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Depth utilization and swimming speed of female green turtles at Huyong Island, Thailand

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ABSTRACT
The resident depth and swimming speed of female green turtles *Chelonia mydas* nested at the Huyong Island, Thailand were examined. Four types of data loggers were used to record depth and swimming speed of turtles during the inter-nesting period with an interval of 1 second. Field experiments were conducted from 2003 to 2007 and the data was obtained from a total of 10 turtles. The turtles used the depth between 0 and 92.72 m and the mean resident depth ranged from 6.27 ± 6.29 to 20.66 ± 9.47 m (n = 10 turtles). Mean swimming speed of the turtles ranged from 0.04 ± 0.09 to 0.27 ± 0.25 m s^{-1} (n = 5 turtles). The nesting rookery and female green turtles at the Huyong Island are protected by the National Acts in Thailand. However, tour boats can go on a cruise around the island, suggesting an impact accident between boats and turtles. Therefore, the data on shallow depth utilization and the slow swimming speed of the turtles obtained through this study provide important information for the proper implementation of conservation of the green turtles.

KEYWORDS: green turtles, data logger, internesting interval, depth, swimming speed

INTRODUCTION

It is well known that the green turtle is an endangered species in the world. Therefore, efforts are made to preserve the places they live, and reduce humanity's impact on their natural habitats. In Thailand, National Acts, for example Fisheries Act, National Park Act, Export and Import Act and Wildlife Reservation and Protection Act protects sea turtles. Under these national actions, the Similan Islands National Park was established in 1982. This national park consists of 9 islands and is known as one of the most popular diving spots. So, many tourists from all over the world visit this national park every year. Also, the national park has an important nesting rookery of the green turtle, the Huyong Island (Fig. 1). The island is located in the southernmost part of the Similan Islands. In the Huyong Island, the Royal Thai Navy has conducted a long-term nesting survey for conservation of the green turtle since 1995. However, to protect their natural habitat, we have to understand the habitat use of the turtles not only on the beach but also in the sea. So, the international cooperative studies on the green turtles in the island, SEASTAR2000, had been started to acquire biological information for a conservation implementation since 1999. To achieve the aim of the project, three approaches have been conducted. First is the conventional tagging study. This was conducted to examine dynamics of a number of nesting females and nesting beach utilization of the turtles (Kittiwattanawong 2004, Yasuda et al. 2006, 2008). As the results of this approach, year-round nesting of the population was found. The second approach is the satellite tracking study. This was conducted to examine horizontal habitat use of the turtles (Kittiwattanawong et al. 2002). The satellite tracking study revealed that female turtles stay around the Huyong Island during the inter-nesting period (Yasuda, 2007) and that they went to the coasts of the Andaman Islands, India and the Phura-Thong Island, Thailand after nesting (Yasuda et al.,

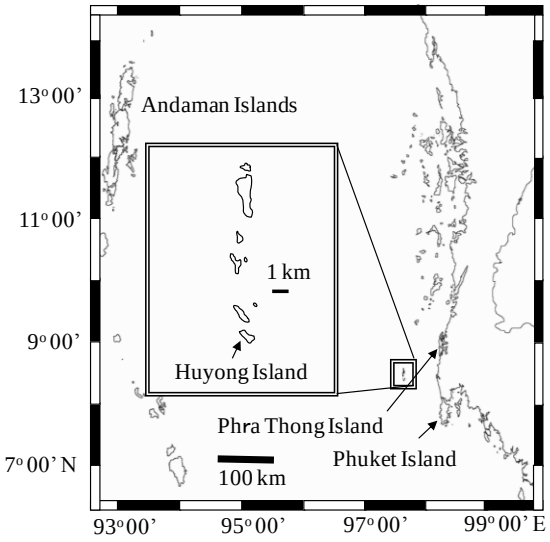

Fig. 1 The map of the study site.

2006). The third approach is logging of diving behavior of the turtles. This was conducted to examine vertical habitat use of the turtles. In the present study, we reported preliminary results of the depth utilization and swimming speed of the turtles obtained by the third approach.

Table 1. Summary of the diving data for female green turtles during the inter-nesting period at Huyong Island, Thailand. [1]Number of Swimming speed was not recorded along the way by an unknown problem in this turtle. CCL: curved carapace length

Turtle	CCL (cm)	Loggers	Recording period	N of data	Mean resident depth (m)	Min and Max resident depth (m)	Mean swimming speed (m s^{-1})	Min and Max swimming speed (m s^{-1})
1	104	DT	15-26 Mar 2003	1010880	7.11 ± 8.74	0 and 49.12	-	-
2	100	PDT	21-23 May 2003	128640	10.23 ± 6.98	0 and 47.22	0.13 ± 0.17	0 and 1.96
3	98	DT	18-31 Sep 2003	1274400	17.78 ± 14.43	0 and 92.72	-	-
4	100	PDT	5-13 Jun 2004	746520 (262971)[1]	9.18 ± 6.04	0 and 57.03	0.04 ± 0.09	0 and 1.41
5	99	PD2GT	3-6 Mar 2006	136620	6.27 ± 6.29	0 and 36.18	0.27 ± 0.25	0 and 1.41
6	99	PD2GT	6-11 Mar 2006	475826	9.94 ± 6.49	0 and 31.01	0.06 ± 0.16	0 and 3.6
7	90	PD2GT	9-15 Mar 2006	480675	14.27 ± 9.27	0 and 45.83	0.08 ± 0.19	0 and 2.94
8	103	D2GT	14-17 Mar 2006	328786	20.66 ± 9.47	0 and 59.47	-	-
9	101	D2GT	14-18 Mar 2006	353759	10.73 ± 10.41	0 and 56.59	-	-
10	109	D2GT	23-29 Sep 2007	466994	6.40 ± 3.53	0 and 28.57	-	-

MATERIALS AND METHODS

To examine resident depth and swimming speed of turtles, we used four types of data logger, M190L-DT, W190L-PDT, M190L-D2GT and W190L-PD2GT. All data loggers were manufactured by Little Leonard Ltd. Tokyo, Japan and were programmed for a sampling interval of 1 second for both depth and swimming speed. Depth was recorded by all loggers, whereas swimming speed was recorded by only the PDT and PD2GT. The data loggers were separately attached on carapaces of a total of 13 turtles using epoxy resin. The experiments were conducted from 2003 to 2007.

RESULTS AND DISCUSSION

Table 1 shows a summary of the data obtained by the experiments. The data was obtained from a total of 10 turtles but Turtle 5 and 6 were the same individual. We attached the loggers to Turtle 2 and 5 although they failed to make nest. However, these turtles with the loggers attached, subsequently succeeded to lay eggs. All data loggers were recovered after nesting.

All turtles continuously dived during the monitoring period. The turtles used the depth between 0 and 92.72 m and the mean resident depth ranged from 6.27 ± 6.29 to 20.66 ± 9.47 m (n = 10 turtles). This shallow depth utilization of turtles results in the resting diving behavior, e.g. the turtles rest on the seabed at shallow water for a long time (Yasuda and Arai, 2009). Mean swimming speed of the turtles ranged from 0.04 ± 0.09 to 0.27 ± 0.25 m s^{-1} (n = 5 turtles). The slow swimming speed, which may be the result of swimming behavior at the surface water, may be associated with breathing and horizontal movement, in addition to the resting behavior on the seabed because speed was recorded as zero once the loggers were exposed to the air.

A limited number of people and boats are allowed ashore or to dive around the island, the overnight stay of tourists is banned, and lighting on boats anchored near the island is prohibited. However, tour boats can go on a cruise around the nesting rookery, suggesting an impact accident between boats and turtles. Therefore, the shallow depth utilization and the slow swimming speed of the turtles provide important information for an implementation of conservation of the green turtles. Previous satellite tracking studies suggested that home range area of the turtles were distributed within the 7km buffer area around Huyong Island (Yasuda, 2007; Kittiwattanawong, 2004). Therefore, our data recommends that motorized boats should travel at a crawling speed within the home range area of the turtles.

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