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Exercise and Marine Species Monitoring Report for the  
U.S. Navy's Mariana Islands Range Complex 2010-2014

APPENDIX D  
Sea Turtle Tagging in the Mariana Islands Range Complex (MIRC)  
Annual Progress Report

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There are two questions from the FY13-15 Monitoring Plan that primarily guide this project. First, are there locations of greater cetacean and/or sea turtle concentration around Guam, Saipan and Tinian? Second, what is the occurrence and/or habitat use of sea turtles in areas that the Navy conducts underwater detonations? Based on an agreement between the U.S. Navy Pacific Fleet and NOAA's Pacific Islands Fisheries Science Center (PIFSC), a project was formed to address these topics. The project consists of three data streams that will be brought to bear on the guiding questions: (i) in-water capture and GPS tagging of sea turtles in Guam and the CNMI, (ii) aerial surveys of sea turtle abundances along coastal waters of Guam, and (iii) tow-diver surveys of the Marianas Archipelago.

The scope of work and the funding for this project is largely devoted to the first data stream of capturing and tagging sea turtles in the Marianas and analyzing those data. In conjunction with local resource agency partners, the authors of this report are solely responsible for this aspect of the project data. These data will provide high-resolution habitat use by sea turtles, but will obviously be limited by where those turtles are. In addition to this data stream, the PIFSC will hire a postdoctoral research associate whose main task will be to analyze the abundance and distribution of sea turtles in the Marianas using the aerial and tow-diver datasets. These latter data streams are not collected by PIFSC but are provided through previous agreements with DAWR Guam, and by the PIFSC's Coral Reef Ecosystem Division. Together, these three data streams and their interpretation will do much to address the questions set forth in the Monitoring Plan.

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**MAY 2014**

**SEA TURTLE TAGGING IN THE MARIANA ISLANDS RANGE COMPLEX (MIRC)  
ANNUAL PROGRESS REPORT**

**PREPARED FOR THE COMMANDER, U.S. PACIFIC ENVIRONMENTAL READINESS OFFICE**

**PREPARED BY:**

**NOAA FISHERIES  
MARINE TURTLE ASSESSMENT GROUP  
PROTECTED SPECIES DIVISION  
PACIFIC ISLANDS FISHERIES SCIENCE CENTER**

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## **GENERAL BACKGROUND**

The U.S. Navy developed the Mariana Islands Range Complex (MIRC) Monitoring Plan to provide required monitoring of protected species under the Marine Mammal Protection Act (1972) and the Endangered Species Act (1973). Of the 5 species of sea turtle associated with the MIRC this annual report provides data on the habitat and movements of green turtles (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*) that were tagged by PIFSC staff and satellite-tracked in the nearshore waters of Saipan, Tinian, and Guam. This report represents the progress from the first year of an anticipated 5-10 years of field research.

There are two questions from the FY13-15 Monitoring Plan that primarily guide this project. First, are there locations of greater cetacean and/or sea turtle concentration around Guam, Saipan and Tinian? Second, what is the occurrence and/or habitat use of sea turtles in areas that the Navy conducts underwater detonations? Based on an agreement between the U.S. Navy Pacific Fleet and NOAA's Pacific Islands Fisheries Science Center (PIFSC), a project was formed to address these topics. The project consists of three data streams that will be brought to bear on the guiding questions: (i) in-water capture and GPS tagging of sea turtles in Guam and the CNMI, (ii) aerial surveys of sea turtle abundances along coastal waters of Guam, and (iii) tow-diver surveys of the Marianas Archipelago.

The scope of work and the funding for this project is largely devoted to the first data stream of capturing and tagging sea turtles in the Marianas and analyzing those data. In conjunction with local resource agency partners, the authors of this report are solely responsible for this aspect of the project data. These data will provide high-resolution habitat use by sea turtles, but will obviously be limited by where those turtles are. In addition to this data stream, the PIFSC will hire a postdoctoral research associate whose main task will be to analyze the abundance and distribution of sea turtles in the Marianas using the aerial and tow-diver datasets. These latter data streams are not collected by PIFSC but are provided through previous agreements with DAWR Guam, and by the PIFSC's Coral Reef Ecosystem Division. Together, these three data streams and their interpretation will do much to address the questions set forth in the Monitoring Plan.

## **SUMMARY OF TASKS:**

1. Capture and tag sea turtles in the MIRC
2. Process and analyze biotelemetry data
3. Send tissue samples to analytical laboratories
4. Prepare interim and final report

## **METHODOLOGY:**

In August of 2013 Dr. T. Todd Jones of the NOAA Pacific Islands Fisheries Science Center visited Guam, Saipan, and Tinian of the Mariana Islands Range Complex. During this time Dr. Jones conducted small boats surveys for marine turtles with local biologists from the Division of Aquatic and Wildlife Resources (Guam) and Department of Fish and Wildlife (CNMI).

The small boat surveys were conducted in the nearshore and coastal waters of Guam (e.g., Cocos Lagoon), northwestern Saipan, and western Tinian. When turtles were encountered on surveys they were hand captured while snorkeling or by diving from a slow moving boat. Hand capture involved free-diving (2-25 m) to capture turtles resting/foraging on bottom substrate. Turtles were immediately brought to the surface, lifted into the boat, brought to shore, and placed in turtle holding bins. All research was authorized under the following permits: NMFS ESA10a1A 17022, USFWS Recovery Permit TE-72088A-0, IACUC Protocols NMFS SWPI 2011-04, and GUAM Department of Agriculture Special Permit for Scientific Research SP2013-004.

All turtles were tagged with metal inconel tags or 'flipper tags' (Style 681, National Band and Tag Company) using the standard technique described in the Marine Turtle Specialist Group Manual on Research Techniques (Eckert et al. 1999) and with Passive Integrated Transponder (PIT) tags – small (14 mm length x 2 mm diameter) electromagnetically-coded glass-encased "microchips" – Destron Tx 1406L. The inconel flipper tags were attached to the trailing edge of a fore flipper and the PIT tags were injected subcutaneously into the left rear flipper. Skin samples were obtained for DNA and stable isotope analysis. Straight carapace length (SCL) and turtle mass were measured and all turtles were outfitted with a satellite tag (Wildlife Computers SPLASH400 tag with GPS Fast-Loc technology, temperature, and depth).

Satellite tag attachment followed the drag recommendations of Jones et al. (2011, 2013) and the attachment methods as described in Jones and Van Houtan (2012). In short, the attachment area on the carapace was lightly sanded to remove algae and cleaned with denatured ethanol. A 0.75 cm layer of a two-part epoxy (Powers T308) was used to affix the tag to the carapace and a second putty-type epoxy (J.B. WaterWeld) was form-molded over the tag to protect the tag from damage from reef and rock ledges during the course of normal turtle behavior. This technique is widely used and works well with reef-dwelling hawksbills or greens.

GPS locations, dive depth, dive duration, and temperature data were obtained in raw form over the ARGOS system, and processed to produce data ready for analysis. Turtle tracks were created using all available x, y ARGOS locations; however, kernel density estimates (KDE) were generated from GPS x, y locations only. All tracks and density estimates were performed in ARCGIS (ESRI 2012). The data analysis is preliminary as the satellite tags are still transmitting and the data are still few. Final analyses will include the full range of GPS data for additional home range analysis and KDEs.

Tissue samples collected for DNA, stable isotope analysis (SIA), and health assessment were sent to analytical laboratory collaborators within NOAA:

Genetic and Stable Isotope analysis NOAA, NMFS, SWFSC  
3333 North Torrey Pines Court  
La Jolla, CA 92037

Biological and Environmental Monitoring and Archival of Sea Turtle Tissues  
National Institute of Standards and Technology  
Hollings Marine Laboratory  
331 Fort Johnson Road  
Charleston, SC 29412

#### **TAG LONGEVITY:**

Of the 6 Wildlife Computers SPLASH400 tags deployed in August of 2013, 4 are still transmitting (see Table 1). Tags 85492, 85494, and 85496 are still reporting from their general capture area off the northwestern coast of Saipan. These deployments include 2 green turtles and 1 hawksbill. Tag 85493, deployed on a Hawksbill in Tinian, is still signaling from southern Guam where the animal moved to after foraging near Tinian in 2013. Tags 85491 and 85495, both deployed on green turtles off Saipan, stopped transmitting on 14 October 2013 and 19 January 2014, respectively.

#### **RESULTS AND DISCUSSION:**

On August 15 and 16 Dr. Jones and a 5 person crew conducted snorkeling and boat surveys from NOAA R/V Tataga. During the 2 day survey, 9 turtles were observed (see Map 1). All 9 observed turtles were greens, were juveniles of less than 60 cm SCL, and were extremely skittish. Observations of turtles were typically at 20 m distance or greater at which point the turtles immediately swam to deeper water. No hand captures were attempted during these surveys. The behavior of the turtles was not conducive to hand capture in Cocos Lagoon; however, the surveys revealed that the turtles often transit over shallow uncolonized substrate (e.g., sand bottom) when moving between the sea grass flats and deeper aggregated patch reef. These shallow sandy areas are suitable for entanglement net capture. Entanglement nets are generally set at the surface extending vertically through the water column and range from 20 to 100 m long and 1.5 to 8.0 m deep. On our second site visit we plan to deploy entanglement nets in sandy substrate near seagrass or macro-algae where turtles were observed to transit.

On August 18-21 Dr. Jones and a 3 person crew from the CNMI Department of Fish and Wildlife conducted snorkeling and boat surveys off the northwestern coast of Saipan (Garapan) and the western coast of Tinian (Fleming Point). The team captured 6 turtles ranging in SCL from 60.4 to 66.6 cm, in mass from 27.5 to 39.1 kg, and consisting of 4 green turtles and 2 hawksbills (see Table 1). The turtles were sub-adults and their sex could not be determined through visual observation. One of the hawksbill turtles was captured off Garapan (August 18) and the other was captured during the survey off Tinian on August 20. All of the 6 turtles were outfitted with Wildlife Computers SPLASH400 tags. The Tinian hawksbill remained nearshore until October 10 (51 days) before traveling 286 km heading east of Rota and taking up residency in the deeper waters outside of Cocos Lagoon (see Figure 2). Kernel density estimates (Sheather and Jones 1991) revealed habitat fidelity and limited movements for the hawksbill while resident of Tinian and Guam, as well as the other tagged turtles (see Figures 3, 4).

The other 5 turtles remained in the nearshore environment off Garapan, Saipan. KDEs show sustained use and residency by all 5 in the area of original capture (see Figures 5, 6). The area stretching from the Balisa Channel to Managaha Island is a patch reef community where the turtles both forage and rest.



Dive patterns suggest that both hawksbill and green turtles remain in deeper waters during daylight hours and move nearshore during the night (Figure 7). Hawksbills spent more time in deeper waters than the greens, reaching depths of 100 m or more. Green turtle average depth was  $12.7 \pm 5.3$  m and  $10.3 \pm 3.5$  m for day and night, respectively. Hawksbill turtle average depth was  $24.9 \pm 14.6$  m and  $18.4 \pm 6.4$  m for day and night, respectively. The data suggest a dichotomy in selected habitat and habitat use for green and hawksbill turtles, which is unsurprising given their unique foraging habits. However, both species display small home ranges typically less than 4 km<sup>2</sup> and limited movement between islands with only one turtle, hawksbill with satellite tag #85943, making an 286 km, 7-day trek from Tinian to Guam.

Much was accomplished in the first year of this project, but much remains before significant progress can be made to address the guiding questions of the Monitoring Plan. The design of this project is to be in a position to address the guiding questions authoritatively, after at least five years of empirical research and a variety of analyses on diverse data streams. In the first year, we were able to establish a logistical process for field research and identified significant field challenges in locating and capturing sea turtles. Additionally, the PIFSC created a hiring mechanism through the National Academy of Science Natural Resources Council to hire and support postdoctoral associates. A suitable candidate has been hired, and will begin work in December 2014. Therefore progress was made toward capturing turtles and deploying biotelemetry devices, the data are coming in from the tags, and we have made preliminary analyses toward that end. However, we will need to deploy tags in additional locations, find locations on Guam that are suitable for work, and will need to bring in the postdoctoral associate to address the aerial and tow-diver surveys.

Revisions of the original scope of work and ensuing research plan could be considered in concert with a revised budget. Currently, the plan consists of 10 satellite tags deployed over 2 weeks of field research on site over the course of one annual project cycle. After five years of such work, our projections are that 50 tags would be deployed with a probable geographical split of 20 tags on Guam, 20 on Saipan, and 10 on Tinian. Taxonomically, our projections are that this effort would tag 38 green turtles and 12 hawksbills. While data from these tags will be used in concert with aerial and tow-diver data (which are not necessarily explicit with respect to species) it is important to consider at this juncture whether such samples are large enough in order to make the interested ecological inferences. At present, it is our opinion that these numbers may not be sufficient to inform on habitat use and residency. The tagging effort may therefore need to be increased and the associated budget revised accordingly to gain sufficient ecological habitat use at the end of five years' time.

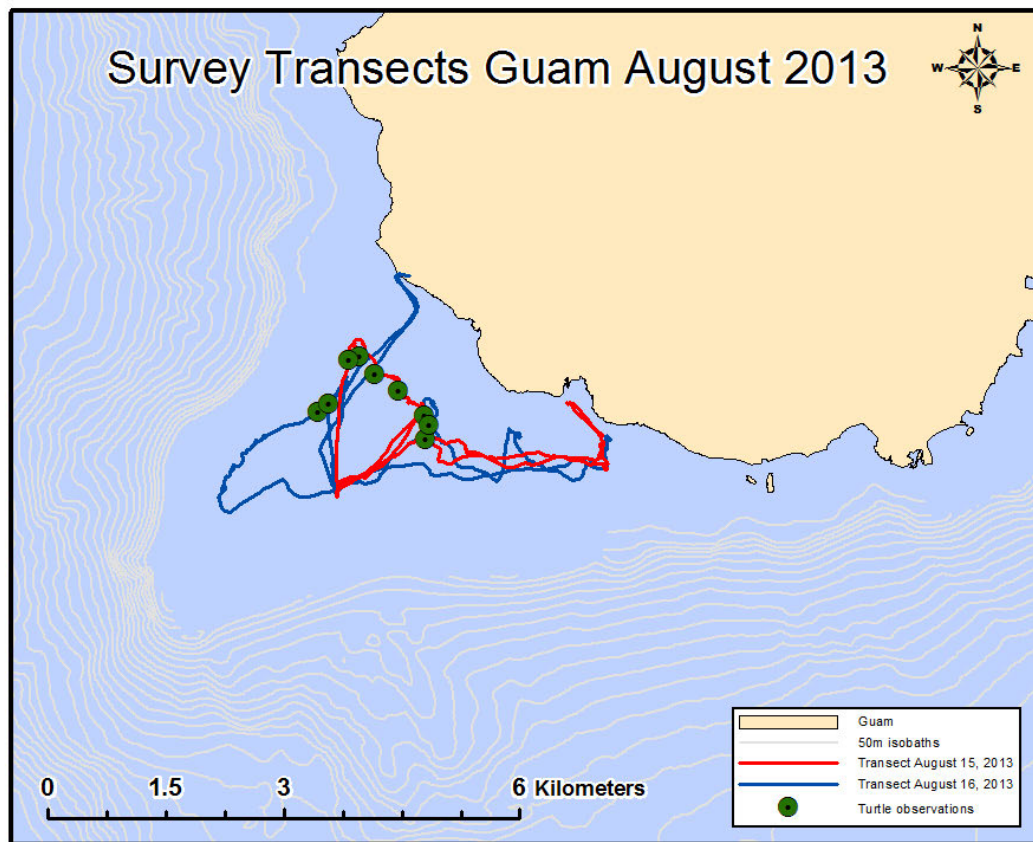
#### **ACTIVITIES PLANNED FOR 2014:**

In July of 2014 we will conduct in-water surveys and capture in Saipan, Tinian, and Guam. Surveys conducted in 2013 revealed suitable habitat for entanglement netting in the shallow sand bottom areas of Cocos Lagoon, should that be a preferable site. But we will also survey areas along the western shore of Guam, beginning in Apra Harbor and moving south. Survey locations will be concentrated on the eastern side of Saipan, and all areas of Tinian (weather depending). During these surveys/in-water capture we plan to deploy an additional 10 Wildlife Computers SPLASH400 satellite tags. Complete analyses of the biotelemetry data will allow understanding of home range, habitat hotspots, preferred depths and temperature, as well as any movement between islands within the archipelago.

A post-doctoral researcher will be joining with the Marine Turtle Assessment Group in 2014 to begin analyses of aerial and tow-diver surveys dating back to the late 1960s. These data will provide essential biogeographical and historical context for understanding the spatial distribution and abundance of sea turtles in the MIRC. Together, combined with the current satellite tag deployments will allow a more complete assessment of habitat use and home range of marine turtles in the Marianas Archipelago.

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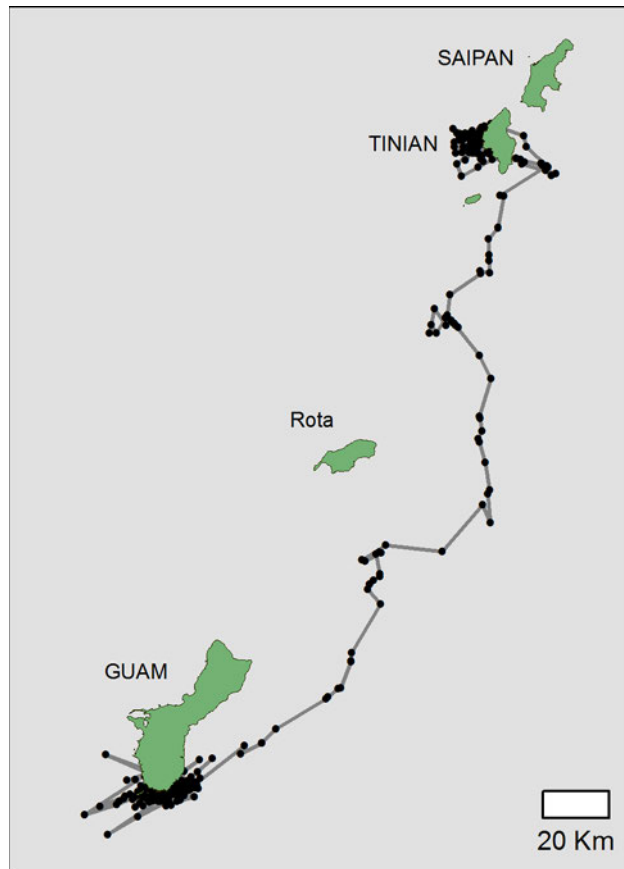
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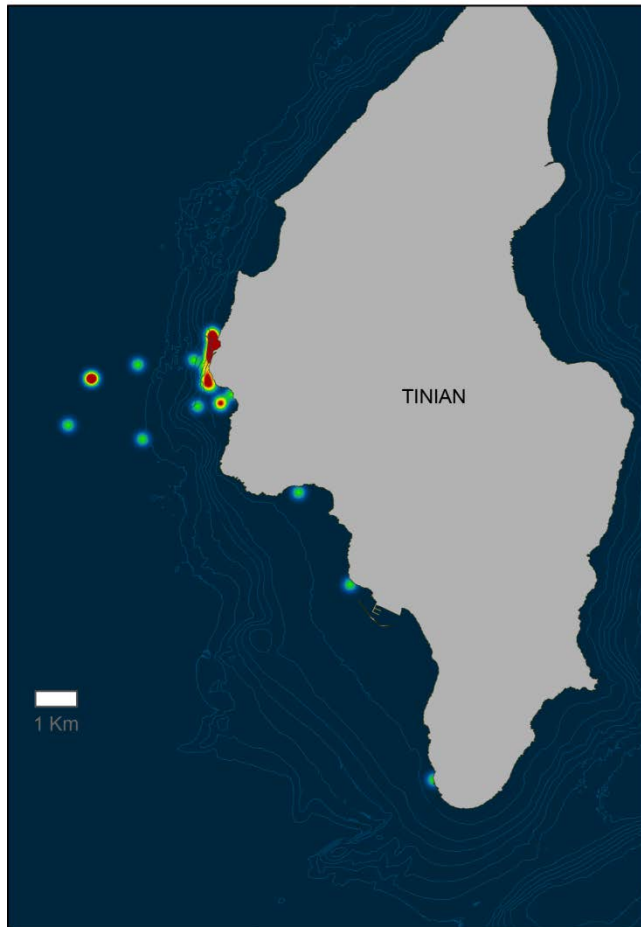
**Figure 1.** Small boat surveys conducted in the nearshore waters of Cocos Lagoon on August 15 and 16, 2013. Turtles were sensitive to boater or snorkeler presence and usually fled when within 20-30 m. Transects revealed areas suitable to entanglement net capture.

Species	Cm	Ei	Cm	Cm	Ei	Cm
Capture date	18-Aug-13	18-Aug-13	19-Aug-13	19-Aug-13	20-Aug-13	21-Aug-13
Capture Location	Balisa, Saipan	Balisa, Saipan	Balisa, Saipan	Balisa, Saipan	Fleming Pt., Tinian	Balisa, Saipan
Capture Latitude	15.19910	15.20227	15.20548	15.21190	15.01610	15.20162
Capture longitude	145.70035	145.70110	145.69785	145.69832	145.58097	145.69923
Capture method	In-water	In-water	In-water	In-water	In-water	In-water
Sex	U	U	U	U	U	U
SCL (cm)	60.9	66.6	60.4	66.1	61.7	62.5
Mass (kg)	32.5	34	30.2	39.1	27.5	34.6
Satellite tag type	SPLASH400	SPLASH400	SPLASH400	SPLASH400	SPLASH400	SPLASH400
Satellite ARGOS ID	85491	85496	85494	85495	85493	85492
Last transmission	14-Oct-13	18-May-14	2-May-14	19-Jan-14	19-May-14	19-May-14
DNA	Y	Y	Y	Y	Y	Y
Inconel Flipper tags	RI08566/RI08565	RI08560/RI08561	RI01207/RI01208	RI08563/RI08552	RI08553/RI08558	RI01351/RI01352
PIT tags	982.000149990073	982.000150012839	982.000153662662	982.000153675029	982.000149986359	982.000153660000

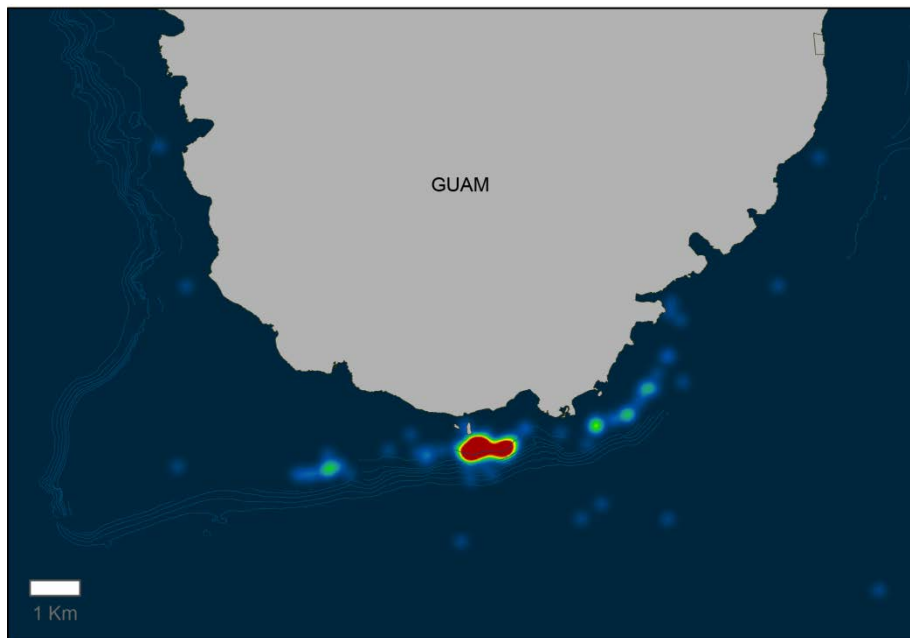
**Table 1. Capture data for marine turtles within MIRC during August 15 – 21, 2013 small boat surveys.** Date represent local time zone, latitude is decimal degrees north, longitude is decimal degrees east. “SCL” is the straight carapace length of each turtle. “Cm” is *Chelonia mydas*, and “Ei” is *Eretmochelys imbricata*. Turtle sex is listed as undetermined (“U”) for all 6 turtles. Flipper tag identification numbers are given for left front flipper and right front flipper, respectively. PIT tags were inserted into the left rear flipper.



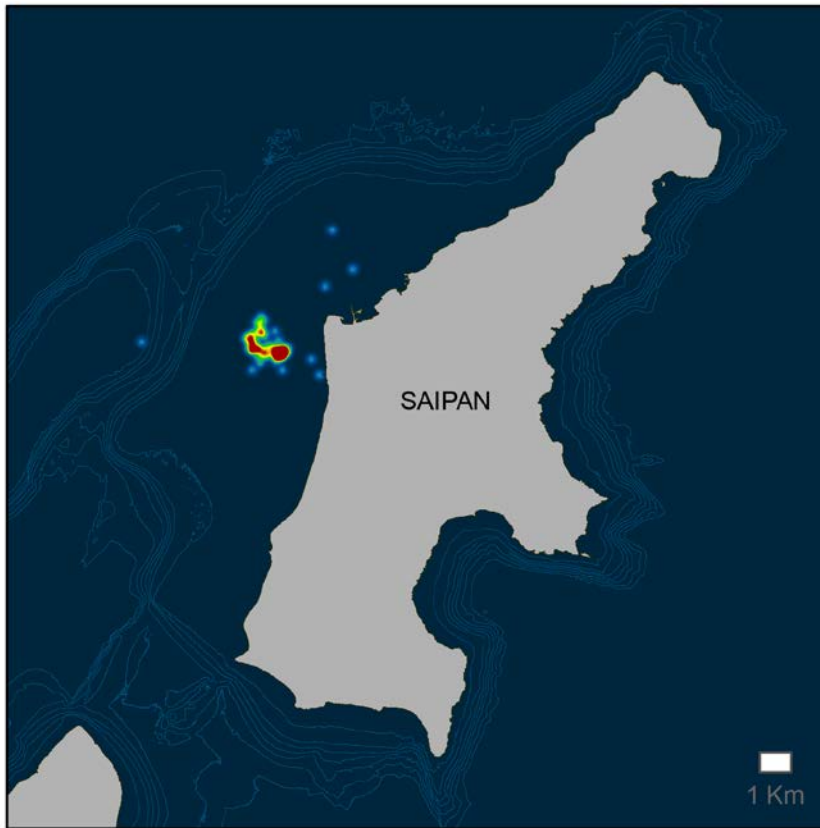
**Figure 2. Migration of subadult hawksbill turtle (ID #85493) from Tinian, CNMI to Guam.** Turtle was initially tagged on 20 August near Fleming Point, Tinian; left Tinian on 10 October; and arrived at Cocos lagoon, Guam on 17 October. The turtle resided off Tinian for 51 days, and remains in the Cocos lagoon area today. The migration covered a distance of 286 km and lasted 7 days.



**Figure 3. Kernel Density Estimate of habitat use for subadult hawksbill turtle (ID #85493) near Fleming Point, Tinian, CNMI.** During its observed 51-day residence on the West side of Tinian (8/20/2013 – 10/10/2013) this turtle constrained its movements to a confined area proximate the coastline of Tinian. This stretch of coast has a rapid drop off to deep waters as demonstrated by the dense isobath lines. Warm colors are highest probability of occurrence, light blue contours are 50m isobaths.

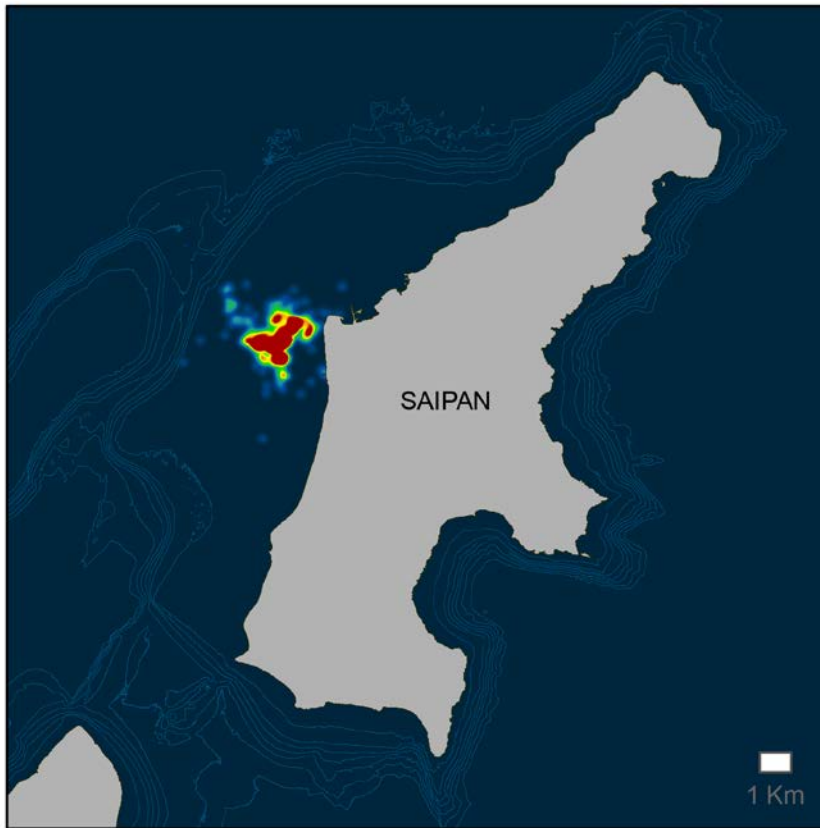


**Figure 4. Kernel Density Estimate of habitat use for subadult hawksbill turtle (ID #85493) near Cocos lagoon, Guam.** During its observed 215 day residence on the south coast of Guam (10/17/2013 – 4/30/2013), this turtle constrained its movements to outside the fringing reef, remaining almost exclusively in the fore reef habitat outside of Cocos lagoon, across a linear distance of 8.6 km. Warm colors are highest probability of occurrence, light blue contours are 50m isobaths.

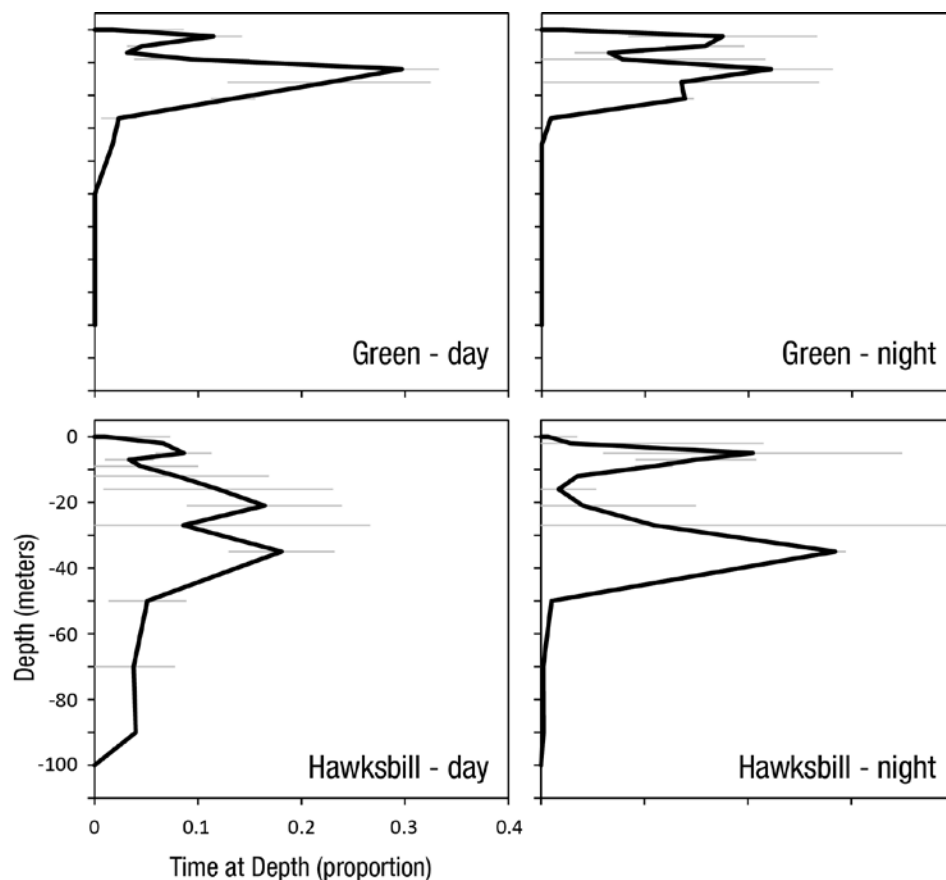


**Figure 5. Kernel Density Estimate of habitat use for subadult hawksbill turtle (ID #85496) near Garipan, CNMI.** During its observed 273-day residence along the west side of Saipan, this turtle remained almost exclusively outside the reef flats, foraging in the fore reef habitat, with a core foraging area of approximately a linear distance of 2km across. Warm colors are highest probability of occurrence, light blue contours are 50m isobaths.





**Figure 6. Kernel Density Estimate of habitat use for 4 subadult green turtles (IDs #85491, #85492, #85494, #85495) near Garipan, CNMI.** During a combined 580 days of observation, these four turtles were documented occupying a core region measuring just 2-3 km across, and never really moving > 2km from this area. Warm colors are highest probability of occurrence, light blue contours are 50m isobaths.



**Figure 7. Time-at-Depth profiles for 4 subadult green turtles and 2 subadult hawksbill turtles in the Marianas region.** Unsurprisingly, turtles occupy shallower depths at night, and move to deeper depths during the day. During the day, the four observed green turtles maintained an average depth of 12.7 m (stdev = 5.3 m), and at night rose to an average depth of 10.3 m (stdev = 3.5 m). Hawksbills had a deeper, but more variable behavior. During the day, the two observed hawksbill turtles maintained an average depth of 24.9 m (stdev = 14.6 m), and at night rose to an average depth of 18.4 m (stdev = 6.4 m). Dark lines are time-at-depth averages, error bars represent standard error of the mean, and axis titles are conserved from lower left panel. Data from a larger sample of individual turtles (but not necessarily more samples from the same individuals) would decrease the error bars.