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Yoshimasa Matsuzawa

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The newsletter is distributed free of cost to a network of government and non-government organisations and individuals in the region. All articles are also freely available in PDF and HTML formats on the website. Readers can submit names and addresses of individuals, NGOs, research institutions, schools and colleges, etc. for inclusion in the mailing list.

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Cover photograph: Movements of leatherback turtles from their nesting beach in iSimangaliso Wetland Park, South Africa
Photo Courtesy: Robinson et al. (2018)

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EDITOR'S NOTE

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Satellite telemetry studies of sea turtles can be used to: elucidate migratory pathways, abundance, behaviour, distribution, preferred habitat, clutch frequency, neonate dispersal; identify conservation hotspots and inform protected area designation and management; and, engage communities with research and raise awareness about threats to sea turtles and their habitats (for examples see Blumenthal *et al.*, 2006; Rees *et al.*, 2010; Richardson *et al.*, 2010; Scott *et al.*, 2012; Schofield *et al.*, 2013; Weber *et al.*, 2013; Hays *et al.*, 2014; Mansfield *et al.*, 2014; Robinson *et al.*, 2016; Bradshaw *et al.*, 2017; Dawson *et al.*, 2017; Esteban *et al.*, 2018; Tucker *et al.*, 2018). There are concerns about scientific rigour of telemetry studies, animal welfare, accumulation of unpublished or unavailable tracking data, the potential to use the technology indiscriminately without clear objectives, and only a small body of evidence that telemetry studies inform policy and management (summarised by Godley *et al.*, 2008; Jeffers & Godley, 2016). However, carefully designed satellite telemetry studies have the potential to fill some of the knowledge gaps about sea turtles in the Indian Ocean and South-East Asia and elsewhere (Hays & Hawkes, 2018).

Jeffers & Godley (2016) determined that the smallest proportion of sea turtle satellite telemetry studies worldwide had occurred in the Indian Ocean when compared with the Mediterranean Sea, Pacific Ocean or Atlantic Ocean, and that only 4% of studies worldwide had occurred in South-East Asia. Contributing factors to this finding may be the challenges to satellite telemetry in the region, including the cost of transmitters, despite improving affordability in recent years (Jeffers & Godley, 2016), and difficulty in obtaining permits (see Mancini *et al.*, 2018). Despite this, there are two tracking studies from the region where turtles have been tracked over a number of years (e.g Robinson *et al.*, 2018; Tiwari *et al.*, 2018) and combined in a regional analysis (Antonopoulou & Pilcher, 2018). Considering that sea turtle Regional Management Units in the Indian Ocean have been described as having “critical data needs” (Wallace *et al.*, 2011), research efforts (and funds) should be focused so as to

address unanswered questions and minimise repetition.

To better understand the breadth and findings of satellite telemetry studies conducted to date in the region and identify knowledge gaps still to be filled, IOTN has produced two special issues on this topic: IOTN28 presents studies from the south-western Indian Ocean north to the Red Sea, Arabian/Persian Gulf, and Arabian Seas, and IOTN29 comprises reports from countries in South Asia, South-East Asia, and the south-eastern Indian Ocean. As the issues will be published in the months prior to the 39th Annual Symposium on Sea Turtle Biology and Conservation to be held in Charleston SC, USA, from 2nd-8th February 2019, we hope the findings presented in IOTN28 (and the forthcoming IOTN29) will be a topic of discussion among participants at the regional meeting for the Indian Ocean and South-East Asia.

We would like to thank all authors of papers in IOTN28 and 29 and members of the IOTN Editorial Board (and especially those who both wrote and reviewed papers) for their significant contribution and patience while we compiled the body of work presented in the two issues. Planning for an IOTN special issue on satellite telemetry studies began in 2016 and it has taken some time to finalise all of the manuscripts, which presented such detail that the issue had to expand from one to two to accommodate the contributed papers. Your efforts have resulted in a combined resource which we anticipate will be of value to IOTN readers and inform future studies and sea turtle management and conservation efforts in the region.

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SATELLITE TRACKING OF LEATHERBACK AND LOGGERHEAD SEA TURTLES ON THE SOUTHEAST AFRICAN COASTLINE

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INTRODUCTION

The waters of southeast Africa contain important habitats for several sea turtle species, including the leatherback *Dermochelys coriacea*, loggerhead *Caretta caretta*, hawksbill *Eretmochelys imbricata*, green *Chelonia mydas*, and olive ridley turtle *Lepidochelys olivacea*. Many of these species are of conservation concern (Rakotonirina & Cooke, 1994; Thorson *et al.*, 2012; Nel *et al.*, 2013) and vulnerable to regional threats such as fisheries by-catch or boat-strikes (Bourjea *et al.*, 2008; Grantham *et al.*, 2008; Pusineri & Quillard, 2008). To help in the development of effective conservation plans for these species, many conservation or research organisations have used satellite transmitters to help identify critical habitats for sea turtles (Harris *et al.*, 2015; Robinson *et al.*, 2016). Here, we review the movement patterns of sea turtles that have been tracked through satellite telemetry from their nesting beaches on the east coast of South Africa.

Sea turtles nest along most of the southeast African coast line. Leatherback and loggerhead turtles predominantly nest below 22°S from southern Mozambique to northern South Africa, while green, hawksbill, and olive ridley turtles predominantly nest above 22°S and throughout

northern Mozambique (Costa *et al.*, 2007). In addition, the nesting range of green and hawksbill turtles, although not olive ridley turtles, extends further north into Tanzania (Muir, 2005). The longest running monitoring program for nesting sea turtles in the region, and one of the longest running worldwide, is found in the iSimangaliso Wetland Park (hereafter referred to exclusively as iSimangaliso), South Africa. This project, which was founded in 1963, has predominantly used metal identification tags to monitor the nesting leatherback and loggerhead turtles (Hughes, 2010; Nel *et al.*, 2013). In the past few decades, however, these mark-recapture methodologies have been complemented with several satellite tracking studies.

SATELLITE TAG DEPLOYMENT

Three different partnerships have deployed satellite transmitters on the leatherback and loggerhead turtles that nest in iSimangaliso. The first partnership was led by scientists from the University of Pisa, Italy, in collaboration with the Natal Parks Board. The partnership tracked 11 leatherback and four loggerhead turtles between 1996 and 2003 (Luschi *et al.*, 2006). The second partnership was led by scientists working for several South African organisations, including Ezemvelo

KZN Wildlife, Department of Environmental Affairs (Oceans and Coasts), the iSimangaliso Wetland Park Authority, as well as Nelson Mandela Metropolitan University. This partnership has now tracked a total of 14 leatherback and 20 loggerhead turtles from 2006 until the present (Harris *et al.*, 2015; Harris *et al.*, 2017). The third partnership was led by scientists from Purdue University, USA, who tracked 20 leatherback turtles between 2011 and 2013 (Robinson *et al.*, 2016, 2017).

KEY FINDINGS

Although iSimangaliso provides comprehensive protection for the turtles that nest within its borders (Nel *et al.*, 2013), until recently it was not known how effective the Park was for protecting inter-nesting turtles. Satellite tracking has now revealed that loggerhead turtles remain a mean distance of 9km from the shoreline during the inter-nesting period (Harris *et al.*, 2015). In contrast, leatherback turtles tend to move far greater distances, remaining a mean of 60km from the shoreline (Harris *et al.*, 2015). Leatherback turtles also show distinct variability

between individuals, with some turtles remaining within 10km of the shoreline, while others making large loops extending over 100km out to sea (Harris *et al.*, 2015, Robinson *et al.*, 2017). Consequently, loggerhead turtles remain within the protective jurisdiction of iSimangaliso ~95% of the time whereas leatherback turtles do so for only ~25% of the time (Harris *et al.*, 2015). More research is needed to determine how to effectively protect leatherback turtles during the inter-nesting period and what drives the inter-nesting movements of these animals. Nonetheless, recent studies suggest that the movements of leatherback turtles may be constrained by the Agulhas Current (Robinson *et al.*, 2017).

After the completion of the nesting season, both loggerhead and leatherback turtles conduct long-distance migrations to foraging areas (Figure 1, Figure 2). Of the 20 loggerhead turtles that have been tracked since 2006, 17 have followed migratory routes in the coastal waters of Mozambique (Harris *et al.*, 2017). Of the remaining three, two migrated across the Mozambique Channel and into Madagascar's coastal waters and one migrated

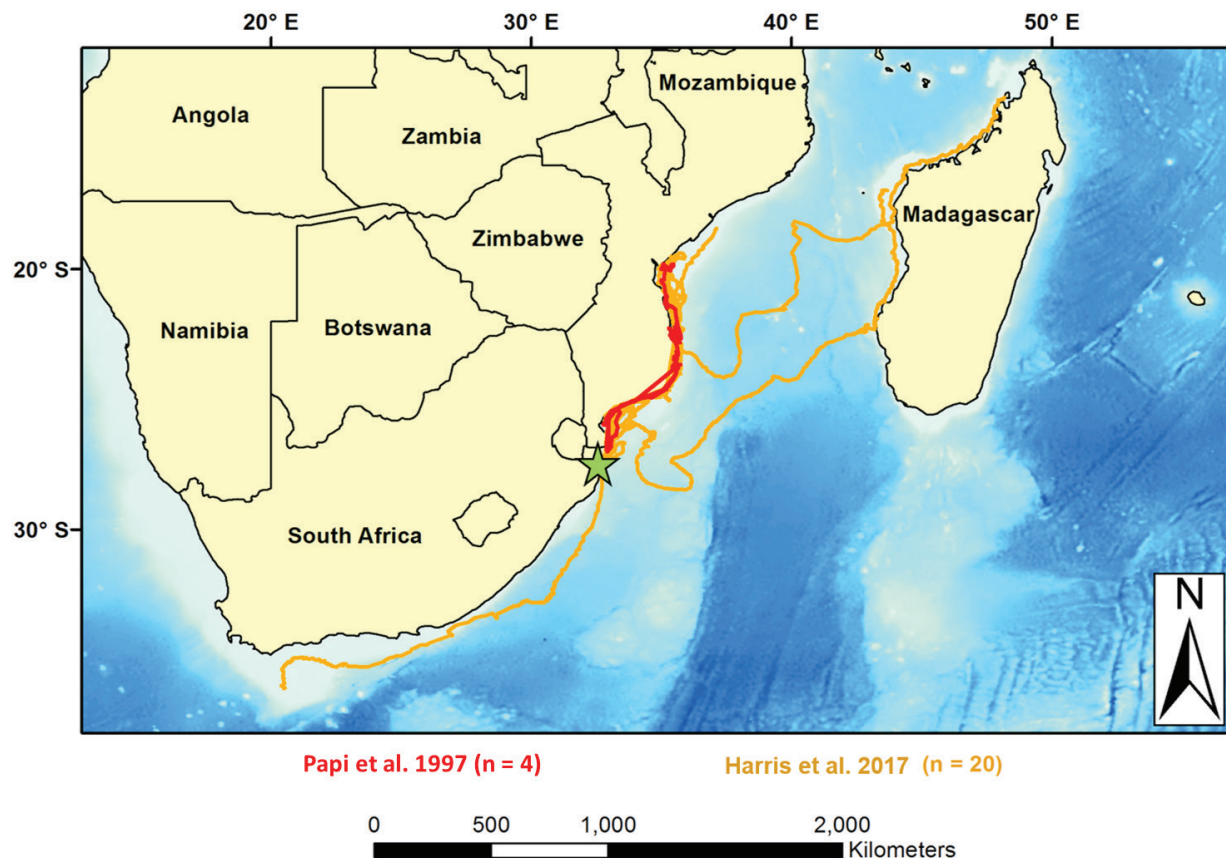


Figure 1. Movements of 24 loggerhead turtles tracked from their nesting beach in the iSimangaliso Wetland Park, South Africa (green star) between 1996 and 2013. Red lines represent the movements of four turtles that have been previously published in Papi *et al.* (1997). Orange lines represent the movements of 20 turtles that were tracked by the South African partnership and published in Harris *et al.* (2017). For reference to colours, see the pdf version available on-line.

south to the coastal waters of the Cape of Good Hope (Harris *et al.*, 2017). Evidently, this only represents a subset of all the foraging habitats utilised by this population. Of the 102 loggerhead turtles with metal tags that have been recaptured since 2012 outside of iSimangaliso, they have occurred over a far wider range of coastal habitats, stretching north from iSimangaliso into Mozambique, Tanzania, and Madagascar, and to lesser extent Kenya and Somalia (de Wet, 2012).

Other satellite tracking studies have also been conducted on the loggerhead turtles in the area to assess the navigational abilities of these animals when displaced from their capture location. In the first of these studies, loggerhead turtles were captured just before oviposition and relocated distances of up to 70km along the coast (Papi *et al.*, 1997). All but one of these animals immediately swam back to the capture site to nest, thus demonstrating an impressive capacity for homing behaviour. In the second study, five animals were captured just before

beginning their post-nesting migrations and relocated distances up to 2,193km, often offshore and far away from their presumed foraging areas in the coastal waters of Mozambique (Luschi *et al.*, 2003a). Three of these turtles migrated and eventually settled in coastal foraging habitats, while two instead conducted nomadic wandering movements in the open-ocean of the western Indian Ocean (Mencacci *et al.*, 2010). Presumably, these animals were unable to compensate their migratory behaviour to account for their earlier displacement (Luschi *et al.*, 2003a).

In distinct contrast to the loggerhead turtles, the first satellite tracking studies on leatherback turtles revealed that almost all individuals migrated into pelagic habitats (Figure 2). After nesting, leatherback turtles would migrate south, following the Agulhas Current along the east coast of South Africa before heading east into the Agulhas Retroflection or west in the Benguela Upwelling System (Hughes *et al.*, 1998; Luschi *et al.*, 2003b; Lambardi *et al.*, 2008). Once in open-ocean water,

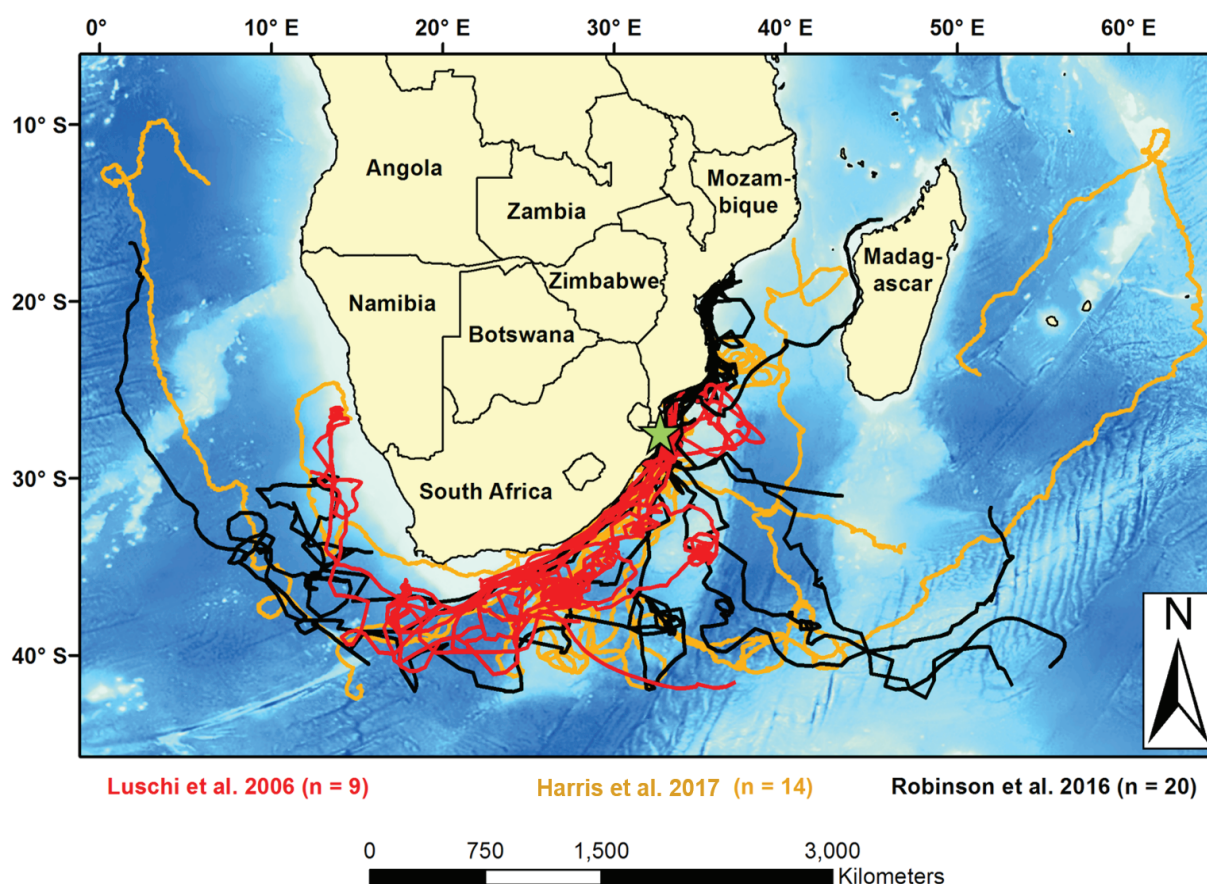


Figure 2. Movements of 42 leatherback turtles tracked by satellite telemetry from their nesting beach in the iSimangaliso Wetland Park, South Africa (green star) between 1996 and 2013. Red lines represent the movements of nine turtles published in Luschi *et al.* (2006). The orange lines represent the movements of 14 turtles published in Harris *et al.* (2017). The black lines represent the movements of 20 leatherback turtles published in Robinson *et al.* (2016). For reference to colours, see the pdf version available on-line.

the leatherback turtles followed meandering movement patterns that were considered more “as a prolonged sojourn in vast feeding areas than as a true migration” in Luschi *et al.* (2006). Oceanographic analyses revealed that these movements largely followed the prevailing surface flow of the Agulhas Current (Luschi *et al.*, 2003b; Lambardi *et al.*, 2008), which flows south along the east coast of South Africa. However, these turtles did not drift passively within the currents, but were found to swim actively during most of their journey, albeit without being able to detect the direction of the flow that they were being entrained by (Galli *et al.*, 2012). Satellite telemetry data also revealed that turtles dove almost continuously throughout their journey, mainly at depths shallower than 200m, but with occasional deep dives that could exceed 1,000m (Sale *et al.*, 2006; Robinson, unpubl. data).

Supporting the early characterisation of leatherback turtles as pelagic specialists, by 2010 only five leatherback turtles with metal tags had ever been captured outside of iSimangaliso (de Wet, 2012). However, a recent study has shown that the migratory behaviour of these animals might be far more diverse. In a recent satellite tracking study, eight of the 16 leatherback turtles tracked swam to coastal foraging areas. Specifically, these animals swam north of the nesting area before reaching resident foraging areas in the shallow waters (less than 50m depth) of the Sofala Banks in the Mozambique Channel (Robinson *et al.*, 2016). These turtles, which were tracked up to 209 days, remained in this coastal habitat for the entire tracking duration. The importance of these habitats for leatherback turtles was further confirmed by stable isotope analysis which estimated that 41% of the leatherback turtles nesting in iSimangaliso forage in the Sofala Banks (Robinson *et al.*, 2016). Although leatherback turtles have been recorded foraging in relatively small, shallow coastal habitats in other locations around the world (James *et al.*, 2005; Dodge *et al.*, 2014), such behaviour is usually tied to seasonal abundance of food in these habitats during summer months (Wallace *et al.*, 2015). The presence of leatherback turtles year-round in the Sofala Banks suggests that this habitat must also host an exceptionally high abundance of gelatinous zooplankton – the obligate prey of leatherback turtles.

CONCLUSION

The leatherback and loggerhead turtles of South Africa have been satellite tracked intensively for many years now and much is now known about their in-water behaviour. Interestingly, some of the earliest paradigms concerning the habitat preferences of these species, e.g. leatherback turtles as open-ocean wanderers and loggerhead turtles as coastal specialists, were largely established following

studies conducted on these populations (Luschi *et al.*, 2006). Through continued tracking however, it is now clear that the migratory patterns of both species are far more diverse than originally considered. This highlights how far we have come in understanding the spatial ecology of these animals and how much there is still to learn. For example, satellite tracking studies in iSimangaliso are yet to investigate the movements of male or non-adult leatherback or loggerhead turtles in the region. Green and hawksbill turtles are also commonly encountered in the waters of iSimangaliso, yet no published studies have reported on the movement patterns of these animals.

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The satellite tracking studies presented in this study were conducted by scientists from several organizations including University of Pisa (Italy), Natal Parks Board (South Africa) and its successor Ezemvelo KZN Wildlife, Department of Environmental Affairs: Oceans and Coasts (South Africa), the iSimangaliso Wetland Park Authority (South Africa), Nelson Mandela Metropolitan University (South Africa), Purdue University (USA), and The Leatherback Trust (USA).

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SATELLITE TRACKING GREEN TURTLES IN THE CHAGOS ISLANDS

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INTRODUCTION

Since 2012 we have been satellite tracking nesting green turtles in the Chagos Archipelago, Indian Ocean which forms part of the British Indian Ocean Territory (BIOT). In 2010, the UK Government created a massive Marine Protected Area (MPA) around this archipelago, spanning 640,000km², making it the World's largest MPA at the time (Sheppard *et al.*, 2012). We have conducted one of the first satellite tracking studies of a migratory species within this MPA to assess use of protected versus unprotected areas. We describe here the initial results from eight tags deployed in 2012.

METHODS

Satellite tags were attached to nesting green turtles on the island of Diego Garcia (7°25'S, 72°27'E) within the Chagos Archipelago. We describe here initial results from the first deployments in October 2012 and mention subsequent deployments in the discussion. Tagging was done on a beach that supports the highest numbers of nesting turtles in the archipelago. In short, turtles were first located while ashore nesting at night. Upon their return to the sea they were restrained in a large open topped and bottomless wooden box. The carapace was cleaned with acetone and then lightly sand-papered, in order to provide a better surface for attachment of the tag. The tags were then attached with quick setting epoxy and covered with anti-fouling paint (see Hays *et al.*, 2014 for full details). Once epoxy had hardened and the paint dried the turtle was allowed to return to the sea. We used two models of Fastloc-GPS Argos satellite tag: (a) SPLASH10-BE, Wildlife Computers, Redmond, Washington USA and (b) model F4G 291A, Sirtrack, Havelock North, New Zealand. These tags provide high resolution Fastloc-GPS locations accurate to a few 10s of meters (see Dujon *et al.*, 2014).

RESULTS

At the end of the nesting season, turtles departed to a broad range of destinations. Four turtles travelled more than 2,500km westwards from the Chagos Archipelago to the Amirantes Islands, which form part of the Seychelles; two turtles travelled >3,800km westwards to the coast of Somalia on mainland Africa; one turtle travelled >1,000km northwards to the Maldives, and one turtle travelled 166km to foraging grounds on the Great Chagos Bank, which lies north of the original nesting beach (Figure 1). Our satellite tracking data also enabled us to assess home range and diel activity patterns of the turtles at their various foraging grounds throughout the region (Christiansen *et al.*, 2016). On their foraging grounds, we have found that turtles tend to use fairly restricted home-ranges only a few kilometres in extent, often with distinct night-time resting and daytime feeding areas.

DISCUSSION

Our initial results emphasise the value of the full protection sea turtles currently receive within the Chagos MPA. These findings have been reiterated by our subsequent deployment of more satellite tags on adult green turtles in July 2015 (see Esteban *et al.*, 2017). We have shown how the Chagos MPA protects adult green turtles during the breeding season because they remain within the MPA close to their nesting beaches. Furthermore, some adults clearly travel to foraging grounds within the MPA and so will remain in protected areas outside the breeding season. In addition, the protection of nests located on beaches in the heart of the MPA will help increase hatchling emergence (i.e., the proportion of eggs laid that result in hatchlings successfully emerging from nests).

Our results show how international co-operation

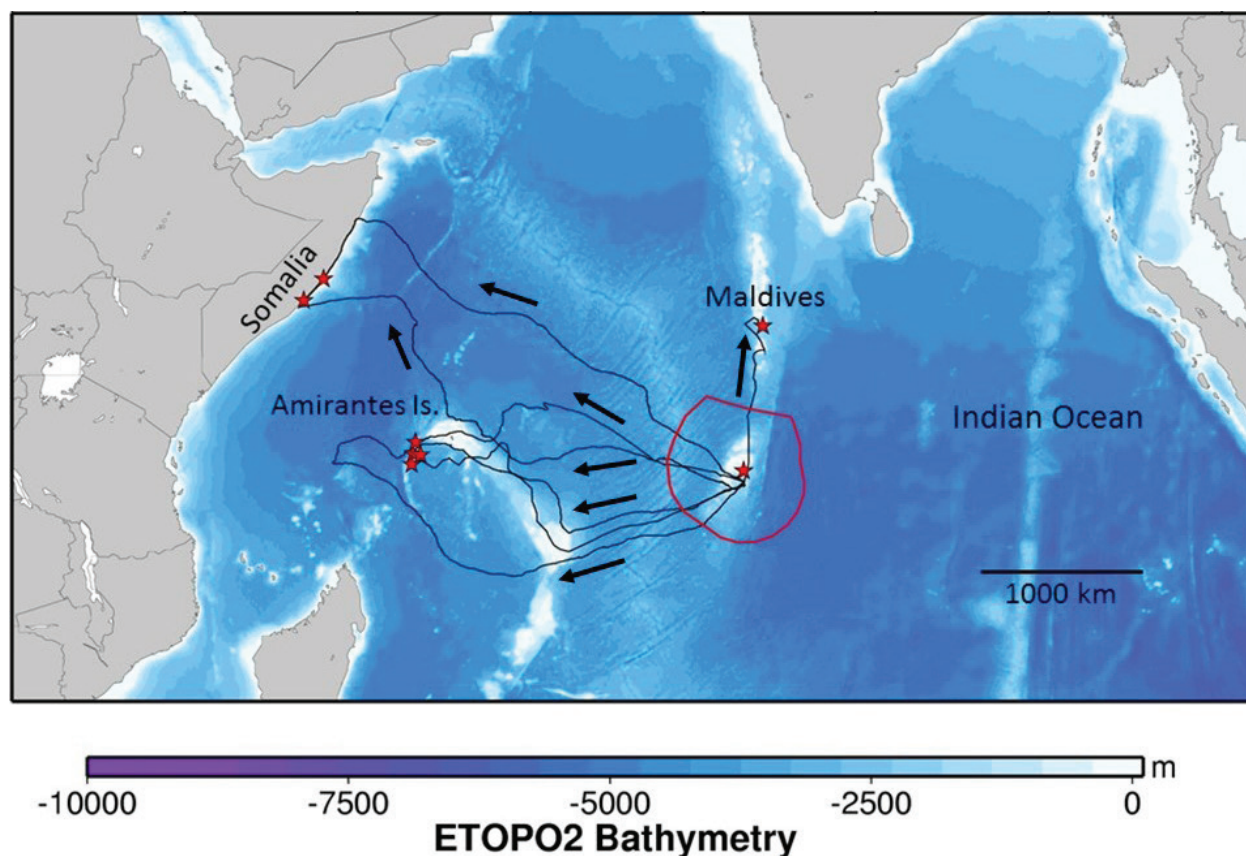


Figure 1. Movements of eight adult female green turtles from their nesting beach on Diego Garcia (red stars, foraging ground location for each turtle; solid red line, extent of the Chagos Marine Protected Area). Direction of travel shown by the arrows. Modified from Hays *et al.* (2014). For reference to colours, see the pdf version, available on-line.

is needed to help the conservation of wide-ranging species and highlight the value of the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats in the Indian Ocean and South-East Asia (IOSEA Marine Turtle MoU). Our satellite tracked turtles have travelled to countries including the Seychelles, Kenya, Somalia, Madagascar, Tanzania and the Maldives. Our conclusion that even the largest MPAs should be supplemented by targeted smaller MPAs or national legislation as well as international agreements, is likely to apply to a broad range of marine migrants spanning several taxa.

ACKNOWLEDGEMENTS

We are grateful for logistical support provided by personnel in the British Indian Ocean Territory (BIOT) to patrol the beach in Diego Garcia and attach satellite transmitters, in particular Antenor Nestor Guzman, Kristi Dunn, Karen Corson, Lee Hardy, Andy Bridson, the Diego Garcia Yacht Club, NAVFACFE PWD Diego Garcia Environmental Department and numerous volunteers from the military and civilian units on Diego

Garcia. Work was approved by Swansea University Ethics Committee, the BIOT Scientific Advisory Group (SAG) of the U.K. Foreign and Commonwealth Office and endorsed through research permits from the Commissioner for BIOT.

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SATELLITE TRACKING STUDIES SHOW NESTING SITE IN EGYPT IS HUB FOR ADULT GREEN TURTLES OF THE RED SEA

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INTRODUCTION

The Egyptian Red Sea is home to five species of marine turtles, however only the endangered green turtle (*Chelonia mydas*) and the critically endangered hawksbill turtle (*Eretmochelys imbricata*) are frequently observed and known to feed and nest in the Egyptian waters (Frazier & Salas, 1984; Hanafy, 2012). The less common species are the olive-ridley turtle (*Lepidochelys olivacea*), the loggerhead turtle (*Caretta caretta*) and the leatherback turtle (*Dermochelys coriacea*) (Frazier & Salas, 1984; Mancini *et al.*, 2015a).

Very little is known about nesting and feeding activities of hawksbill turtles in the Egyptian Red Sea. Frazier & Salas (1984) reported two main nesting sites in Shedwan and Giftun Islands (Hanafy & Sallam, 2003), with 50 to 100 nests estimated per year (PERSGA/GEF, 2004). No information is available on their post-nesting migratory routes.

More information is available on green turtle nesting and feeding activities. Feeding aggregation sites have been identified in various shallow lagoons and bays along the Red Sea coast where seagrass patches (particularly *Halophila ovalis*; Shaffai, 2011) are abundant (Mancini *et al.*, 2015a; Mancini *et al.*, 2015b). Recent surveys using snorkelling transects provided an estimated relative population of 280 turtles, at 12 index sites (Mancini *et al.*, 2015b; Elsadek, 2016). The population is

composed of 46% juvenile, 42% adult female, and 12% adult male turtles (Elsadek, 2016). Nesting activities for this species occur mainly on offshore islands, with Zabargad Island being the major nesting area (estimated nesting population of 200 females/season; Hanafy, 2012). Scattered nesting also occurs along the coast but at a much lower level (Hanafy, 2012).

Little is known about movements of green turtles within the Egyptian Red Sea, as only four adult females have been tracked by satellite telemetry after nesting on Zabargad Island in 2010 (Attum *et al.*, 2014).

STUDY AREA

Zabargad Island, located in the Southern Egyptian Red Sea, is approximately 71km from the mainland coast (Figure 1) and covers an area of around 4.5 square-km. The island is part of the Gebel Elba Protected Area. Access on land is forbidden, however, due to low enforcement, fishers are known to stay on the island at night. Carcasses of turtles have been found on the nesting beach, suggesting that poaching is on-going although the scale of such a threat is unknown (Mancini & El-Sadek, pers. obs.). Mooring facilities for safari boats are located in front of the east end of the nesting beach and diving activities usually take place around the island. From May to October, a relatively stable population of approximately 200 green turtles lay eggs on the sandy beach (3.5km long) located on the southern side of the island (Hanafy



Figure 1. Location of Zabargad Island (Egypt) and Ras Baridi (Saudi Arabia), two major green turtle nesting sites within the Red Sea.

& Sallam 2003; Hanafy, 2012; EEAA, unpubl. data).

SATELLITE TAG DEPLOYMENT

In 2010, four turtles, equipped with Sirtrack KiwiSat 101 satellite transmitters (www.sirtrack.com, Attum *et al.*, 2014), were tracked for 207-647 days. Post-nesting migration routes varied between 150-940km (Table 1, Figure 2).

MAIN FINDINGS

Green turtles tagged in the Egyptian Red Sea executed short-to-long range (from 150 to 940km) post-nesting migrations in order to reach their preferred feeding grounds. The four turtles tagged by Attum *et al.* (2014) showed that Zabargad Island may act as a hub for

Table 1. Details of the four green turtles tagged and released after nesting on Zabargad Island, Egypt, on 25th July 2010. The migration distance refers to the minimum distance (sum of distances between each migration point) travelled by each turtle during the tag deployment period. (Modified from Attum *et al.*, 2014.)

| Turtle | Duration (days) | Migration Distance (km) |
|----------|-----------------|-------------------------|
| Fahd | 397 | 150 |
| Nada | 207 | 760 |
| Sallam | 237 | 940 |
| Rasheeda | 647 | 550 |

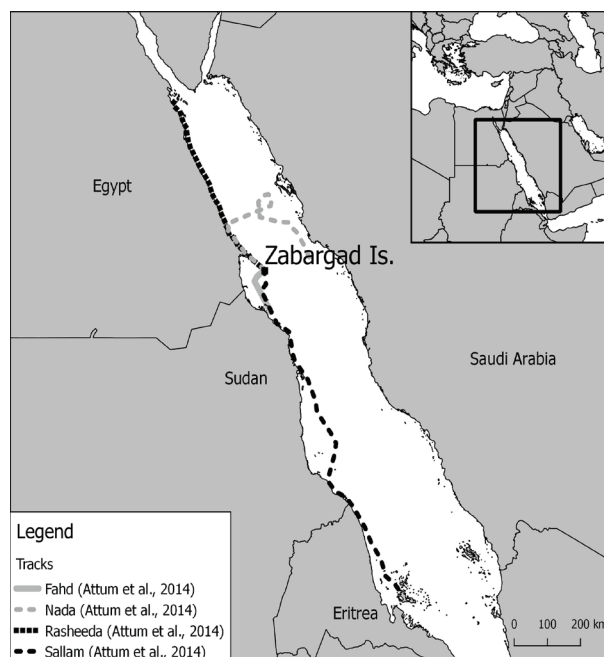


Figure 2. Migratory patterns of green turtles tagged and released from Zabargad Island (Egypt) in 2010. (Based on data from Attum *et al.*, 2014.)

adult female turtles feeding in at least four of the seven countries encompassing the Red Sea. In addition, two of the four turtles in that study moved past suitable feeding grounds during their post-nesting migration, which suggests that those turtles may be exhibiting fidelity to particular feeding and nesting sites and not simply frequenting the most proximate areas (Attum *et al.* 2014).

Finally, while no turtle tracked from locations outside the Red Sea have migrated as far north as Egyptian waters (see Rees *et al.*, 2012), nesting green turtles tagged in Ras Baridi (Saudi Arabia) were found to migrate to Egyptian waters for feeding (L. Glower, pers. comm.). This seems to suggest that feeding grounds along the Egyptian Red Sea coast are shared by green turtles coming from different nesting areas, therefore highlighting their importance for conservation management of populations within the Red Sea.

RECOMMENDATIONS FOR FURTHER STUDIES

Further satellite tracking studies should focus on the virtually unknown hawksbill populations, for which only scattered and anecdotal data are available. Furthermore, migratory studies should focus not only on adult females but include also adult male and juvenile individuals of both species for which almost no information has been collected. Currently, a photo-identification study conducted between 2011 and 2013 shows high site fidelity of both green and hawksbill adult male and

juvenile individuals, with only one juvenile green turtle moving to a different feeding area during the study period (Mancini *et al.*, In Prep.). Further data are needed in order to cover migratory patterns of all species and size classes and identify important turtle areas.

CHALLENGES OF SATELLITE TELEMETRY STUDIES IN EGYPT

The use of satellite tracking equipment is not easy in Egypt and no clear procedure currently exists to apply for permits. Tracking and GPS devices are generally considered military equipment and would require the approval of the Ministry of Defence. However, when a program is run in collaboration with the Ministry of Environment (i.e. EEAA) no permit is required (M. Hanafy, pers. comm.).

ACKNOWLEDGEMENTS

We would like to thank Dr Mahmoud Hanafy for providing information on how to obtain permits for research programmes in Egypt.

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THE MASIRAH TURTLE CONSERVATION PROJECT: THE FIRST TURTLE TRACKING ON MASIRAH ISLAND, OMAN

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INTRODUCTION

Oman hosts important nesting colonies for four species of sea turtle; loggerhead turtles (*Caretta caretta*), green turtles (*Chelonia mydas*), olive ridley turtles (*Lepidochelys olivacea*) and hawksbill turtles

(*Eretmochelys imbricata*), with all four species nesting on Masirah Island (Ross & Barwani, 1982). The Masirah Turtle Conservation Project (MTCP) aimed to establish a population assessment of the four species of turtle that nest on Masirah Island as well as produce environmental education packages and a General

Management Plan for the Island, based on sustainable development. The 5-year project (2004-2008), the first of its kind in the region, worked closely with local authorities, fisher's associations and schools as well as the people of Masirah. An integral part of the project involved the use of satellite telemetry to track loggerhead, olive and green turtles that nested on the Island.

This project summary reviews published findings and recommends areas for further work.

METHODS

We used standard attachment methods (Godley *et al.*, 2002), using two-part epoxy to attach either Kiwisat 101 satellite transmitters (Sirtrack Ltd, Havelock North, New Zealand) or SPLASH 5 satellite transmitters (Wildlife Computers, Redmond, Washington, USA) to the carapace of randomly selected individual nesting turtles. Using Kiwisat 101s, we tracked 10 nesting loggerhead turtles from north eastern Masirah in May 2006 and two green turtles from eastern Masirah (one in August 2008 and one in September 2008). Using seven Kiwisat 101s and two SPLASH 5s we tracked nine nesting olive ridley turtles in March/April 2008.

The transmitters were programmed to be continuously on for the duration of the battery life, with transmissions suppressed when the turtles were submerged through use of an on-board saltwater switch. Tracking data were collected and managed through the Satellite Tracking and Analysis Tool (STAT; Coyne & Godley, 2005).

RESULTS

As indicated above, analysis and reporting of tracks from these three species have been previously published (Rees *et al.*, 2010; Rees *et al.*, 2012a, 2012b). The dispersed end-points of the tracks for the different species and individuals ranged from the southern Red Sea to the vicinity of the Strait of Hormuz (entrance to the Arabian Gulf). No turtles migrated eastwards to the Indian sub-continent (Figure 1). For loggerhead turtles the main findings were that they largely remained in oceanic habitats with a focal area between Socotra Island and mainland Arabia (see also Tiwari *et al.*, 2018). For olive ridley turtles, the main findings were that they mainly migrated to neritic habitats often within 120km of the nesting site, and that there was a suggestion that foraging site selection had carry-over effects on adult body size. For green turtles the main findings were that both individuals migrated over 2,400km into the Red Sea, but selected different foraging grounds separated by several hundred kilometres.

DISCUSSION

Since the initial MTCP tracking study, extensive tracking of nesting loggerhead turtles has been undertaken by the Masirah Conservation Project and continues to date (Tiwari *et al.*, 2018). The tracking results, when analysed and published, should benefit practical conservation and management of this threatened population significantly.

No further tracking of green turtles from Masirah Island has taken place since the MTCP work in 2008, so interpretation of overwintering and foraging hotspots of that population remains hampered by small sample size. There is a pressing need for additional turtles to be tracked from the island to verify the single migratory route exhibited by both turtles from this area and to confirm the importance of the coastal waters of Oman and Yemen as a critical migratory corridor for this population. However, additional green turtles have been tracked from Ras Al Hadd, the species' main nesting area in Oman (Ross & Barwani, 1982). Some information on those tracking efforts is outlined in Antonopoulou & Pilcher (2018) and combining these data with the published data from the Masirah population will benefit understanding of regional, metapopulation behaviour of this species.

No further tracking of olive ridley turtles nesting on Masirah Island has been undertaken. Consequently, no progress has been made on confirming the influence on foraging area on body size, suggested in results of the MTCP project, and the relative importance of Oman both for nesting and foraging locations of this species lacks verification. Further tracking of nesting females in combination with extensive tissue sampling for stable isotope analysis (e.g. Zbinden *et al.*, 2011) would facilitate broad-scale interpretation of the behaviour and distribution of this unique Arabian population.

It should be noted that the hawksbill turtle, which also nests on Masirah Island, was not tracked as part of the MTCP but has subsequently received some attention with a total of 10 individuals tracked from the Island in 2011 & 2012. Data on these turtles have been published in Pilcher *et al.* (2014) and Antonopoulou & Pilcher (2018).

ACKNOWLEDGEMENTS

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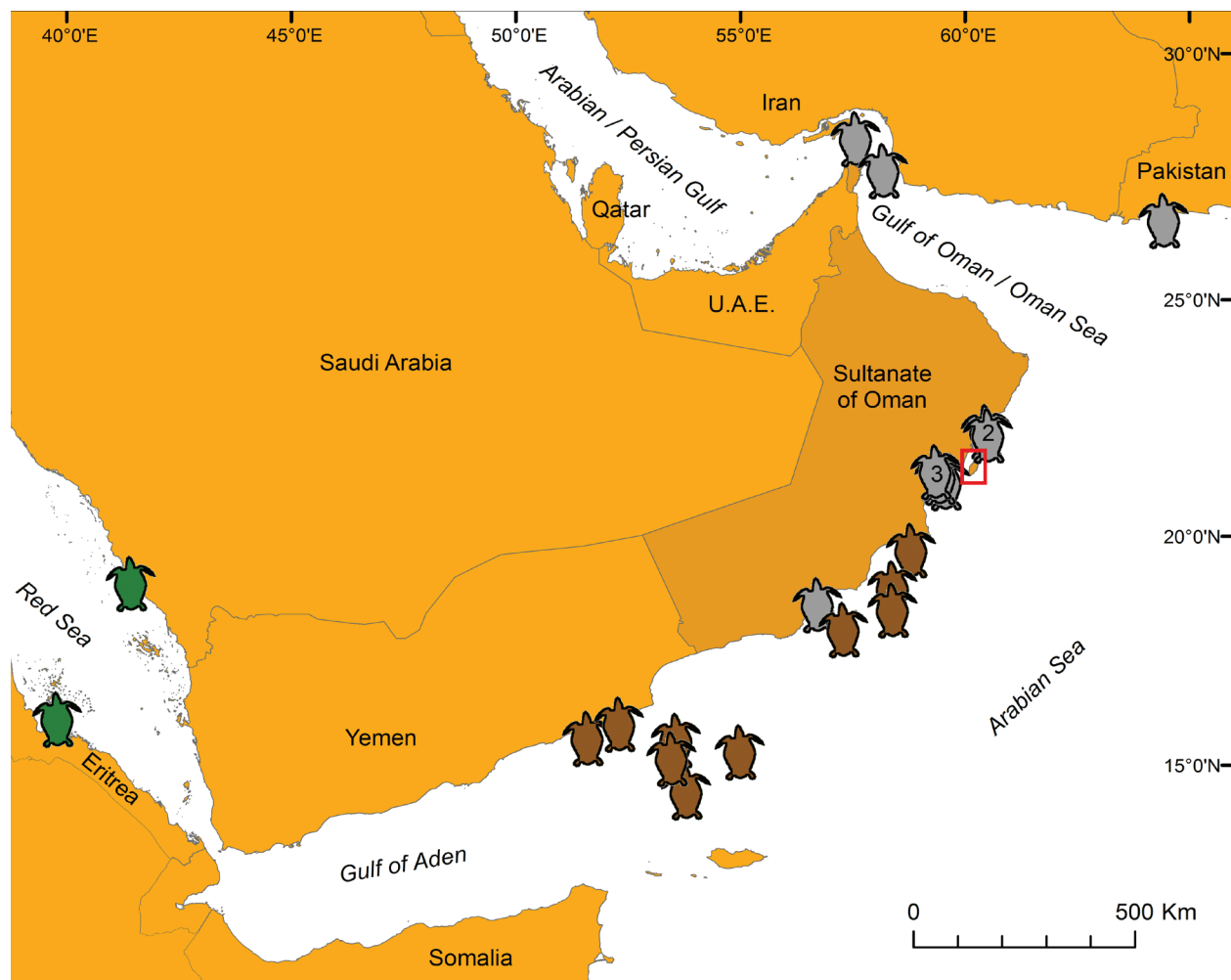


Figure 1. End locations of the 21 sea turtles tracked after nesting on Masirah Island, Oman, as part of the *Masirah Turtle Conservation Project*. Location of the Masirah Island (tagging site; red rectangle). Loggerhead turtles (brown), olive ridley turtles (grey) and green turtles (green). For reference to colours, see the pdf version available on-line.

leader of Masirah Island; Salman Al Farsi and the municipality wildlife rangers who assisted with locating and tagging the turtles; and Mussalam Al Madhousi who coordinated activities on the island. We would also like to thank Jean-Claude Farina of TOTAL SA, Muscat Branch; Guy Sallavyard, Gina Sardella-Sadiki, and Laure Fournier of the TOTAL Foundation; and Henri Crouhade, Hubert Faure, and Maurice Drapier of IPEDEX/ SPIE who each supported implementation and showed personal interest in the projects. Permission to work with turtles was granted by Oman's MECA.

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MARINE TURTLE CONSERVATION PROJECT: MONITORING HAWKSBILL NESTING POPULATIONS IN THE ARABIAN REGION

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INTRODUCTION

In the Arabian (Persian) Gulf, hereafter referred to as the Gulf, hawksbill turtles (*Eretmochelys imbricata*) nest at several key sites in Saudi Arabia (Miller, 1989; Pilcher, 1999), on a number of Kuwaiti islands (Meakins & Al-Mohanna, 2004), the Iranian coast and islands (Mobaraki, 2004), Qatar (SCENR, 2006; Pilcher *et al.*, 2008), and the United Arab Emirates (UAE) on islands off Abu Dhabi and Sharjah (EAD, 2007; Pilcher *et al.* 2014a). In the Gulf of Oman and the Arabian Sea, nesting hawksbill populations are present in the Daymaniyat Islands and Masirah Island (Ross & Barwani 1982; Salm *et al.*, 1993; Rees & Baker, 2006). The Gulf is a relatively shallow water body that undergoes extreme water temperature fluctuations with surface waters typically exceeding 30°C for sustained periods during the summer. Monitoring behavior patterns of marine turtles within these conditions can offer valuable insights on how turtles might adapt to climate change and elevated global temperatures in other parts of the world.

PROJECT PARTNERS

The Marine Turtle Conservation Project was implemented as a partnership between the Emirates Nature-WWF, formerly known as Emirates Wildlife Society-WWF (EWS-WWF), the Marine Research Foundation (MRF), as well as a number of other organisations in the region:

- UAE: Environment Agency - Abu Dhabi (EAD), Emirates Marine Environmental Group (EMEG), Environment & Protected Areas Authority, Sharjah (EPAA).
- Oman: Ministry of Environment and Climate Affairs (MECA), Environment Society of Oman (ESO), 5 Oceans Environmental Services.
- Qatar: Qatar University, Ministry of Environment Qatar, Ras Laffan Industrial City.
- Iran: Wildlife and Aquatic Affairs Bureau of the Department of Environment.

PROJECT DETAILS

The overall goal of the project was to identify post-nesting migratory routes and key foraging grounds for hawksbill

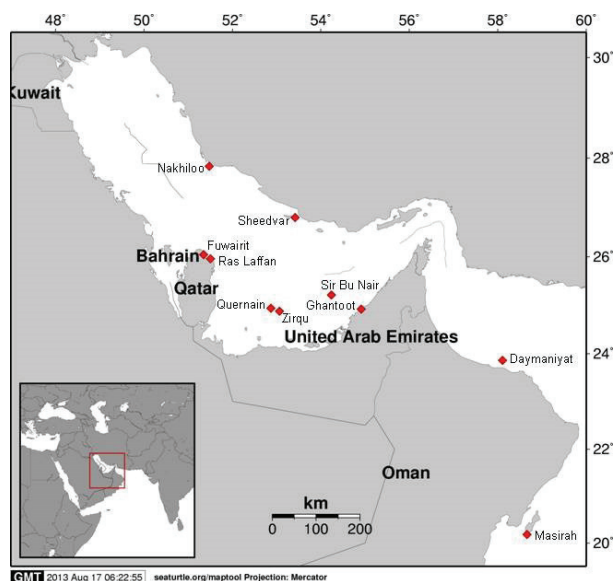


Figure 1. Locations where PTTs were deployed on hawksbill turtles in the Arabian (Persian) Gulf. (Source: EWS-WWF, 2015.)

populations in the region. To achieve this, the project used satellite telemetry from 2010-2013 to monitor 75 post-nesting female hawksbill turtles tagged at various nesting sites in four countries in the Arabian region; UAE, Oman, Iran and Qatar (Table 1). These sites (Figure 1) were selected based on previous published literature and expert advice offered by project partners. This allowed the project to obtain differing migration patterns and to determine whether turtles from nesting sites spread across the region used the same or differing feeding sites.

The project used Kiwisat 101 Platform Terminal Transponders (PTTs) made by Sirtrack Ltd. The PTTs were attached using a modified version of the Balazs *et al.* (1996) fiberglass and resin attachment. Satellite

signals were sourced from Service Argos with Kalman filtering (www.argos-system.com) and automatically downloaded by the Satellite Tracking and Analysis Tool (Coyne & Godley, 2005). Table 1 describes the number of PTTs deployed per year and by location.

PROJECT FINDINGS

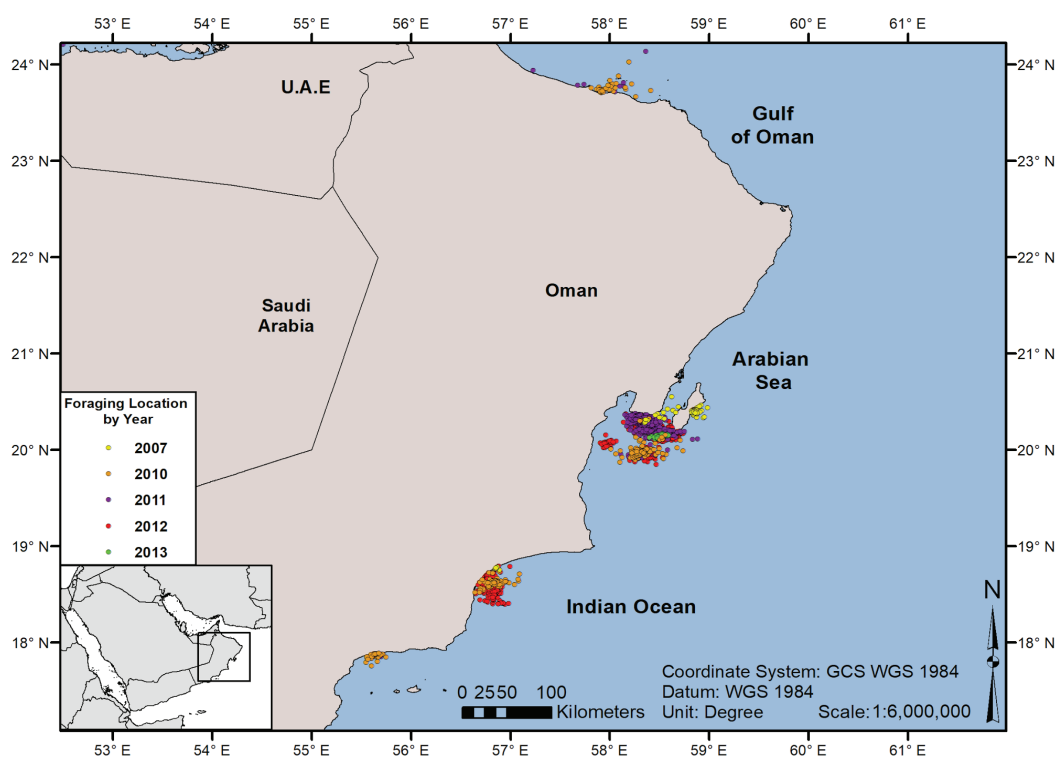
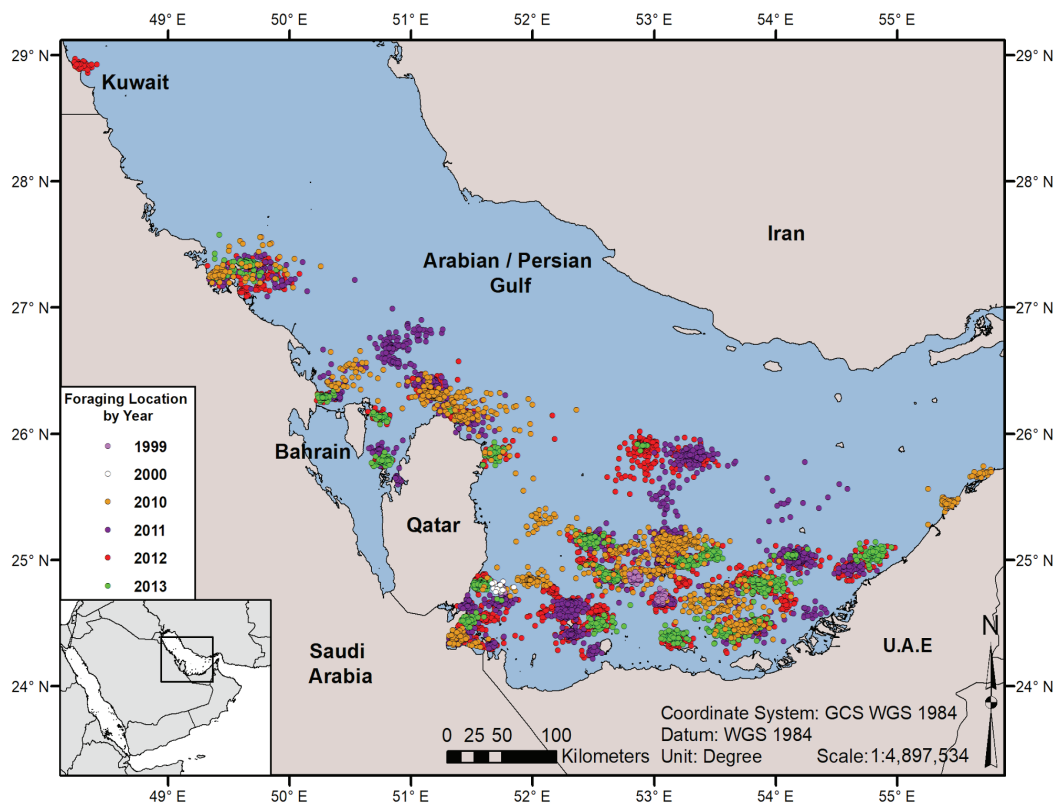
The project identified a number of foraging grounds, primarily in the southwest corner of the Gulf, across the waters of the UAE in Abu Dhabi, as well as areas shared by the UAE, Saudi Arabia, and Qatar (Figure 2). Only a few turtles traveled into the Gulf of Salwa (between Qatar and Saudi Arabia) or northwards towards Saudi Arabia and Kuwait. Outside the Gulf, hawksbill turtles utilised discreet foraging sites along the Omani coast south of Masirah Island (Figure 3).

In the Gulf, the foraging habitats were spread over large areas, but at the individual turtle level typically ranged over only 40-60km² with core areas of only 3-5km². Home ranges and core areas for Omani turtles were substantially smaller than those for Gulf turtles, suggesting Oman turtles have access to higher quality foraging areas than those turtles living in the climate-challenged Gulf, where sea surface temperatures can exceed 35°C in the summer and fluctuate over 5-10°C in a period of months, and therefore likely did not need to conduct wide-spread foraging movements (Pilcher *et al.*, 2014b).

Another interesting finding of this project was the temporary movement of turtles from shallower warm waters to deeper and cooler waters during summer months (June-August), when sea surface temperatures averaged 33.5°C and peaked at 34.9°C (Pilcher *et al.*, 2014a). This behavior was recorded in 55 turtles out of 65 tracked inside the Gulf over three consecutive years, and turtles typically returned after 2-3 months to

Table 1. Summary of PTT deployment dates and locations. Deployment coordinates are given in decimal degrees.

| Country | Location | Latitude | Longitude | Year | | |
|---------|-------------|----------|-----------|------|------|------|
| | | | | 2010 | 2011 | 2012 |
| UAE | Ghantoot | 24.920 | 54.910 | 1 | | 2 |
| | Sir Bu Nair | 25.211 | 54.237 | 4 | 3 | 6 |
| | Quernain | 24.937 | 52.870 | | 4 | |
| | Zirqu | 24.874 | 53.064 | | | 5 |
| Oman | Masirah | 20.182 | 58.663 | | 4 | 5 |
| | Daymaniyat | 23.858 | 58.109 | 5 | 3 | 5 |
| Iran | Sheedvar | 26.794 | 53.420 | 5 | | |
| | Nakhiloo | 27.830 | 51.474 | | 5 | |
| Qatar | Fuwairit | 26.031 | 51.376 | 3 | 3 | 6 |
| | Ras Laffan | 25.952 | 51.506 | 2 | 2 | 2 |
| TOTAL | | | | 20 | 24 | 31 |



Figures 2 and 3. Locations of individual hawksbill turtle foraging grounds in the Gulf and off the coast of Oman. (Source: EWS-WWF, 2015.) For reference to colours, see the pdf version available on-line.

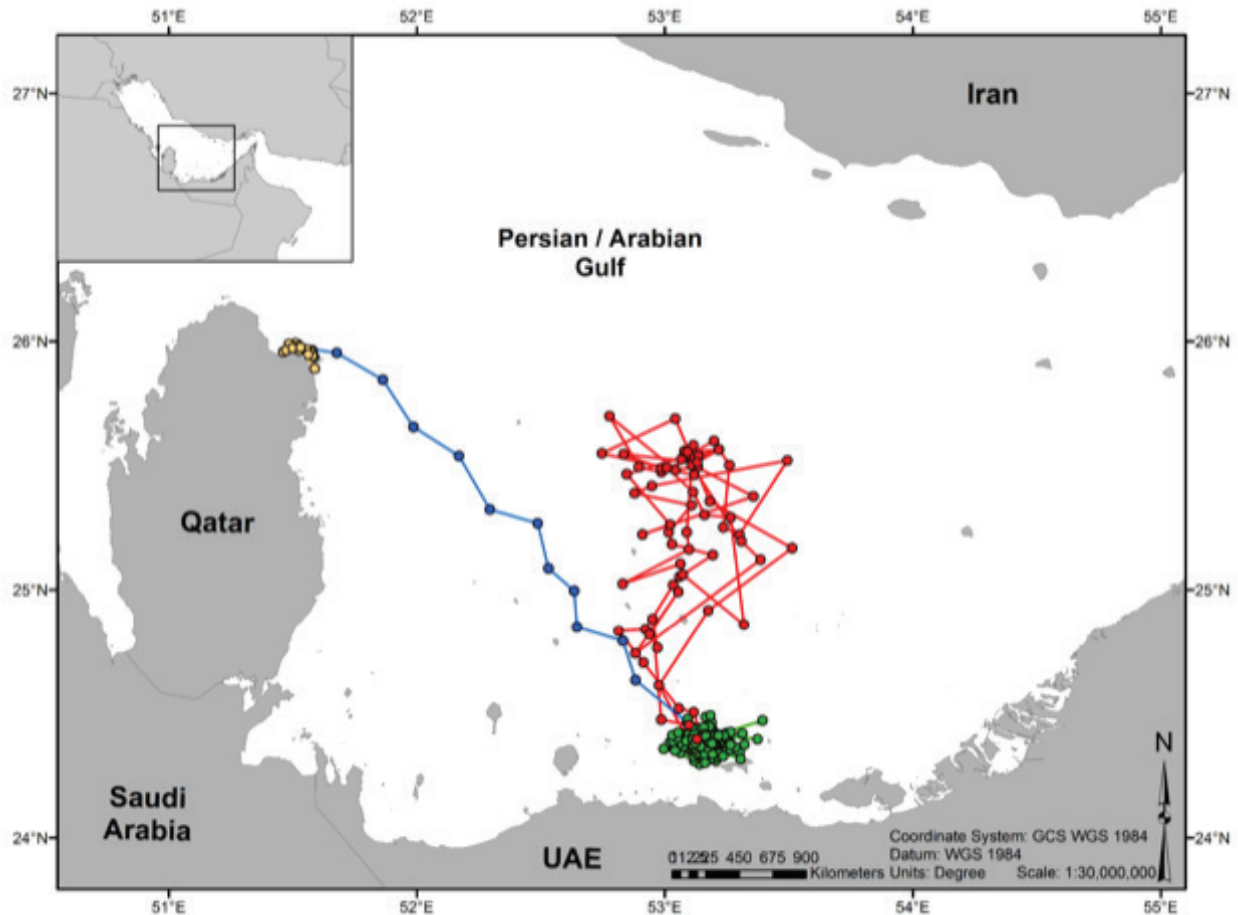


Figure 4. Typical migration loop track of a hawksbill turtle that nested in Qatar. Yellow fixes depict interesting movements. Blue track and fixes depict the migration from nesting habitat in Qatar to foraging habitat in the UAE. Red track and location fixes depict the movements away from and returning to the original foraging ground respectively. Green fixes depict movements within the foraging ground. (Source: Pilcher *et al.*, 2014a.) For reference to colours, see the pdf version available on-line.

resettle at the same foraging grounds. Figure 4 shows such a typical migration loop track by a hawksbill turtle nesting in Qatar. This type of behavior was unique only to turtles foraging in the Gulf, indicating that these populations employ thermoregulatory responses which take them out of high temperature and potentially physiology-threatening conditions (Pilcher *et al.*, 2014a).

The information gathered by the project helped improve our understanding of at-sea hawksbill habitat and behavior in a climate-challenged environment, where extreme high and low temperatures cause physiological stress and reduced growth rates for both turtles and prey species, and contributed to the identification of habitats critical for the survival of these populations. In an effort to streamline our findings with policy decision making processes, the critical habitats identified by the project were characterised as 'Important Turtle Areas' (ITAs) and

were shared and integrated in a number of biodiversity conservation planning and policy related initiatives. Such initiatives were: (i) The process to describe 'Ecologically and Biologically Significant Areas' (EBSAs) as part of the Convention of Biological Diversity (CBD), (ii) Sites in the UAE nominated under the Indian Ocean and South East Asia Memorandum of Understanding for the Conservation of Marine Turtles (IOSEA MoU), and (iii) Local spatial planning and conservation prioritization initiatives, as well as integration of findings into local GIS databases managed by local Environmental Authorities.

The project results can be further used to prioritise marine turtle conservation action by government and conservation agencies, as well as to support spatial analysis on risk assessments for turtles in the face of urban and industrial development, climate change, fishery pressure, and shipping activities.

NEXT PHASE OF RESEARCH FOCUSING ON GREEN TURTLE POPULATIONS

Following on from these results, in 2016 Emirates Nature-WWF commenced a new phase of research focusing on green turtles (*Chelonia mydas*) in the region with the launch of the Gulf Green Turtle Project. This project is again implemented in partnership with MRF and a number of partner organisations in the region: the Environment Agency - Abu Dhabi, Environment Protected Areas Authority - Sharjah, Environmental Protection and Development Authority - Ras Al Khaimah, Environment Society of Oman, Five Oceans Limited, Ministry of Climate Change and Environment - UAE, Ministry of Environment and Climate Affairs - Oman.

The new study aims to gather information on green sea turtles, as these comprise the most abundant turtle species in the inner Gulf region and the second most abundant in Oman. The project will use multiple methods such as satellite tracking, genetic analysis and laparoscopic research targeting reproductive adults in foraging areas as well as post-nesting females. Up to now, the project team deployed 46 satellite transmitters on turtles at various sites. Early data highlights the regional importance of the Oman rookery, as well as linkages between Oman and the UAE's nesting and foraging grounds. This project is in its final year of implementation and aspires to engage with key governmental agencies and stakeholders on the research findings and relevant recommendations.

ACKNOWLEDGEMENTS

This work was made possible with the support of the following individuals who worked for the project partner organisations mentioned above. These experts have offered continuous support to the project and participated in various scientific publications announcing the results of our project as co-authors: Her Excellency Hana Saif Al Suwaidi, as well as Mohamed A. Abdel-Moati, Thabit Zahran Al Abdessalaam, Mohammad Albeldawi, Mehsin Abdalla Al-Ansi, Salman Fahad Al-Mohannadi, Nessrine Al Zahlawi, Robert Baldwin, Ahmed Chikhi, Himansu Sekhar Das, Shafeeq Hamza, Oliver J. Kerr, Ali Al Kiyumi, Asghar Mobaraki, Lisa Perry, Ali Saqar Al Suwaidi, Moaz Sawaf, Christophe Tourenq, James Williams, and Andrew Willson.

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Excellency Mr. Mohammed Al Tobi, as well as Lamees Daar, Dr. Shaikha Salem Al Dhaheri, Dr. Saif Al Ghais, Edwin Mark Grandcourt, Suaad Al Harthi, Ahmed Esmaeil Al Hashmi, Thuraya Said Al Sariri, Maïa Sarrouf Willson, Obaid Ali Humaid Al Shamsi and Hiba Obaid Mohammed Al Shehhi. The new project is led by Clara J. Rodriguez-Zarate on behalf of Emirates Nature-WWF.

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SATELLITE TELEMETRY STUDIES ON NESTING LOGGERHEAD TURTLES IN OMAN

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INTRODUCTION

Telemetry studies of loggerhead turtles in the Sultanate of Oman were initiated in 2006. To date, the only study site has been Masirah Island, approximately 13km off the mainland in the Arabian Sea (Figure 1). Masirah has been noted as one of the most important rookeries in the world for nesting loggerhead (*Caretta caretta*) turtles with initial estimates of 20-40,000 females nesting per year on approximately 80km of beach (Ross & Barawani, 1995; Baldwin *et al.*, 2003). In 2015, the IUCN review of loggerheads classified the nesting population in the North West Indian Ocean as Critically Endangered based on historical and recent nesting trend data (Casale, 2015).

Two separate research programmes have undertaken tagging of nesting females on Masirah. The Masirah Turtle Conservation Project (MTCP), comprised of the Oman Ministry of Environment and Climate Affairs, the Marine Turtle Research Group, UK, and Biodiversity East,

deployed ten tags in May 2006 with funding from Total Foundation. The second group, the Masirah Conservation Project (MCP), a partnership between the Oman Ministry of Environment and Climate Affairs, US Fish and Wildlife Service, National Marine Fisheries Service and Florida Fish and Wildlife Commission, deployed their first tags in August 2006. Between 2010-2016, this latter group expanded to include the Environment Society of Oman, Five Oceans Environmental Services, NOAA's Southwest Fisheries Science Center, Ocean Ecology Network, and Mote Marine Laboratory with funding support from US Fish and Wildlife Service and the US Department of Interior. To date this partnership has deployed a total of 73 transmitters (Table 1).

The primary objectives of both groups have been to evaluate inter- and post-nesting movements of females and to determine nesting/clutch frequency. For the second group, the telemetry work has also been part of a broader study of sea turtle ecology on the island that resulted in

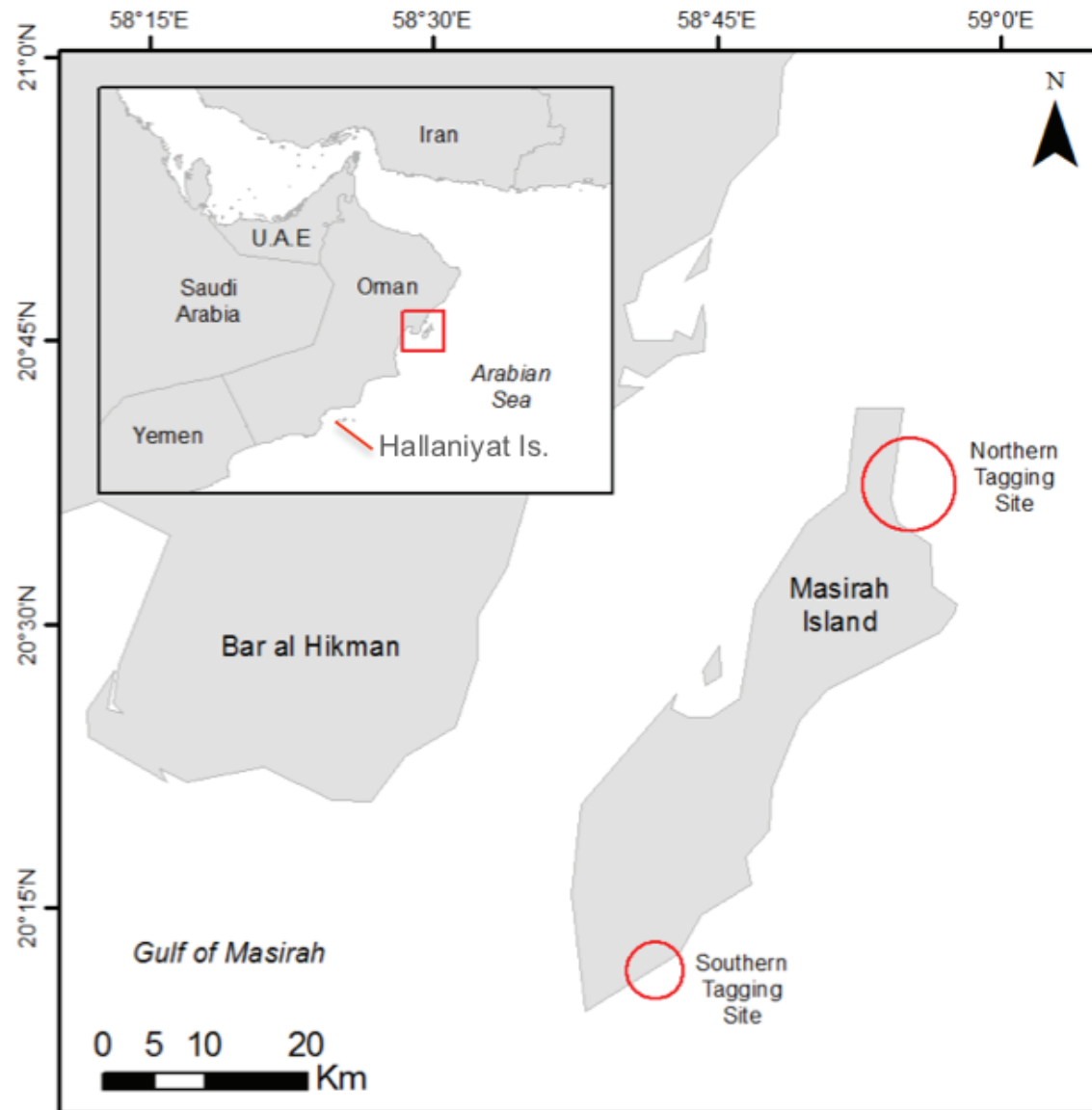


Figure 1. Location of the Hallaniyat Islands and northern and southern tagging sites on Masirah Island.

detection of a nesting decline since initial nest monitoring work was initiated in the late 1970's. The early evidence of population decline, together with the outcomes of community consultation, resulted in the expansion of project research objectives to also include an evaluation of the impact of coastal artisanal fisheries on Masirah's loggerheads. To meet these objectives, platform terminal transmitters have also been instrumented with FastlocGPS and pressure sensor instrumentation to provide fine scale tracking and dive profile information (Table 1).

RESULTS

Rees *et al.* (2010; see also Rees *et al.*, 2018) reported on the behavioural plasticity of the turtles tagged in the first study

group. Six of the tracked turtles stayed close to the island during the interesting period whilst four others undertook 'circuitous loops' of hundreds of kilometres away from the island. Multi-parameter assessment of telemetry data from the interesting period revealed an average nesting frequency of 4.8 ± 1.2 (SD) nests per season ($n=8$). Post nesting turtles predominantly moved south as far as Yemen spending $76 \pm 15.4\%$ time in oceanic habitat ($n=8$). Six turtles are described to have undertaken 6 large-scale oceanic loops between the mainland and Socotra Island. One turtle, tracked for 22 months, exhibited a 1-year remigration interval back to Masirah and re-migration to waters off Yemen. Post nesting telemetry data further revealed a polymodal foraging strategy where females moved between neritic and offshore oceanic habitats

Table 1. Summary of deployment details, equipment models and objectives followed by two research groups, Masirah Turtle Conservation Project (MTCP) and the Masirah Conservation Project (MCP), from 2006 onwards.

| Date | Group | Deployment Location | # Tags | PTT Transmitter Types | Objectives Code |
|-------------|-------|------------------------------------|--------|-------------------------------------|-----------------|
| May '06 | MTCP | North Masirah | 10 | Sirtrack Kiwisat 101 | a,b,c |
| Aug '06 | MCP | North Masirah | 10 | Teleonics ST-14 | a,b |
| Apr '10 | MCP | North Masirah | 4 | Wildlife Computer MK-10 * | a,b,c,d,e |
| Apr '11 | MCP | North Masirah | 18 | Wildlife Computer MK-10 * | a,b,c,d,e |
| Apr '12 | MCP | North Masirah | 12 | Wildlife Computer MK-10 * | a,b,c,d,e |
| May '16 | MCP | South Masirah | 7 | Wildlife Computer MK-10 *+ | a,b,c,d,e |
| May-Jun '17 | MCP | Hallaniyat Islands & South Masirah | 22 | Wildlife Computer MK-10 & SPOT tags | a,b,c,d |

* Fastloc GPS Enabled tags

+ Pressure sensor instrumented tags

Objectives Code: 'a' post-nesting migration; 'b' inter-nesting coastal movements; 'c' nesting frequency; 'd' dive behaviour; 'e' fine scale coastal movements for fisheries co-occurrence study

over a spatial range of 400 to 1400km (Rees *et al.*, 2010).

More recently, Tucker *et al.* (2018) provided a revised estimate of mean clutch frequency of 5.4 nests per female annually (SD=0.87, Range of 4-7 nests, n=34) from satellite tags deployed on early season nesters. With the noted dramatic decline of this population, further work to identify sources of mortality remains high on the research agenda. Additional analyses and publication of sea turtle tracking results, by the second group (MCP), are currently in process, and fisheries research has continued with the deployment of GPS tracking devices on fishing vessels with the aim of generating more robust fishing effort density maps.

ACKNOWLEDGEMENTS

This work has been made possible by the support of the Ministry of Environment and Climate Affairs ranger team, and the Environment Society of Oman field team based on Masirah Island (Ghasi Al Farsi, Juma Al Araiymy and Juma Al Humaidi). The Environment Society of Oman management team (Lamees Daar, Suaad Al Harthi, Asma Al Bulushi) facilitated field and logistic work. Other team members of Five Oceans Environmental Services (Elayne Looker) are to be thanked for their field effort and availability. Nick Pilcher, Blair Witherington and Tony Tucker are to be thanked for their role in supporting the deployment of tags together with Barbara Schroeder of NOAA who guided purchase, configuration and hosting of telemetry data. The project has been mainly financed by Total Foundation, US Fish

and Wildlife Service and the US Department of Interior.

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TRACKING HAWKSBILL AND GREEN SEA TURTLES IN KUWAIT REVEALS VARIABILITY IN MIGRATORY AND RESIDENCY STRATEGIES

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INTRODUCTION

Five species of sea turtle have been identified in Kuwait. Hawksbills (*Eretmochelys imbricata*) are the most common, nesting in three principal locations: Qaru and Umm Al-Maradim (UAM) islands and Ras Al Zour (RAZ) on the mainland (Figure 1). Annual nest numbers at each location are in the low tens of nests (Papathanasopoulou, unpubl. data (Qaru and UAM); Deemer, pers. comm., 2012 (RAZ)). Until recently (2005), green turtles (*Chelonia mydas*) also nested on

both these islands, but have been restricted to Qaru since then, after an extended Coast Guard station, customs facility and harbour were constructed on UAM (Al-Mohanna *et al.*, 2014). The annual number of nesting turtles between 2008 and 2016 has ranged from 0 to 5 (Rees *et al.*, 2013a; Papathanasopoulou, unpubl. data). Less-common, non-breeding species present are the olive ridley (*Lepidochelys olivacea*; Bishop *et al.*, 1997), the loggerhead (*Caretta caretta*; Al-Mohanna & Meakins, 2000a) and the leatherback (*Dermochelys coriacea*; Al-Mohanna & Meakins, 2000b) turtle.

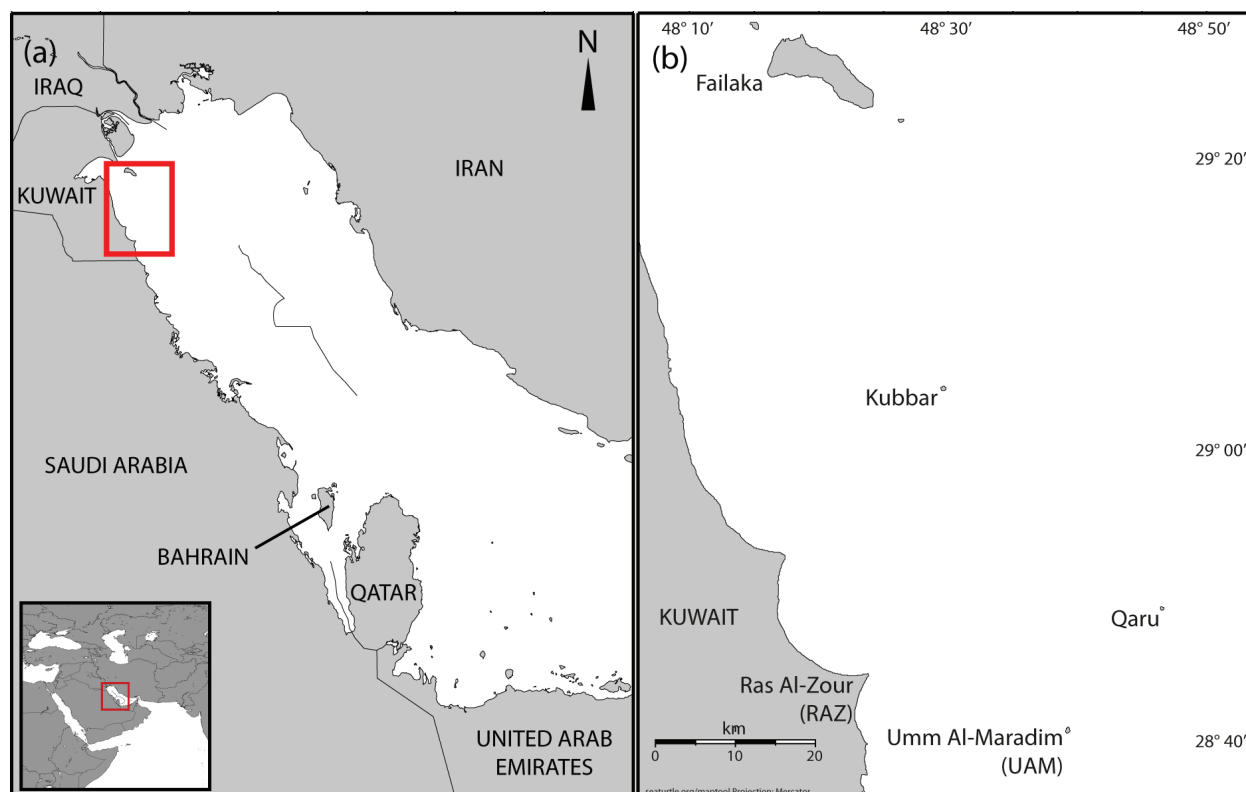


Figure 1. Kuwait in a regional setting. a) Map of region showing Kuwait's neighbouring countries. b) Kuwait's Islands and other locations mentioned in the text.

To aid sea turtle conservation and management and raise awareness of their plight, between 2009 and 2013, we undertook a tracking study to determine foraging locations and migratory routes of adult turtles encountered in Kuwait.

SATELLITE TAG DEPLOYMENT

To date, 10 Kiwisat Argos satellite transmitters (www.sirtrack.com) have been deployed on turtles in Kuwait (see Table 1. A - J). Six were applied to post-nesting females, and four to rescued turtles. Of the six, four tags were placed on nesting hawksbill turtles in 2010 (two at UAM (A & B) and two at Qaru (C & D)); and two tags were placed on nesting green turtles at Qaru, the first in 2009 (E) and the second in 2010 (F). The other four tags were placed on adult-sized, rescued female green turtles: two in 2010 (G & H) and two in 2013 (I & J). The first two rescued turtles were recovered from power-plant water intakes on the mainland at Fahaheel, and the second two from inside fish traps (*hadra*) – a passive fishing gear that indiscriminately captures marine life – on the coast of Failaka Island.

KEY FINDINGS

Nesting females

The four nesting hawksbills remained within approximately 150km of their nesting areas (Table 1), mainly within Kuwaiti waters, but two (B & C) migrated into Saudi Arabian territorial waters (Rees, In Prep.).

Only one of the two tagged nesting green turtles (F) provided any useful data, remaining to nest at Qaru island one more time before migrating approximately 105km south into shallow coastal waters in Saudi Arabia (Figure 2a, Rees *et al.*, 2013a).

Rescued adult female green turtles

All four rescued green turtles migrated to the coast of Failaka Island (Figure 2b). The two rescued green turtles from 2010 (Table 1; G & H) were released at Kubbar Island and migrated to Failaka Island where they remained for the duration of their tag life span, although one (H) undertook a looping winter migration (Figure 2a, Rees *et al.*, 2013). The two green turtles from 2013 (Table 1) were

Table 1. Details of the ten turtles tracked from Kuwait. Ei = Hawksbill, Cm = Green, CCL = Curved Carapace Length (notch to tip). Max displacement = maximum distance from release location for nesting turtles and from Failaka Island for rescued turtles.

| Turtle | Species | Release Location | CCL (cm) | Deployment Date | Duration (days) | Max. Displacement (km) |
|-----------------------------|---------|------------------------|----------|-----------------|-----------------|------------------------|
| Nesting females | | | | | | |
| A | Ei | 28.683° N 48.655° E | 78.5 | 24/05/10 | 826 | 65 |
| B | Ei | 28.683° N 48.655° E | 69.0 | 24/05/10 | 155 | 170 |
| C | Ei | 28.817° N 48.776° E | 70.5 | 29/05/10 | 363 | 80 |
| D | Ei | 28.817° N 48.776° E | 77.0 | 19/06/10 | 73 | 45 |
| E | Cm | 28.817° N 48.776° E | 96.0 | 12/08/09 | 2 | - |
| F | Cm | 28.817° N 48.776° E | 105.0 | 28/07/10 | 121 | 105 |
| Rescued adult-sized females | | | | | | |
| G | Cm | 29.071° N 48.490° E | 98.8 | 07/11/10 | 248 | 5 |
| H | Cm | 29.071° N 48.490° E | 97.0 | 07/11/10 | 238 | 100 |
| I | Cm | 29.197° N 48.116° E | 108.0 | 20/09/13 | 371 | 175 |
| J | Cm | 29.266° N 48.091° E | 104.0 | 06/10/13 | 214 | 710 |

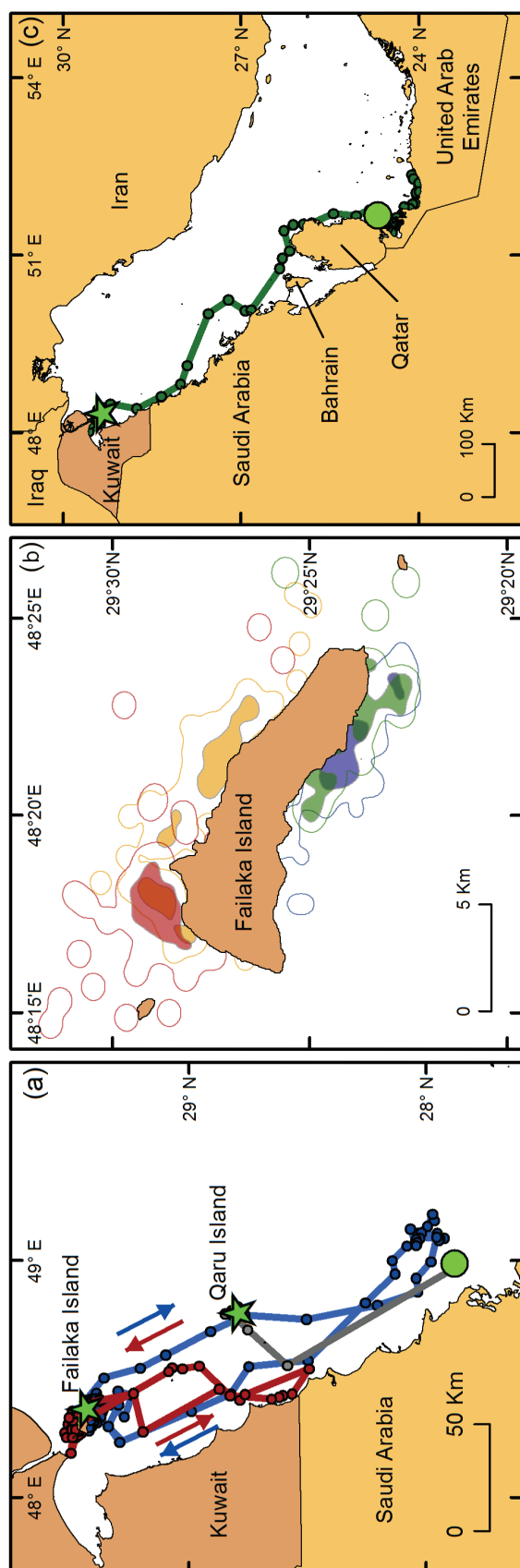


Figure 2. Movements and residency patterns of green turtles tracked from Kuwait. a) Short-distance migrations of turtles F, H & J. Migratory loops for rescued turtles H & J occurred during winter. b) Fine-scale residency patterns at Failaka Island of the four rescued turtles G-J. Core areas (50% use) are displayed in solid colours and home ranges (95% use) are shown as lines in the corresponding colour. c) Long-distance migration of turtle J, originating in Kuwait and terminating east of Qatar. Key: Nesting turtle (F) coloured grey, Rescued turtles coloured yellow (G), red (H), blue (I) and green (J). Track origin indicated by a star and end-point by a circle for unidirectional tracks. Home range and core habitat use kernels were created in Geospatial Modelling Environment v0.7.2 (www.spatialecology.org) using smoothing factor 1000 and bandwidth 150,000. For reference to colours, see the pdf version available on-line.

released on the mainland coast and both also migrated to Failaka Island. One (I) spent the majority of its 371 day tag's lifespan there, except for a two-month, 350km loop south into Saudi Arabian waters during winter (Figure 2a). The other (J), after 68 days, migrated approximately 710km southeast and became resident in UAE waters east of Qatar approximately 620km from the island (Figure 2c).

The one green turtle (J) that migrated south to the UAE passed the Gulf's main green turtle nesting areas of Karan and Jana Islands in Saudi Arabia (Pilcher, 2000), hence it is possible that she may belong to this nesting population rather than the remnant population nesting in Kuwait.

Information gaps that remain

Behaviour of hawksbill turtles nesting on Qaru and UAM have, with small sample sizes, been explored and have generated data broadly in-line with the findings of similar work carried out further east in the Gulf (Pilcher *et al.*, 2014). However, the movements and behaviour of hawksbills nesting at the mainland site of RAZ remain unstudied.

All 10 tags deployed to date were placed on adult or adult-sized female turtles. There is almost a complete lack of data on adult male turtle migrations and residency in Kuwait, the exception is the recurrence over 14 years of an adult male hawksbill at Qaru Island, determined through Photo Identification (Rees *et al.*, 2013b).

Furthermore, no juvenile turtles of any species of sea turtle found in Kuwait's waters have yet been tracked. It is not known if adults and juveniles share the same foraging locations in Kuwait, so it is not yet possible to define multi-age-class Important Turtle Areas. Without complete turtle distribution data, robust spatial planning for marine protected areas is difficult to achieve.

Recommendations for further sea turtle telemetry studies

- Deploy satellite tags on several hawksbills nesting at RAZ to determine foraging areas and post-nesting migratory behaviour for this nesting aggregation together with further tags on the insular nesting hawksbills to increase sample size.
- Attempt to deploy satellite tags on adult male hawksbill and green turtles located near to the nesting beaches to determine their residency and post-breeding migrations.
- Acquire further information on juvenile turtle distribution from 'third party' observers, e.g. fishers, snorkelers, SCUBA divers and other sea-goers, to identify areas that would warrant investigation before any potential satellite tracking research is undertaken on this life-stage.

ACKNOWLEDGEMENTS

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PRESIDENT'S REPORT FOR 38TH ANNUAL SYMPOSIUM ON SEA TURTLE BIOLOGY AND CONSERVATION, KOBE, JAPAN, 18-23 FEBRUARY 2018

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The 38th International Sea Turtle Symposium was held in Kobe, Hyogo, Japan from 18th to 23rd of February 2018. The theme of the Symposium was “Beyond Protection of Sea Turtles”. As a result of decades of hard work, we have witnessed the protection and recovery of some sea turtle populations while at the same time facing a myriad of threats and issues to others. As researchers and conservationists, it is easy to get so caught up in the day-to-day activities of our work, and we lose sight of our mission and goals. It is important to step back, envision our goals and discuss them with colleagues, and take our efforts “beyond protection”.

The Kobe Municipal Suma Aqualife Park and the Sea Turtle Association of Japan (STJ) were key partners in hosting the Symposium, providing personnel and access to their facilities. A total of 632 people registered for the Symposium, all of who came together to learn about sea turtles and conservation of ocean resources. The main venue for the symposium was the Kobe Convention Center, Kobe, Japan. In addition to oral and poster presentations, the symposium program included 10 workshops, seven regional meetings, the annual Marine Turtle Specialist Group meeting, three special sessions, as well as several fun and productive social networking events, which were held at Ariston Hotel, Portopia Hotel, and Suma Aqualife Park. Overall the meeting was exciting and a success from every perspective; details are offered below.

Logo

Urashima Taro is the protagonist of this year's Symposium and is featured on the meeting's logo, representing both Japanese culture and demonstrating this nation's appreciation of sea turtles. Urashima Taro is a Japanese fairy tale where a fisherman rescues a turtle and is rewarded with a visit to a palace under the sea. Everyone has a version of Urashima Taro inside of them, urging

them to protect, understand and discover the mysteries of the sea turtles, with no personal expectations other than the intrinsic joy of knowing that sea turtles and their habitats are protected. The logo was created by Moe Wajiki.

Workshops and Regional Meetings

The structure of the symposium in Kobe was similar to that of year's past: 10 workshops and seven regional meetings were scheduled during the two days prior to the symposium's main four days of presentations, providing the opportunity to exchange and share ideas and information regarding environmental and sea turtle conservation issues, as well as cutting-edge research techniques. These meetings were successful and also helped bring attendees early to the symposium. The theme of the workshops were: Captive Rearing for Research and Conservation; Geographic Information System; Introductory R and Statistics; Temperature-dependent Sex Determination; Beyond Protection of Sea Turtles; Marine Debris and Sea Turtles; Western Pacific Leatherback Turtle Working Group; Sea Turtle Medicine and Rehabilitation; Use of Unmanned Aerial Vehicles or Drones in Sea Turtle Conservation and Research; Building Income Generating Activities Adapted to the Local Context to Ensure the Long-term Success of Sea Turtle Conservation Projects; and The Art of Writing Science lead by the Student Committee. Seven regional meetings were held allowing participants from over 54 countries around the world to discuss specific problems that impact their regions. These were: Africa, East Asia, Indian Ocean and South-east Asia, Mediterranean, Pacific Islands/Oceania; Latin America (RETOMALA), and the 28th Annual Japanese Sea Turtle Symposium. Besides these workshops and regional meetings, the IUCN Marine Turtle Specialist Group (MTSG) was also held as a side meeting in the Tuesday evening.

Main Symposium Program

Opening Remarks from the ISTS President Yoshimasa Matsuzawa inaugurated the main symposium program. A Japanese traditional Shinto ritual to pray for safety and success of the symposium followed his words. This special ceremony was conducted by Mr. Miyajima, who is a chief priest of “Urashima shrine”, the enshrined deity of which is Urashimako – a model of Urashima Taro who is drawn in the logo of the symposium. During the Shinto ritual, he invited the deity and recited a Shinto prayer called *Norito* that praises virtues of the deity and prays for benefits and protection. While enjoying the beauty of traditional prayer, participants spent a bit of time thinking of the relationship between sea turtles and ancient people and prayed for the success of the symposium. Just after the ceremony, Dr. Naoki Kamezaki, from Okayama University of Science, addressed attendees with the presentation “Historical review of relationship between sea turtle and humans in Japan: Recognition of the importance of local research and management coordination”.

The Symposium program of oral and posters presentations ran from Tuesday, February 20th through Friday, February 23rd. The Oral and Poster presentations consisted of traditional session categories, including Anatomy, Physiology and Health; In-Water Biology; Nesting Biology; Population Biology and Monitoring; Fisheries and Threats; Conservation, Management and Policy; Education, Outreach and Advocacy; and Social, Economic and Cultural Studies. Program Chairs Takahashi Ishihara, Tomomi Saito, Isao Kawazu and Kei Okamoto, along with 36 Session Chairs developed an amazing symposium program consisting of 139 oral papers and 199 posters presented within the sessions mentioned above. Poster presenters had also the opportunity to give more details on their presentations as well as answering some questions during “Meet the Authors” scheduled after the last session of every day.

In addition to these regular sessions, three special sessions were held. “Beyond Protection of Sea Turtle” was aimed to broaden the discussion on the main theme of this symposium. This session consisted of short panelist presentations and discussion facilitated by Kartik Shanker. Panelists were: Yoshimasa Matsuzawa, Jack Frazier, Paolo Casale, Matthew Godfrey, Colin Limpus, Neca Marcovaldi and Hiroyuki Suganuma. Special Session “North Pacific Loggerhead Turtle” focused on this dynamic migratory population, with experts providing an overview of each life history stage and highlighting the need and ongoing efforts for international cooperation. Line up of the experts was Jeff Seminoff, Cali Tuner Tomaszewicz, Takashi Ishihara, Hideo Hatase, and Alexis Gutierrez. The third Special Session was “Linking Space

Exploration and Sea Turtle” where it reviewed the current conservation activities at nesting beaches adjacent to satellite launch stations and discussed the prospects of the space exploration and nature conservation with a focus on how the space industry benefits sea turtles and sea turtle people. Jane Provancha, Mark Hamann, Sophi Baudel and George Balazs gave presentations. During the main oral presentation sessions, simultaneous English-Japanese translation was available.

Kobe Declaration

On the basis of a meaningful discussion at the special session, ISTS President Yoshimasa Matsuzawa read through the following personal statement at the business meeting:

*The Kobe Declaration: Beyond Protection of Sea Turtles**

“At the 38th International Sea Turtle Symposium in Kobe, Japan, on 20 February 2018, a panel of international sea turtle experts have taken an important step forward in discussing issues surrounding the idea of moving beyond protection. The panel members encouraged further dialogue on the need for flexible and diverse conservation and management strategies in accordance with sea turtle population status, management context, scientific knowledge, local and traditional knowledge, socioeconomic needs, and cultural considerations. In doing so, we commit to respecting the diversity in conservation and management strategies and recognize that the path to thriving sea turtle populations may differ with each community, culture, country, and region that have shared populations of sea turtles. As the President of the 38th International Sea Turtle Symposium, I declare this moment as the start of a new conversation to take us beyond protection of sea turtles.”

**Personal statement by 2018 ISTS President, not intended as a resolution.*

Student Committee

The Student Committee chaired by Itzel Sifuentes and Catalina Uruena conducted its 8th year of activities dedicated to welcome and encourage student attendees. This year there was three core activities: Student Presentation Feedback during which 70 evaluators volunteered to give feedback to 124 student presentations. The second activity was a half-day workshop “The Art of Writing Science”, which aimed to help students develop skills needed to write, submit, and publish scientific manuscript. Four speakers –Richard Reina, Jeff Seminoff, Kate Mansfield, and Sean Williamson– kindly shared their experiences with 24 attendees. Lastly, with the aim to promote networking and communication among students and other symposium participants, and also enhance their participation in the Society, a Student Social Mixer was held in the Tuesday evening. The

mixer included the “Speed Chatting with the Experts”. The lineup was: Tomo Eguchi, Irene Kelly, Nicolas Pilcher, Nancy FitzSimmons, Takahiro Shimada, Kei Okamoto, David Booth, Michael Salmon, Simona Ceriani, Brian Shamblin, and Katherine Comer Santos.

Social Events

The social component of the symposium was highlighted by the Welcome Social, Student Committee activities, Japan Night, Silent and Live Auctions, as well as the Award Ceremony and Banquet, and Field Trip. The Welcome Social was held Monday evening at Suma Aqualife Park, during which attendees were able to enjoy watching a variety of marine animals as well as the demonstration of a Turtle Releasing Device from a model underwater pound net set up in the main tank. As participating co-hosts, the aquarium staff was on hand to answer questions and assist meeting attendees throughout the week. Another highlight of social events in Kobe was “Japan night”, which was held Wednesday evening. This activity aimed to introduce a part of Japanese culture to attendees. People enjoyed watching performance of Japanese drum and art of calligraphy, trying Kimono, origami, Japanese wrapping cloth, and rice-cake making, as well as tasting rice-cake and Kobe beef. As it is typical, the Silent (from the beginning of the symposium until February 22nd) and Live Auctions (on the 22nd from 7:00pm to 11:00pm) were among the most popular events. The auction teams successfully maximized fun and funding under new auction guidelines. The events jointly raised approximately US\$17,000 to help students to attend future symposia via travel grants.

On the final day of the Symposium, February 23rd, the Banquet was held in the Portopia Hotel's Ballroom. A welcome speech by Kizou Hisamoto, Kobe Mayor, was followed by a sake barrel opening and cheers with wooden square cups of sake. The evening proceeded with the Award Ceremony presenting the Archie Carr Student Awards, the ISTS Career Awards, and the Grassroots Conservation Award. The formal portion of the evening closed with words of appreciation from the President and the ceremonial passing of the ISTS Presidential Trowel to incoming 2019 President Ken Lohmann. A spirited two hours of dancing with live band brought an end to an intense yet relaxed week of activities.

ISTS Career Awards

Thushan Kapurusinghe, ISTS Career Awards Committee chair, and team members: Andres Estrades, Shaya Honarvar, Michael Jensen and Erin Seney did an excellent job and presented this year's meeting with an incredible group of awardees. ISTS Lifetime Achievement Awards were presented to Maria Ângela (Neca) Marcovaldi from

TAMAR in Brazil, Donna Shaver of Padre Island National Seashore, Naoki Kamezaki of Okayama University of Science, and to Hiroyuki Suganuma of Everlasting Nature of Asia. “Colola: Capital Mundial de la Tortuga Negra” in Mexico received the ISTS Champions Award. Kazuyoshi Omuta of Yakushima Umigame-Kan was awarded the Ed Drane Award for Volunteerism. President's Awards were given to Yasuo Kondo for his pioneer work started at Hiwasa in 1950, and to Team Minabe for its contribution to conservation and research of sea turtles.

Archie Carr Student Awards

There were 39 student oral presentations and 78 student poster presentations nominated for the Archie Carr Student Awards. Judges of the student presentations in Kobe were: Agnese Mancini, ALan Rees, Aliko Panagopoulou, Carlos Carreras, Hideaki Nishizawa, Jillian Hudgins, Joe Pfaller, Kate Mansfield, Katsufumi Sato, Kelly Stewart, Mark Hamann, Michael Jensen, Mick Guinea, Rupika Rajakaruna, Scott Whiting, and Simona Ceriani. Coordinators Matthew Godfrey and Andrea Phillott presented eight students with Archie Carr awards for outstanding presentations: Kennta Fujita (Biology winner), Sara Abalo Moral (Biology runner-up), Helen Pheasey (Conservation winner) and MacKenzie Tackett (Conservation runner-up) won in the Poster Category. Shohei Kobayashi (Biology winner), J. Roger Brothers (Biology runner-up), Ryan Pearson (Conservation winner) and Seh Ling Long (Conservation runner-up) won in the Oral Category.

Grassroots Conservation Award

Now in its 8th year, the Grassroots Conservation Award given to a poster or oral presentation that best demonstrates a positive contribution towards the conservation of marine turtles and/or their habitats went to Ning Yen from Hiin Studio for their presentation “From Trash to Money: A Successful Case Combining Green Turtles Protection and Beach Clean-up in Taiwan”. The judges were Ingrid Yanez, Jack Frazier, Angela Formia, Zahirul Islam, Manjula Tiwari and Muralidharan Manoharakrishnan.

Travel Grants

Making the symposium accessible to students and international participants is a major priority of the Society, and to this end travel grants are provided to offset the cost of attending. Alexander Gaos chaired the Travel Grant Committee, along with the Regional travel chairs Angela Formia, Kelly Stewart, Karen Eckert, Andrea Phillott, ALan Rees, Alejandro Fallabrino, Aliko Panagopoulou, and Emma Harrison. Through their coordinated efforts the ISTS was able to support a total of 127 overseas travel grant applicants with full lodging during the symposium and 50 Japanese students partially. The distribution

of bed grants per region was as follows: 9 to Africa representatives, 25 to Asia Pacific, 3 to Caribbean, 21 to Europe, 17 to Mexico & Central America, 12 to South America, 9 to South Asia, 4 to Middle East & North Africa, and 27 to US & Canada. In accordance with some Japanese sponsor wishes, the symposium allocated US\$7,800 in cash awards to applicants from Asia and the Pacific.

Board of Directors Meeting

The Board of Directors meeting was held on Tuesday, February 20th. The meeting was fruitful and lasted until midnight. The Board received and discussed reports from the Nominations Committee, ISTS Career Awards Committee, Students Awards Committee, Student Committee, Travel Grant Committee, as well as reports from the Treasurer.

ISTS Business Meeting

The 2018 ISTS Business Meeting was held on Friday, February 23rd. ISTS President Yoshimasa Matsuzawa called the meeting to order, and reports were provided by Treasurer (George Balazs), Travel Grant Committee (Alexander Gaos), Nominations Committee (Kate Mansfield) and Students Committee (Itzel Sifuentes). Other issues related to our Society also were discussed. No Resolutions were submitted for consideration at this Symposium. Ken Lohmann, 2019 ISTS President, provided details regarding the next year's symposium to be held in Charleston, South Carolina, USA. The theme of next year's meeting is "Navigating the Future". Dates have been set as 2-8 February 2019, during which time Society members will once again get together to celebrate sea turtles.

ISTS Elections

As a result of the 2018 Society's annual election, Diego Amorocho from Colombia was elected President for the ISTS symposium in 2020. Also, the elections added two new members to the Board of Directors (year indicates board member's end of term): Andres Estrades (2023) and Richard Reina (2023). Sheryan Epperly and Irene Kelly were elected to join the Awards Committee.

Funding

Generous funding by many entities made the success of the 38th symposium possible. The organizing committee deeply thanks the following donors for their generosity. At the Platinum level (US\$25,000 and above): Mitsubishi Heavy Industries, and Suma Aqualife Park. At the Gold level (US\$10,000-US\$24,999): Osaka College of ECO & Animals, Lion Corporation, and Sea Turtle Association of Japan. At the Silver level (US\$1,000-US\$9,999): Kanetetsu Delica Foods, Stella Chemifa, Orgabits, Okinawa Churaumi Foundation & Aquarium, NYK Group, Nestle Japan, Sysmex, Kamihata Fish Industry

Group, Chubu Doboku, George Balazs & Golden Honu Services of Oceania, US Fish and Wildlife Service, Wildlife Computers, and Lotek. At the Bronze level (US\$500-US\$999): Native Vision, and Teikyo University of Science. At the Inconel level (US\$100-US\$499): Janet Hochella, パシコ貿易株式会社, 株式会社オキナワマリンリサーチセンター, 株式会社日本ドルフィンセンター, 紀宝町役場, 株式会社日本海洋生物研究所, 国民宿舎 紀州路みなべ, 堺市漁業協同組合, 洲崎神社, カロラータ株式会社, アースウォッチ・ジャパン, マイスター大学堂, 横浜商科大学, 椎名大敷組合, 三津大敷組合, 高岡大敷株式会社, 漁師のNPO, 名古屋港水族館, 浦嶋神社, 日映エンタープライズ株式会社, 南知多ビーチランド, うみまーる企画, いであ株式会社, 日和佐うみがめ博物館カレッタ, hau'oli, キュービックアイ, 有限会社松仙ベッ甲製作所, 株式会社モンベル, ITストアMANATO, 特定非営利活動法人宮崎野生生物研究会, 西大和学園中学校・高等学校, 大本山 須磨寺, 株式会社串本海中公園センター, ホクト環境システム株式会社, 日本ミクニヤ株式会社, and 恋の浦ウミガメの会. At the Monel level (up to US\$99): 株式会社神戸ゴマルゴ, 門井社会保険労務士事務所, コマタニ商会, ペンションむぎわらぼうし, 株式会社西尾製作所, 株式会社吉高屋, 谷内FP保険事務所有限会社, させばパールシー株式会社, 神戸動植物環境専門学校, 小学館, 紀伊半島ウミガメ情報交換会, 国立公園成ヶ島を美しくする会, 料亭花月, 須磨ふるさと生きものサポート, 水中カメラ専門店 海の写真屋さん, アクアワールド茨城県大洗水族館, 株式会社アドバンス, 志摩半島野生動物研究会, 江崎グリコ株式会社, すさみ海立エビとカニの水族館, 株式会社ビデオエイベックス, 特定非営利活動法人Turtle Crew, 琴引浜鳴き砂文化館, 有限会社浦田帆屋, 有限会社月灘屋, 南浦はくせい店, 有限会社ウミガメフーズ, 図書出版南方新社, and 株式会社 海の中道海洋生態科学館

Exhibitors and Vendors

The exhibitors and vendors that participated in the Kobe symposium were: CLS America, Inc.; 4K-UHD Deep Sea Camera System (Kanso Co., Ltd.); Lotek Wireless Inc.; Telonics, Inc.; Wildlife Computers; Bioko Marine Turtle Program; Everlasting Nature of Asia (ELNA); Hiin Studio; MarineLife Alliance (MLA); Pro Delphinus; Taiwan Sea Turtle Conservation Society; Turtle Crew; TurtleSpot in Taiwan; The State of the World's Sea Turtles (SWOT); and Japan Bekko Association.

Going Green

The ISTS made efforts to minimise waste, including use of the mailing list, ISTS website and various social network service. Participants were strongly encouraged to bring their own mug for coffee break. Paper cups prepared for those who did not bring their own mug

were made from forest thinning products. Instead of paper or plastic bags, a Japanese traditional wrapping cloth was used for a participant package. During Japan Night, symposium participants had the opportunity to train how to fold and use the wrapping cloth. Aquarium staff sorted waste one by one after any social events.

Acknowledgments

Organising the Kobe symposium took a large number of volunteers allocated to various committees: registrars, fundraising, program, sessions, poster, workshop, student, travel grants, awards, exhibitor, volunteer, auction, visitor visa application support, communications, and proceedings. All of these individuals gave a significant number of hours, effort and dedication towards their entrusted tasks. By alphabetical order of their first name, the Society thanks: Agnese Mancini, Akira Oda, ALan Rees, Alejandro Fallabrino, Alexander Gaos, Alexandre Girard, Alexis Guilleux, Alexis Gutierrez, Aliko Panagopoulou, Andrea Phillott, Andrew DiMatteo, Andrews Agyekumhene, Andy Estrades, Angela Formia, Antonio Di Bello, Ayaka Asada, Asuka Ishizaki, Brendan Godley, Brian Shamblin, Cali Turner Tomaszewicz, Camryn Allen, Carlos Carreras, Catalina Uruena, Chiho Kuzuka, Colin Limpus, Connie Ka-Yan Ng, Daisuke Shiode, Daniel Gonzalez-Paredes, Daniela Freggi, Dave Owens, David Booth, Emma Harrison, Erin Seney, George Balazs, George Shillinger, Hector Barrios-Garrido, Heather Harris, Hideaki Nishizawa,

Hideo Hatase, Hiroyuki Suganuma, Hiroyuki Yoshida, Ingrid Yañez, Irene Kelly, Isao Kawazu, Itzel Sifuentes, Jack Frazier, Jacques Fretey, Jane Provancha, Jean-Michel Guillon, Jeanette Wyneken, Jeff Seminoff, Jesus Tomas, Jillian Hudgins, Joanna Alfaro, Joe Pfaller, John Wang, Junichi Okuyama, Karen Eckert, Kartik Shanker, Kate Mansfield, Katherine Comer Santos, Katsufumi Sato, Kazunari Kameda, Kei Okamoto, Kelly Stewart, Kensuke Matsumiya, Kiyomi Nakamura, Koji Baba, Kojiro Mizuno, Lalith Ekanayake, Laura Gibbons, Mai Takase, Manjula Tiwari, Marc Girondot, Marina Zucchini, Mario Mota, Mark Hamann, Matthew Godfrey, Michael Jensen, Michael Salmon, Mick Guinea, Misako Munechika, Moe Wajiki, Momoyo Muramoto, Motoki Sugiura, Muralidharan Manoharakrishnan, Nancy FitzSimmons, Naoki Koga, Natalie Wilderman, Neca Marcovaldi, Nicolas Pilcher, Paolo Casale, Richard Reina, Rod Mast, Rupika Rajakaruna, Sandra Hochscheid, Satomi Kondo, Saya Hirai, Scott Whiting, Sean Williamson, Shaya Honarvar, Shigetomo Hiram, Simona Ceriani, Sophie Baudel, Takahide Sasai, Takahiko Ide, Takahiro Shimada, Takashi Ishihara, Takuya Fukuoka, Tatsuya Oshika, Thushan Kapurusinghe, Tomo Eguchi, Tomoka Eguchi, Tomoka Higuchi, Tomoko Hamabata, Tomoko Narazaki, Tomotomi Saito, Tsung-Hsien Li, T. Todd Jones, Vanessa Bezy, Yakup Kaska, Zahirul Islam, and the various volunteers that were assigned on-site. Also, the symposium would not have been possible without the support from the donors mentioned above.

INSTRUCTIONS FOR AUTHORS

Please refer to the style requirements listed below. Manuscripts should be submitted in MS Word or saved as text or rich text format. Appropriate files should be submitted by email to: iotn.editors@gmail.com. For further details please see www.iotn.org or consult a recent issue of IOTN.

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Tables and figures: Figures should not be embedded in the text file, they may be sent separately as JPEG, TIFF, BMP or PNG files. All figures and tables should carry a caption. Figures and illustrations must be accompanied by the appropriate credit/source. High resolution figures may be requested after acceptance of the article.

References in text: References should appear first in chronological then alphabetical order.

Two authors to be separated by ‘&’ symbol, e.g., as Rai & Sahu, 2001

More than 2 authors: first author *et al.* (*et al.* in italics) e.g., Roy *et al.*, 2004

Two publications of the same year for the same author(s), the reference in the text should be Sharma 1960a, b not 1960a, 1960b and the two publications should be dated accordingly in the references.

Multiple references to be separated by a semi colon and in chronological order (Zade, 1995; Mathew, 1996a, b, 1998; Sharma, *et al.*, 2004; Forman & Gordon, 2005, 2007)

Page numbers are essential when quoting or referring to some aspect or information from a report (Sharma 1960: 22 or Sharma *et al.*, 1960: 22).

References that are long and/or have acronyms: Only acronym in text,

e.g., INRA 2008

List personal communication references in text only. e.g. (Hariya pers. comm., 2011)

Unpublished/Undated references: In press, Forthcoming, In review, etc.

References in list: References should appear first in alphabetical then chronological order.

For references with more than 7 authors: first 7 names, *et al.*

Use complete page ranges. e.g., 371-379 (not 371-9); 227-235 (not 227-35).

Reference that are long and/or have acronyms: Full name followed by acronyms in parenthesis in reference list, e.g., Instituto Nacional de Reforma Agraria (INRA). 2008.

Unpublished/Undated references: In press, Forthcoming, In review, etc.

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