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Identification of a Dead Green Turtle (*Chelonia mydas*) Using Photographic Identification

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The stability and distinctive facial scale patterns of sea turtles allow individuals to be identified using photographic identification (photo-ID) as a complementary or an alternative tagging method in the study of sea turtles (Chew *et al*. 2015; Carpentier *et al*. 2016). Photo-ID is non-invasive, reliable for long-term monitoring and allows the public to participate in data collection with minimal training (Davies *et al.* 2012; Chassagneux *et al*. 2013). It has been used to examine the population sizes, sex ratios (Schofield *et al*. 2008; Su *et al*. 2015), resighting and recapture rates (Jean *et al*. 2010; Hall & McNeill 2013), tag loss (Reisser *et al*. 2008), geographical distribution and movement patterns (Chassagneux *et al*. 2013) of sea turtles.

Perhentian Islands Marine Park, a tourist destination where boat traffic is increasing, is also important foraging and nesting grounds for green and hawksbill turtles (Fig. 1) (Tan & Teh 2001; Ibrahim *et al.* 2003). However, without the identification of individuals, not much is known about their populations and such information is crucial for species conservation and management (Reisser *et al*. 2008; Jean *et al*. 2010). Thus, photo-ID was used to identify individuals in the Perhentians. The photo database, containing photographs of the left and right faces of each individual, was stored in the automated pattern recognition software, NaturePatternMatch (NPM). Information of every sighting such as date and location were recorded in a sighting database, providing a sighting history for each individual turtle. To identify an individual from a new photograph, NPM first uses the Scale-Invariant Feature Transform (SIFT) algorithm (Lowe 2004) to extract distinctive features from the facial scales and match the extracted features of the individual against all individuals in the database, then ranks the matches using similarity scores, in which a higher score indicates more similarities, and finally the program shows top matches in a hierarchical order from most to least similar (Town *et al*. 2013; Stoddard *et al*. 2014). The matches were visually checked for a correct match. When a match was not found, often due to poor-quality photographs, identification was done through manual matching by visually comparing a new photograph against photographs of all the individuals in the database. If no match was found after using both automated and manual matching, photographs of the individual was added to the database as a new individual, only if it was sighted alive.

As sea turtles show fidelity to foraging grounds, resighting of individuals in the same area occurs (Broderick *et al*. 2007). On 30 August 2015, a dead green turtle was found by a local at Teluk Pauh (5° 54’ 18.1”N, 102° 44’ 26.4”E, Fig. 1), showing injuries from boat strike. The turtle was checked for tags, measured for curved carapace length and photographs of the turtle were taken. Although the turtle did not have any tags on either of its front flippers, it was positively identified using photo-ID when the scale patterns of both sides of the face and the top of the head matched one of the turtles in the database (Fig. 2). Based on previously collected data, this turtle was first seen at Teluk Pauh on 26 July 2013 and resighted twice at the same area on 5 September 2013 and 31 October 2014. It was not seen in 2015 until it was found dead, measuring 77.4 cm curved carapace length.

Photos do not only capture the identifiable features of an individual, they also show injuries, the healing process and scars (Hall & McNeill 2013). Therefore, similar to tag recovery, photo-ID could be used to document the number of individuals that are injured or killed. Nonetheless, there are limitations to the use of photo-ID in positively identifying a dead turtle. Firstly, unless the turtle is spotted immediately after death, identification is nearly impossible as it would have decomposed beyond recognition. In 2015, photos of

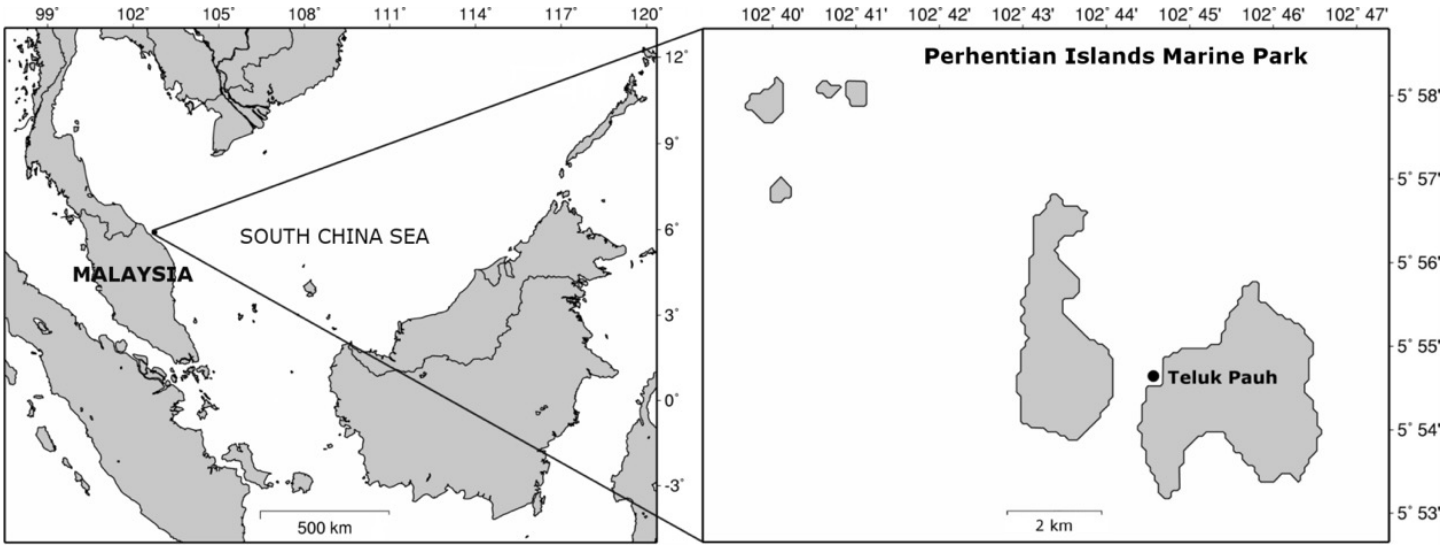

Figure 1. The location of Teluk Pauh in Perhentian Islands Marine Park, Malaysia.

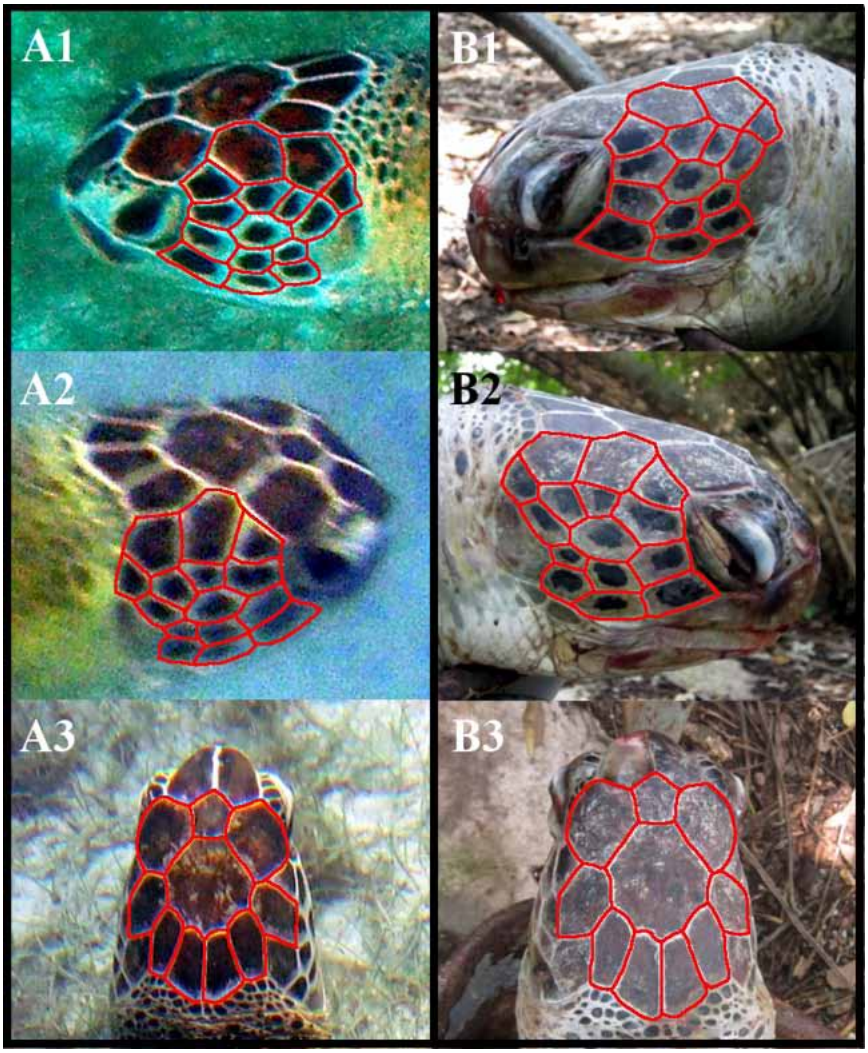

Figure 2. The left and right face profiles and the top of the head of the green turtle when it was alive between 2013 and 2014 (series A) and after it was found dead in 2015 (series B). Both face profiles and the top of the head display similar scale patterns.

four dead green turtles were collected but only one turtle matched an individual in the database. One could not be identified as the scaled skin had come off the skull, thus showing no facial characteristics. Secondly, unlike tags that can be traced back to the source, a turtle identified by photo-ID cannot be documented as a recapture when encountered elsewhere (Hall & McNeill 2013). Despite having facial scale patterns that were recognizable, no matches were found from the database for the remaining two dead turtles because they had not been sighted in the Perhentians prior to their deaths, however, there might be a match if the photos were compared against other photo databases.

Despite its limitations, the use of photo-ID to study sea turtles has gained popularity within the last decade with the development of computer-assisted identification systems to reduce the time needed to identify individuals (Carter *et al*. 2014; Dunbar *et al*. 2014) and the integration of citizen science that allows monitoring on a larger geographical scale and over a longer time period (Carpentier *et al*. 2016). A centralized open access photo database could be useful for long-term identification of individual turtles and tracking movements on a wider scale (Hall & McNeill 2013).

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