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Novel Use of Satellite Tracking as a Forensic Tool to Determine Foraging Ground of a Rescued Green Turtle (*Chelonia mydas*)

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Since the advent of satellite tracking technology for marine turtles in the 1980s, numerous studies have advanced knowledge of the foraging areas of turtles (Benson *et al*. 2007; Godley *et al*. 2008; Seminoff *et al*. 2012). However, the use of satellite telemetry as a potential forensic tool to trace turtles found in the illegal markets back to their origins or foraging grounds has not been explored, despite studies that show marine turtles have a true navigational mechanism to return home after displacement (Åkesson *et al*. 2003; Hays *et al*. 2003; Girard *et al*. 2006). As marine turtles exhibit fidelity to specific foraging sites (Balazs 1976; Craig *et al*. 2004), identifying these key habitats is imperative to their conservation (Broderick *et al*. 2007). If these areas are sufficiently resolved, increased protection measures and cooperation with relevant authorities in these localities create the potential for more effective conservation.

Marine turtles in the South China Sea are heavily traded illegally due to their significant commercial demand for consumption, jewelry, and decoration in China (Lam *et al*. 2011). Turtle poachers are pushing into adjacent waters of neighboring South-east Asian countries, such as Vietnam, Malaysia, Indonesia, and the Philippines, in search of sea turtles to satisfy the growing demand (Lam *et al*. 2011). Based on seizure reports, Hainan, an island province in China, is considered an important landing and selling point of marine turtles (Pilcher *et al*. 2009). The news media has reported significant apprehensions of Hainan-based vessels, and confiscations of hundreds of marine turtles by the authorities in South-east Asia (PRI's The World 2012), culminating in high profile international incidents (Fox News 2014). Due to the paucity of scientific-based knowledge concerning the migratory routes and location of foraging grounds for these poached marine turtles, the potential to protect turtles before being poached is minimal.

In an effort to collect data to discover source foraging areas and movement pathways of sea turtle individuals or cohorts that are transported to Hainan for illegal sale, we rescued an adult female green turtle (*Chelonia mydas*) named "Star Blue" from the commercial market on 17 February 2012, and tracked her using satellite telemetry. For 38 days, she was observed feeding normally in captivity at the Sea Turtles 911 floating hospital. Star Blue

measured 95.5 cm in curved carapace length (CCL), and weighed 120 kg with a good body condition index of 1.38 (calculated using the formula in Bjorndal *et al*. 2012). To keep track of Star Blue's movement, a platform transmitter terminal (PTT) from Telonics Inc. (Model TAM-2639) was deployed and attached to her carapace, using elastomer, polyester resin and fiberglass cloth, following the attachment protocols adopted by Balazs *et al*. (1996).

On 26 March 2012, local police authorities and members of Sea Turtles 911 released Star Blue into Lingshui Bay, Hainan, China, generating local and international press coverage (Chen 2012; Hawaii 24/7 2012). Star Blue traveled a total of 2,572 km for 103 days from Hainan to Patongong Island, Palawan, in the Philippines (Fig. 1). More specifically, she traveled 1,256 km across the South China Sea, from Hainan to Luzon Island, then south along the coastline before moving offshore and traveling 1,316 km to the coral reefs off Patongong Island. The mean speed of travel was 0.9 km/hr. Data were processed and distances and mean speed of travel were calculated as stated in Parker *et al*. (2009). Ocean depths across the South China Sea reach over 4,300 m; however, based on previous green turtle dive research Star Blue likely did not dive much deeper than 135 m while traveling (Rice & Balazs 2008). Star Blue settled and persisted for 46 days near Patongong Island in water depths of 7-30 m, according to the GEBCO bathymetry data from around this area (<http://www.google.com/earth>), before signals faded away presumably due to normal antenna damage from abrasive contact with coral ledges and reef structures. Other reasons for the tag ceasing to transmit include battery exhaustion, electronics failure, natural mortality, or human interaction such as tag or turtle removal.

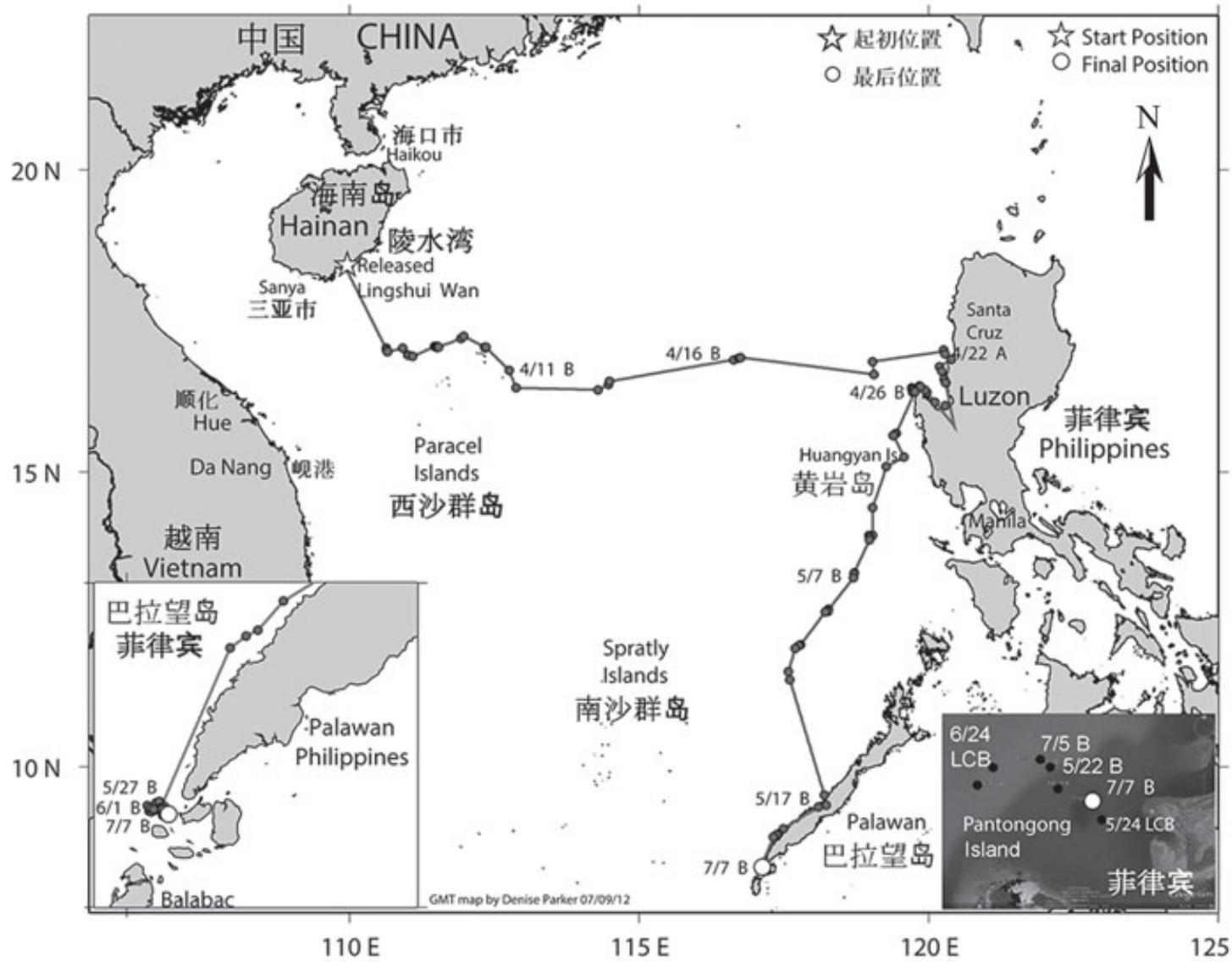

Figure 1. Movement of an adult female green turtle (ID: 53747) rescued from the illegal market trade and released from Hainan Island, China. The turtle arrived at her foraging ground near Patongong Island, Philippines. The satellite tag was deployed on 26 March 2012 and transmitted for 103 days with a programmed duty cycle of 6 h on and 24 h off (6/24).

The home range or area covered by Star Blue's last two months was approximately 24 km^2, ranging from 1-6 km offshore of Patongong Island, Palawan, the Philippines. Because these final positions were not of high accuracy (> 1 km based on Argos estimates), it is possible that the home range for this turtle was less than 24 km^2. Star Blue could have stopped at many other potential foraging areas along the coasts of the Philippine islands, but traveled in a direct manner until she reached Patongong Island. Thus, her fidelity toward this site suggests Star Blue was resting and foraging around the reefs of Patongong Island before capture. While her nesting beach remains unknown, previous satellite tracking reports have shown post-nesting turtles foraging in this area after they nested in Taiwan and Yap, Micronesia (Pilcher 2009).

The addition of Star Blue's track adds to information about the foraging habitat for green turtles around the Philippines, as well as revealing insights into her possible capture area. The inferred 'removal' of Star Blue from her home foraging pasture near Patongong Island, to the illegal market in Hainan Island, demonstrates how satellite telemetry studies may serve as a forensic tool to improve marine turtle conservation efforts in relation to illegal poaching. DNA analysis has been used extensively as a forensic tool in the conservation of sea turtles (Encalada *et al*. 1994) through determining the genetic origin of sea turtles in the illegal market trade. Matching the DNA of sea turtles in the illegal market with the population of turtles in the inferred capture area from satellite tracking, would strengthen the case in wildlife forensic investigations. We recommend that more satellite tags be deployed on rescued turtles from the market trade in order to backtrack and increase enforcement at foraging grounds with the establishment of marine protected areas (MPAs).

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