GROWTH RATES AND SITE PREFERENCE OF SEA TURTLES IN MABUL AND SIPADAN ISLANDS, SABAH, MALAYSIA.

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DECLARATION

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ABSTRACT

Mabul and Sipadan Islands which are both located at the east coast of Sabah, served not only as the nesting beaches for the female sea turtles but also as habitat and foraging ground for the resident sea turtles. The objectives of this study were to monitor the short-term growth rates, site fidelity and the morphometrics relationship of the resident sea turtles through capture, mark and recapture technique in Mabul and Sipadan Islands, Malaysia. Eight (8) sampling trips to the study sites was conducted from August 2010 until December 2011 resulting in a total of 810 successful captures of green and hawksbill turtles. Seven (7) morphometric measurements for the green turtle, *Chelonia mydas* and thirteen (13) for hawksbill, *Eretmochelys imbricata* were collected and the relationship between each attribute was analysed with simple linear regression. The short-term growth rates of the resident green and hawksbill turtles were recorded based on the increment of straight carapace length (SCL) measurements which were recorded during the first and subsequent captures. Data for site-fidelity was recorded based on the established dive sites in both islands where the turtles were found and analysed based on the number of captures at these specific sites. The mean short-term growth rate of juvenile green turtles in Mabul was 20.44mm/yr±17.16 SD which was higher than the adult female turtles which was 1.10mm/yr±1.146 SD. Higher short-term growth rates were also observed in juvenile green turtles in Sipadan which was 13.51mm/yr±11.68SD as compared to adult male turtles with a mean growth rate of 1.1mm/yr±2.56SD. As observed in green turtles, the short-term growth rates in juvenile hawksbill turtles in Mabul and Sipadan Islands were higher as compared to the adult turtles. Based on the frequency of turtles captured in each sampling site, the turtles in Mabul ($\chi 2$ = 118.7, df = 7, $p < 0.000$) and Sipadan ($\chi 2$ = 386.062, df = 9, $p < 0.000$) significantly preferred selected sites over others. The morphometric data of green and hawksbill turtles in Mabul and Sipadan showed positive correlation between each attribute. The high number of juvenile turtles in this study indicates a healthy recruitment of green and hawksbill turtles in Mabul and Sipadan islands.

ABSTRAK

KADAR PERTUMBUHAN DAN PEMILIHAN KAWASAN TERTENTU OLEH PENYU LAUT DI PULAU MABUL DAN PULAU SIPADAN, SABAH, MALAYSIA.

Pulau Mabul dan Pulau Sipadan yang terletak di pantai timur Sabah, berkhidmat bukan sahaja sebagai pantai untuk penyu laut bertelur tetapi juga sebagai habitat dan kawasan meragut untuk penyu residen yang yang mendiami perairan tersebut. Objektif kajian ini adalah untuk memantau kadar pertumbuhan jangka pendek, kesetiaan tapak dan hubungan morphometriks daripada penyu residen yang mendiami kawasan ini melalui teknik penangkapan, tanda, lepas dan tangkap semula di Pulau Mabul dan Sipadan, Malaysia. Sebanyak lapan (8) pensampelan ke tapak kajian telah dijalankan dari bulan Ogos 2010 hingga Disember 2011. Sebanyak 810 tangkapan telah berjaya dilakukan ke atas penyu hijau, Chelonia mydas *dan penyu sisik,* Eretmochelys imbricata. *Tujuh (7) ukuran morphometriks untuk penyu hijau,* Chelonia mydas *dan tiga belas (13) untuk Penyu sisik,* Eretmochelys imbricata *direkodkan dan hubungan antara setiap ukuran dianalisis dengan linear regresi. Kadar pertumbuhan jangka pendek bagi penyu hijau dan penyu sisik residen direkodkan berdasarkan pertambahan panjang ukuran lurus karapas (SCL) yang telah dicatatkan semasa penangkapan kali pertama dan seterusnya. Data untuk kesetiaan tapak dicatatkan berdasarkan nama kawasan menyelam di mana penyu residen ditangkap di kedua-dua pulau dan dianalisis berdasarkan bilangan tangkapan. Secara purata, kadar pertumbuhan jangka pendek bagi penyu hijau juvenil di Mabul adalah 20.44mm/tahun±17.16 SD iaitu lebih tinggi berbanding dengan penyu jantan dewasa iaitu 1.10mm/tahun±1.146SD. Kadar pertumbuhan jangka pendek yang lebih tinggi juga diperhatikan dalam penyu hijau juvenil di Sipadan iaitu 13.51mm/tahun±11.68SD berbanding dengan penyu jantan dewasa dengan kadar pertumbuhan 1.1mm/tahun±2.56SD. Sebagaimana yang dilihat pada penyu hijau, kadar pertumbuhan jangka pendek pada penyu sisik juvenil di Pulau Mabul dan Sipadan juga lebih tinggi berbanding dengan penyu dewasa. Berdasarkan rekod kekerapan penyu ditangkap dalam setiap kawasan persampelan, penyu di Mabul ($\chi 2 = 118.7$, $df = 7$, $p < 0.000$) dan Sipadan ($\chi 2 = 386.062$, $df = 9$, $p < 0.000$) didapati dengan signifikan memilih untuk mendiami kawasan tertentu di kedua-dua pulau. Data morphometriks penyu hijau dan penyu sisik residen di Mabul dan Sipadan menunjukkan hubungan yang positif antara setiap ukuran morphometriks. Bilangan tangkapan penyu juvenil yang tinggi di kedua-dua pulau ini menunjukkan pertumbuhan populasi yang sihat.*

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LIST OF ABBREVIATIONS

CA	-	Curved A
CB	-	Curved B
CC	-	Curved C
CCL	-	Curved Carapace Length
CCW	-	Curved Carapace Width
CMR	-	Capture Mark Recapture
et al.	-	And Others
HL	-	Head Length
HW	-	Head Width
IUCN	-	International Union for Conservation of Nature
PL	-	Plastron Length
SA	-	Straight A
SB	-	Straight B
SC	-	Straight C
SCL	-	Straight Carapace Length
SCW	-	Straight Carapace Width
SD	-	Standard deviation
SE	-	Standard error
UMT	-	Universiti Malaysia Terengganu
SWD	-	Sabah Wildlife Department
WWF-Malaysia	-	World Wildlife Fund For Nature – Malaysia

LIST OF SYMBOLS

% - Percent

” - Inch

< - Less than

> - More than

cm - Centimeter

ha - Hectare

kg - Kilogram

m - Meter

mm - Milimeter

°C - Degree Celsius

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CHAPTER 1

INTRODUCTION

1.1 Sea Turtles in Malaysia

The sea turtles in Malaysia belong to Cryptodirans (Lim and Das, 1999). Four of seven existing sea turtles in the world had been reported to be found in Malaysian waters and beaches, the leatherback turtle (*Dermochelys coriacea)*, green turtle (*Chelonia mydas*), hawksbill *(Eretmochelys imbricata),* and olive ridley *(Lepidochelys olivacea),* (Lim and Das, 1999; Chan, 2006; Isnain 2008). Sea turtles in Malaysia can be categorized into two which are nesting and resident turtles. Nesting turtles refers to the female turtles that come to nest along the shore which then recognised as nesting beaches. While resident sea turtles referring to the foraging sea turtles that stay in the foraging ground during non-breeding season (Ceriani, *et al.,* 2012). All four species were reported to nest on Malaysian beaches (Chan, 2006), however only green and hawksbill turtles were reported to inhabit Malaysian water (Mortimer, 1991; Pilcher, 2010; Joseph *et al.*, 2016).

Rantau Abang was once popular with the nesting of leatherback turtle, *Dermochelys coriacea* with over 10,000 nests was recorded in 1956 (Chan & Liew, 1996). Sadly, as in other parts of the world, the leatherback turtle in Malaysia is facing extinction as the number of female come for nesting on Malaysia shores had declined every year (Chan, 2006). As published in The Star (2015), the Department of Fisheries Malaysia (DOFM) Deputy Director-General (development) En. Zulkafli Abd. Rashida reported that the last landing of leatherback turtle at Terengganu was in 2010. However none of the eggs from 8 nests hatched. As a result of the drastic decline in nesting number in the West Pacific subpopulation (i.e., Malaysia, Indonesia, Papua New Guinea, Solomon Islands) over three generations, leatherback turtles are now classified as vulnerable under by the International Union for Conservation of Nature (IUCN) (Wallace *et al.*, 2013).

The olive ridley turtle (*Lepidochelys* olivacea), which is listed as vulnerable by IUCN (IUCN, 2016) are characterized with a relatively large and triangular head if seen from above. Their carapace is usually short and wide with five to nine pairs of costal scutes (usually six to eight) and often with asymmetrical configuration (Pritchard and Mortimer, 1999). This turtle is named for the greenish color of their carapace and skin. In Malaysia, they are locally known as 'Penyu lipas'. According to Isnain (2008), there were only six nests of Olive Ridley turtles that were recorded in the Turtles Islands Parks, Sabah from 1986 to 2001. In Tunku Abdul Rahman Park, off Kota Kinabalu only one nest was recorded which is in 1999. Hence, very little is known about this species of turtle in Sabah. In Peninsular Malaysia the last nesting by this species was reported in 2013 (Jabatan Perikanan, 2016).

The green turtle which is listed as an endangered species by International Union for Conservation of Nature (IUCN, 2016) is easily identified with an anteriorly rounded head, broadly oval shaped carapace with four pairs of costal scutes and it is dorsally black in hatchlings which become brown with radiating streaks in immatures, and very variable in adults (Pritchard and Mortimer, 1999). They are locally known as 'Penyu hijau' in East Malaysia and 'Penyu agar' in Peninsular Malaysia. This species which is also known as 'penyu bokko' among the locals on the east coast of Sabah was reported as the most sighted and abundant in Sabah (Mortimer, 1991; Chan, 2006; Isnain, 2008).

Hawksbill turtles are listed as critically endangered by International Union for Conservation of Nature (IUCN, 2016). They are characterized with a narrow and protruding beak and locally known as 'Penyu sisik' in East Malaysia and 'Penyu Karah' in Peninsular Malaysia. They have an oval carapace, with a strongly serrated posterior margin and thick overlapping (imbricate) scutes (Pritchard and Mortimer, 1999).

In Peninsular Malaysia, green and hawksbill turtles were reported to nest in Terengganu beaches, Pahang mainly in Chendor and Cherating and Perak (Chan, 2006). In east Malaysia, this species was observed to nest extensively in Turtles Islands Park and Sipadan island in Sabah, and Talang-Satang National Park in

Sarawak (Chan, 2006). In Sabah, the sea turtles are protected under the Wildlife Conservation Enactment 1997, Schedule I Section II, Totally Protected Species of Animals and Plants, Part I (Section 25 (2)) (Yap, 1997). Any kind of trade and consumption of sea turtles eggs is prohibited under this enactment.

Green turtles are the most abundant species found in Sabah to nest with peak nesting period between July and December (Mortimer, 1991; Isnain, 2008). While hawksbill turtles are the second most abundant species which are more concentrated in the east coast of Sabah and was reported to nest mainly in Gulisaan island, Sabah (Isnain, 2008). In recent years, there seems to be rise in the number of nests deposited at Turtle Islands Park (Isnain, 2015). The 34 years of data recorded in Turtles Islands Park showed an increase in the turtle nesting trend with a total of 256,634 nests recorded since 1979. From this data, 93.8% nest belong to green turtles, *Chelonia mydas* while the other 6.2% belong to hawksbill turtle, *Eretmochelys imbricata*. This is believed to be due to the conservation efforts by the authorities from the 1960s.

As in Sabah, the trend of nesting green turtles in Peninsular Malaysia also increased from an estimated 2000 nests per year to 4000 nests per year as reported by the Department of Fisheries Malaysia (DOFM) Deputy Director-General (development) En. Zulkafli Abd. Rashida to The Star in November 2015. The nesting report in Malaysia showed an increase of green turtles nests from only 3268 nests in year 2001 to a peak with 7980 nests in 2013. The recent number of green turtles nests (2014) by Department of Fisheries Malaysia was 4625 nests (Jabatan Perikanan, 2016). Apart from green turtles, the number of hawksbill turtle nesting in Peninsular Malaysia also increased from 261 nests in 2001 to 403 nests in 2014 with the highest nests recorded in 2011 (n=628 nests) (Jabatan Perikanan Malaysia, 2016).

In Malaysia, studies on resident or foraging turtle are few compared to those on nesting turtles due to the high cost to conduct and support such projects. Few studies that had been done in the foraging ground in Malaysia include the study of population structure of green turtles in Mantanani Island by Pilcher (2010) which is located at northwest of Sabah, and study on the genetic stock composition

and natal origin of the foraging green turtle population at Brunei Bay by Joseph *et al.,* (2016). The study of green turtles in Mantanani Island by Pilcher (2010) was identified as the pilot project site for the study of the Southeast Asian foraging turtle populations.

1.2 Resident Sea Turtles in Mabul and Sipadan Islands

This study were conducted in Mabul and Sipadan islands which are located on the east coast of Sabah were identified as foraging areas as turtles were present all year-round even during the nonbreeding season. This was also reported by Mortimer (1991) where juvenile green and hawksbill turtles were observed foraging at the seagrass and coral reefs habitat, respectively. The size classes of resident turtles comprises of juveniles to adult sea turtles. Few documented studies that have been done related to the resident sea turtles in these areas including the study done by Ooi and Palaniappan (2011), which looked at the influence of occurrence of cleaning stations with the quantity of barnacles (epibionts) present on the turtle's body, study on the spatial site fidelity of sea turtles in Mabul island by Palaniappan and Abd. Hamid (2017) and a genetic study lead by Dr. Juanita Joseph from Universiti Malaysia Terengganu.

The resident green turtles in Sipadan island were observed to occupy large areas of seagrasses during the high tide and shallow coral reef during low tide (Tinsung *et al,* 2011). In Mabul island, the resident green and hawkbills turtles have shown preferences towards some sites due to the natural underwater structures of the preferred areas (Palaniappan and Abd. Hamid, 2017). Although Mabul and Sipadan islands were known to serve as foraging habitat for green and hawksbill turtles, little is known about them. It is therefore of the utmost important to come up with a study to understand the factors that bring turtle to Mabul and Sipadan island. Also, by looking into the short-term growth rate of the turtles here, we can determine how the availability of the food resources in its preferred habitat is contributing to the growth and well-being of the foraging and residential turtles. Hence with such study, we can further promote more comprehensive conservation effort to preserve and protect all crucial habitats (coral reefs and seagrass) for the turtles.