analysing the film footage will bring valuable information on the number, size, species and foraging behaviour of the immature turtles in the lagoon.

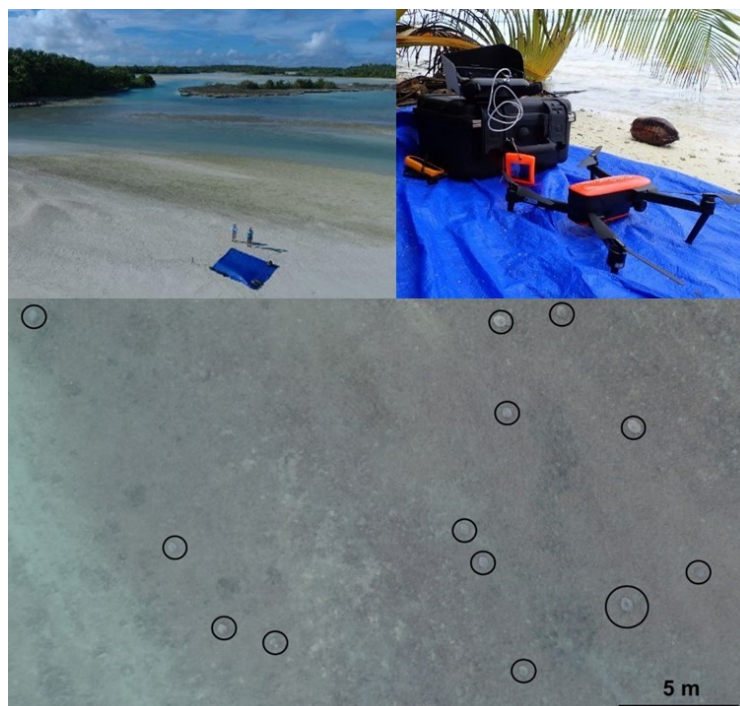


Figure 3. We monitored immature hawksbill and green sea turtles found in the lagoon using a quadcopter UAV. Turtles can be seen clearly in the footage recorded by the UAV. Results from these aerial surveys and from the satellite-tracking of immature turtles in the lagoon will help identify ‘turtle hotspots’ in the lagoon.

Objective 4: To assess the effect microplastics have on sand temperatures and incubating eggs.

We buried temperature loggers in the sand in the middle of experimental plots, which had varying levels of microplastic contamination. Four replicate sites were set up along the Index beach. At each site, four experimental plots (1 m × 1 m) were set up. These data will help assess how microplastics are affecting the incubation environment of sea turtle eggs.



Figure 4. We set up new experiments aiming to measure the impact of microplastics on the incubating environment of sea turtle eggs. Temperature loggers were deployed in the middle of experimental plots with varying levels of microplastic contamination.

Objective 5: To service all equipment used for the year-round remote monitoring.

We downloaded photos of the nesting beach from remote camera traps that we deployed in 2018 and 2019. We replaced the SD memory cards and batteries of devices when needed after which camera traps were redeployed on the Index beach.

We replaced a temperature logger that had been uncovered during recent beach erosion events and handed in to the Environmental Officer. The loggers are set up at two sites on the Index beach. These devices are used to monitor the nesting conditions on Diego Garcia year-round.



Figure 5. Data from camera traps and temperature loggers were downloaded. Devices were serviced and redeployed on the Index beach for continued long-term monitoring of the beach.

PRELIMINARY RESULTS

We attached satellite tags to 18 female hawksbill turtles on Diego Garcia in November-December and tracked their movements. To date (6 February 2020):

- All 18 hawksbills are still in BIOT. Some of them still have not reached their foraging destination and are still migrating.
- 12 hawksbills migrated to the Great Chagos Bank over 80 km to the north of Diego Garcia. Some have stopped at foraging grounds close to the turtles that were tracked there in 2018. Others migrated further north and some have not settled yet.
- 3 hawksbills are currently on Pitt Bank, which is a large submerged atoll (>10 m depth) west of Diego Garcia. This is the first time we have tracked turtles to Pitt Bank.
- 1 hawksbill travelled beyond Pitt Bank to the southwest to a much smaller submerged and unstudied atoll called Centurion Bank.

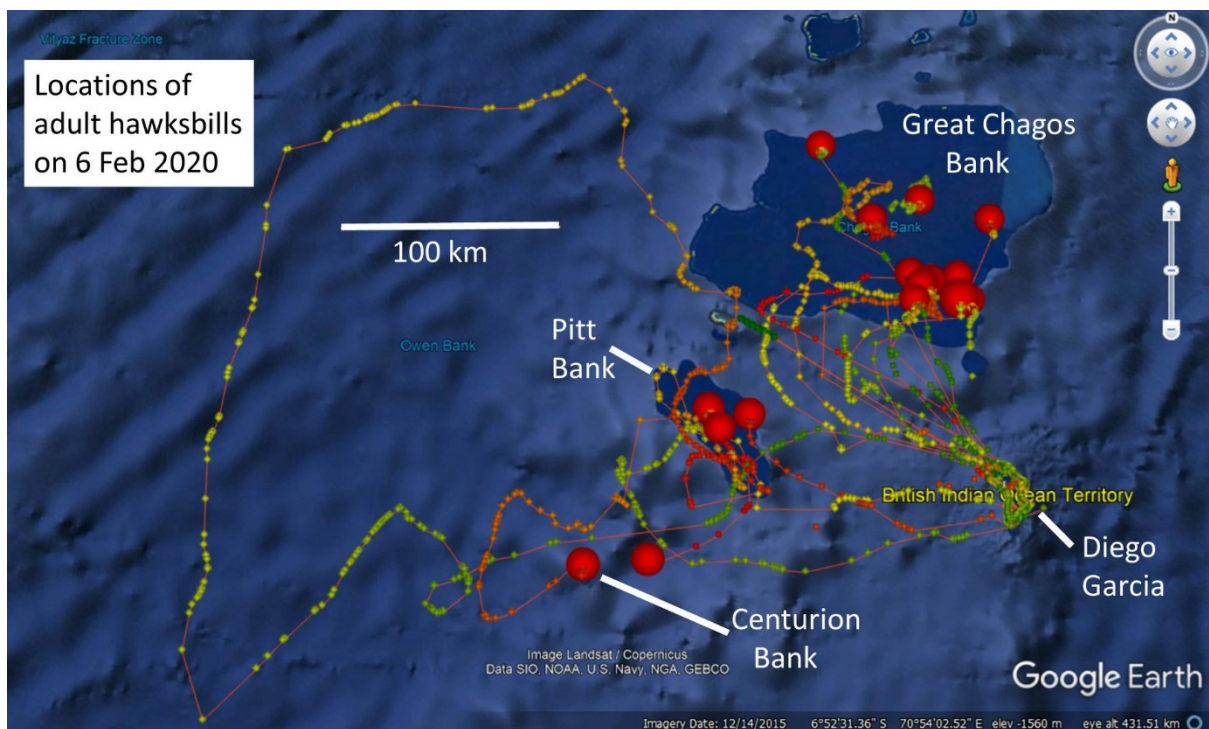


Figure 6. 18 adult female hawksbill turtles are being tracked from their nesting beach in Diego Garcia to their foraging grounds. The current locations of the turtles are shown as red circles. Most turtles travelled towards the northwest of Diego Garcia. Some turtles travelled almost directly to their foraging grounds whilst others took a very circuitous path. The longest track to date (>1000 km) is from a turtle that took an extremely circuitous route to Centurion Bank via Pitt Bank, the Great Chagos Bank and Danger Island.



Figure 6. Remote camera traps are taking pictures of the beach every day of the year and help better quantify when turtles are nesting on Diego Garcia. Turtle tracks are clearly visible on the pictures and provide valuable information for days when beach surveys are not conducted.

DISCUSSION:

The data collected on this expedition will contribute to a better our understanding of key ecological questions regarding hawksbill sea turtles, specifically: how much time do the females spend in Diego Garcia and where do they go after the breeding season? Over the course of this four-year research project we have already gained valuable information on the biology and ecology of the two turtle species that nest in BIOT. With these additional tag deployments, we will be able to assess whether there are differences between different sea turtles species migratory behaviours (i.e. hawksbill and greens) and how the movements of adults hawksbills is different to that of immature hawksbills. Ultimately, results of this work will inform conservation management for these two different species and at two different life stages.

VALUE OF RESEARCH TO BIOT:

The information gained from this research will inform on the ecology and conservation of hawksbill and green sea turtles in BIOT. For example, there is limited information about when hawksbills breed in BIOT and when they make use of the surrounding MPA. Results from our work will fill this knowledge gap. In addition, knowing where the turtle's foraging grounds are and whether or not they are found within the MPA is critical information for their protection and conservation. Preliminary results suggest that their foraging grounds are found within the MPA and that the turtles never leave the MPA, demonstrating that the MPA has significant impact on the conservation of adult hawksbill nesting on Diego Garcia. As such, findings of this research will have direct relevance to the BIOT Conservation Management Plan (CMP).

CONCLUSION:

The November-December 2019 expedition to Diego Garcia was an extensive success. Aided by numerous volunteers, we tagged 18 adult hawksbills, recorded 79 new turtle nesting activities (i.e. tracks and nests), surveyed immature turtles in the lagoon, set up new experiments examining the detrimental effects of microplastics on sea turtles, and serviced important scientific equipment used in the long-term and remote monitoring of beaches on Diego Garcia. Findings that will emerge out of this work will complement research conducted in BIOT in previous years and will add new information to our knowledge of these globally-important sea turtle populations, which in turn will inform conservation management strategies for hawksbill and green sea turtles in BIOT.

ACKNOWLEDGMENTS:

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Figure 7. Volunteers wave goodbye to a turtle that returned to the sea after being tagged with a satellite tag.

Research expedition diary

NOTE: For further information please contact Nicole Esteban at n.esteban@swansea.ac.uk

Date	Tide (time, m)	Activity
Tue 26 Nov Day 1		Travel/arrive.
Wed 27 Nov Day 2		Introduction meetings, collect vehicle, collect equipment, prepare satellite tags.
Thu 28 Nov Day 3	0242 2.00 0843 0.57 1451 2.04	Prepare equipment, take boxes to beach, conduct beach survey.
Fri 29 Nov Day 4	0318 1.92 0917 0.63 1526 1.96	Daytime patrol: tag nesting hawksbill turtles (approx. nine hours encompassing the periods before, during and after daytime high tide, depends on tides and turtles located). Talk at 16:30
Sat 30 Nov Day 5	0352 1.83 0950 0.71 1600 1.86	Daytime patrol: tag nesting hawksbill turtles (approx. nine hours encompassing the periods before, during and after daytime high tide, depends on tides and turtles located).
Sun 1 Nov Day 6	0426 1.72 1022 0.80 1634 1.75 2248 0.74	Daytime patrol: tag nesting hawksbill turtles (approx. nine hours encompassing the periods before, during and after daytime high tide, depends on tides and turtles located).
Mon 2 Dec Day 7	0501 1.63 1058 0.89 1713 1.64 2328 0.86	Daytime patrol: tag nesting hawksbill turtles (approx. nine hours encompassing the periods before, during and after daytime high tide, depends on tides and turtles located). Talk at 16:30
Tue 3 Dec Day 8	0545 1.54 1145 0.99 1805 1.54	Daytime patrol: tag nesting hawksbill turtles (approx. nine hours encompassing the periods before, during and after daytime high tide, depends on tides and turtles located).
Wed 4 Dec Day 9	0024 0.97 0649 1.47 1300 1.07 1930 1.46	Daytime patrol: tag nesting hawksbill turtles (approx. nine hours encompassing the periods before, during and after daytime high tide, depends on tides and turtles located).
Thu 5 Dec Day 10	0154 1.05 0830 1.44 1503 1.09 2124 1.46	Daytime patrol: tag nesting hawksbill turtles (approx. nine hours encompassing the periods before, during and after daytime high tide, depends on tides and turtles located).
Fri 6 Dec Day 11	0342 1.04 1008 1.50 1636 1.01 2245 1.54	Data entry, tag preparation.
Sat 7 Dec Day 12	0452 0.97 1106 1.60 1727 0.89 2334 1.64	Nesting beach surveys, aerial survey lagoon side, re-battery camera traps, deploy temperature loggers in plastic assessment trial sites.
Sun 8 Dec Day 13	0538 0.88 1146 1.70 1804 0.76	Nesting beach surveys, aerial survey lagoon side, re-battery camera traps, deploy temperature loggers in plastic assessment trial sites.

Date	Tide (time, m)	Activity
Mon 9 Dec Day 14	0012 1.74 0615 0.78 1221 1.80 1837 0.64	Nesting beach surveys, aerial survey lagoon side, re-battery camera traps, deploy temperature loggers in plastic assessment trial sites.
Tue 10 Dec Day 15	0048 1.83 0648 0.69 1254 1.89 1910 0.53	Nesting beach surveys, aerial survey lagoon side, re-battery camera traps, deploy temperature loggers in plastic assessment trial sites.
Wed 11 Dec Day 16	0121 1.90 0721 0.62 1326 1.96 1942 0.46	Nesting beach surveys, aerial survey lagoon side, re-battery camera traps, deploy temperature loggers in plastic assessment trial sites.
Thu 12 Dec Day 17	0154 1.94 0754 0.59 1359 2.00 2015 0.42	Daytime patrol: tag nesting hawksbill turtles (approx. nine hours encompassing the periods before, during and after daytime high tide, depends on tides and turtles located).
Fri 13 Dec Day 18	0229 1.95 0827 0.57 1433 2.02 2051 0.42	Daytime patrol: tag nesting hawksbill turtles (approx. nine hours encompassing the periods before, during and after daytime high tide, depends on tides and turtles located).
Sat 14 Dec Day 19	0304 1.94 0903 0.59 1510 2.01 2128 0.45	Daytime patrol: tag nesting hawksbill turtles (approx. nine hours encompassing the periods before, during and after daytime high tide, depends on tides and turtles located).
Sun 15 Dec Day 20	0343 1.91 0942 0.63 1550 1.97 2209 0.53	Daytime patrol: tag nesting hawksbill turtles (approx. nine hours encompassing the periods before, during and after daytime high tide, depends on tides and turtles located).
Mon 16 Dec Day 21	0425 1.85 1024 0.71 1634 1.90 2254 0.64	Clean equipment & store, return boxes to store, return vehicle. Meetings with British Representative, Police and Review of Drone footage.
Tue 17 Dec Day 22		Depart/travel.