Habitat condition and nesting behavior of Hawksbill, *Eretmochelys imbricata*, population at Kimar Island Beach, Belitung District of Indonesia

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ABSTRACT
Hawksbill turtle (*Eretmochelys imbricata*) which is categorized as endangered species is known from many aspects related to the habitat condition and nesting behavior. The current paper describes nesting activity, habitat condition and time period of nesting of the turtles nesting at Kimar Island Beach, Belitung District of Indonesia. The results of observation during a period of March – May 2007 revealed that: (i) the nesting season of hawksbill turtle in Kimar Island coincided with west monsoon to transition period during March-May 2007; (ii) the natural beach in Kimar Island is suitable for hawksbill nesting; (iii) there were six main phases for the turtle in the nesting process; and (iv) nesting was observed in about 95% of 146 individuals landed at the beaches and 5% did not lay eggs.

KEYWORDS: hawksbill, habitat condition, nesting behavior, Kimar Island

INTRODUCTION

Hawksbill turtle (*Eretmochelys imbricata*) is one of the six sea turtles species inhabiting Indonesian waters (Nuitja, 1992). This species has been protected since 1992 through the Minister of Forestry's Decree No. 882/Kpts-II/1992 and was categorized as endangered species in the Red Data Book IUCN in 1970. Hawksbill turtle is also listed in Appendix I of the Convention on International Trade on Endangered Species of Wild Flora and Fauna (CITES). Indonesia ratified this convention with the consequence of prohibiting the trade of hawksbill turtle. This protection is also strengthened with the Government Regulation No. 7/1999 concerning protection of all sea turtle species including green turtle. The meaning of these regulations would, by stopping the exploitation of all parts of sea turtles, give a change for sea turtles to enhance their population in nature. To manage the sea turtle population, a knowledge on some aspects of bio-ecology such as nesting behavior, habitat condition and time period of nesting is needed. There was little information on these aspects, especially on hawksbill turtle in Indonesia, because of the relatively high difficulty to conduct research due to its nesting habitat usually located in the remote islands (Wiadnyana, 2003).

The nesting habitat of hawksbill turtle might be very specific as stated by Nuitja (1992). In general, the hawksbill turtle nests in solitary on small islands, at narrow beaches of 2 – 12 m beach width above highest tide and in the beaches with moderate sand diameter. Some experts mentionned that sea turtles are capable of coming back home to where they are born, this is called *"Homing Orientation"* (Miller, 1997). The physical beach characteristic is one of many factors influencing the instinct of sea turtle in recognizing the beach where the sea turtle was born, such as beach width and elevation, sand texture, beach vegetation and sand temperature (Miller, 1997).Some nesting areas of hawksbill turtle have been identified in Indonesia. Yusuf (2000) predicted that hawksbill are spread widely, especially in small islands with no habitation. The largest populations occured in Riau Islands until Belitung Island, Seribu Island, Karimun Jawa, Sulawesi Sea, South Sulawesi until South-East Sulawesi (Wakatobi) and Papua (Soehartono, 1993; Halim & Dermawan, 1999). The Bangka Belitung Island Province, especially Belitung District, has potential coastal natural resources such as mangrove forest, seagrass, and coral reef. This condition might be ideal and attract sea turtles as a fertile foraging ground. However, the existence of sea turtles in this area, mainly hawksbill turtles, has not been well documented. The current work describes the nesting habitat condition and nesting behavior of hakwsbill during a short nesting season in Kimar Island of Belitung District – Sumatera.

MATERIALS AND METHODS

Research on hawksbill turtle in Kimar Island (Fig. 1) was carried out during a part of a nesting season from March to May 2007. We obtained habitat condition data (beach slope, sand temperature and

texture) and bio-ecology data (size, nesting behavior, number of landed sea turtle on the beach) in the research. Some species of landed individuals were determined on the beach by the structure of carapace.

Direct measurement of the beach slope was made by using surveyor's level and staff with step: (i) attach a cord at nearest vegetation point from coastline; (ii) connect the cord to a gradual stick and set an angle of 90^0 by correcting with a line gauge and a surveyor's level; (iii) measure the length of cord from vegatation point until the stick; and (iv) measure the height of stick by the cord. The measurement was often done by using two sticks. The first one at the intertidal zone by setting a straight line from lowest tidal point to highest tidal point, whereas for the second stick at the supratidal zone from the highest tidal point to vegetation point.

Sand temperature was measured using a digital thermometer ($\pm 1^0$C) two times in the night between 21.00–22.00 during nesting time and after nesting activity.

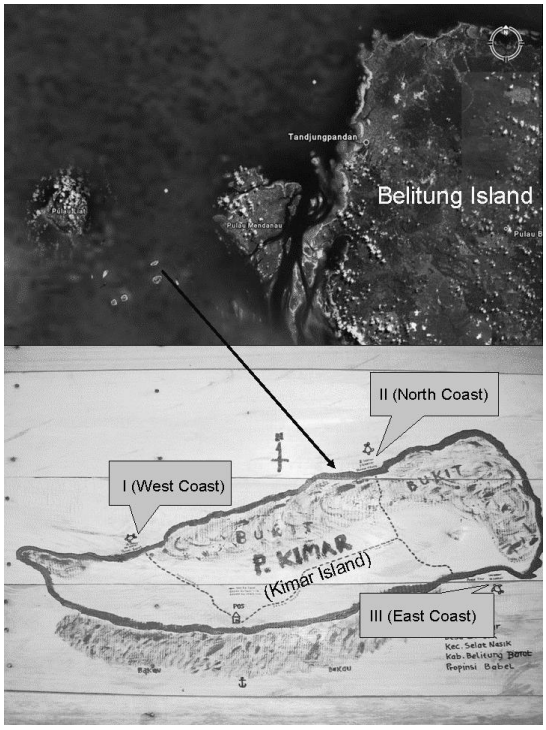

Fig. 1 The position of Kimar Island (upper) and diagrammatic sketch of Kimar Island (not to scale)

Sand texture was measured by collecting surface sand using a spoon. The sample was kept in a plastic bag until laboratory analysis. Measurements of diameter of sand and classification of sand size were made using sieves following to USDA (1973) as presented in Table 1.

Beach vegetation around Kimar Island was observed visually. The vegetation was identified and grouped by nesting plot observation.

The visual observation of sea turtle nesting behavior was carried out from the tidal line where the turtle emerges from the sea to the selection of nesting location. Data of the observation includes track, nesting location, distribution of the nest, and the subsequent behavior of sea turtle during nesting. The total number of hawksbill turtle landed in Kimar Island during 75 observations was about 146 individuals. Measu the morphology included the length and width of carapace, was done after the sea turtle finished laying eggs.

Table 1 Classification of sand

No.	Classification	Size (mm)
1	Very crude sand	0.90 – 2.00
2	Crude sand	0.45 – 0.90
3	Moderate sand	0.19 – 0.45
4	Soft sand	0.09 – 0.19
5	Very soft sand	0.04 – 0.09

The length was measured using Curve Carapace Length (CCL) and Straight Carapace Length (SCL) methods, starting from precentral to posterior marginal of post central (Fig. 2).

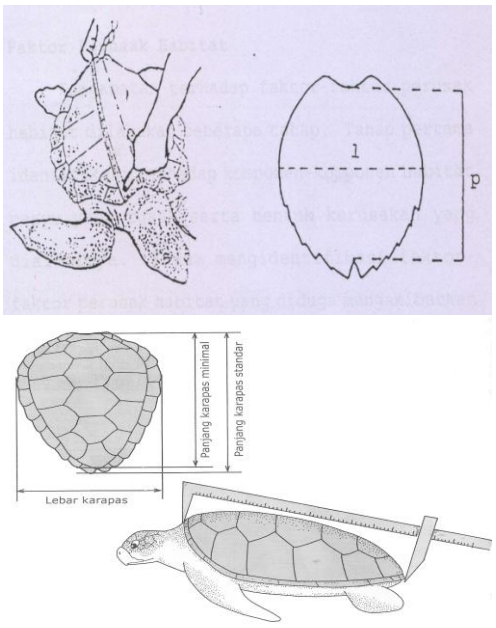

Fig. 2 Measurement of carapace length and width: left-side for CCL method (WWF, 1998) and right-side for SCL method (Yusuf, 2000)

Angle of beach elevation was calculated by using the formulation of Sastrosudirdjo (1984) as well:

$$\text{Arc } \square^0 = a/b$$

Where □ = the angle of beach slope; a = the hight of stick tagged by a cord; and b = the length

of cord attached at vegetation point nearest coastline.

RESULTS

Habitat condition

Kimar Island (Fig. 1) is located at $02^0$57'53.5" – $02^0$57'45.5 N and $107^0$13'23.0" – $107^0$13'55.5" E. This relatively small island consitutes land of granite stone, very steep in nothern part, and has a shallow lagoon of coral reef and seagrass bed.

There are three nesting zonations of hawksbill turtles in this island (Fitriyanto, 2007): West Coast (Site I); North Coast (Site II); and East Coast (Site III). The beach measurement shows that the beach slope was 5.46^0 – 13.30^0 (8.70^0 on average) for East Coast (Site III) where it is the most steep and has a slightly higher slope compared to the other coasts, which were 4.53^0 – 6.15^0 (5.50^0 on average) and 4.58^0 – 5.82^0 (5.13^0 on average) for West Coast (Site I) and North Coast (Site II), respectively. This beach slope variation is < 30^0, still ideal for sea turle to nest (Nuitja, 1992).

The sand temperature measured is comparable for three sites with variation of 28.2 ^{0}C – 30.2 ^{0}C (28.8 ^{0}C on average), 28.8 ^{0}C – 29.1 ^{0}C (28.6 ^{0}C in average), and 26.6 ^{0}C – 27.5 ^{0}C (27.1 ^{0}C on average) for West Coast, North Coast, and East Coast, respectively. The sand temperature observed seems to be in range of favorable sand temperature (Rebel, 1974).

The analysis of the composition of sand fraction indicated four kinds of sand composition, such as sand fraction, soft sand fraction, dust fraction, and solid-land fraction as outlined in Table 2. According to precentage value, it seems that all three sites have almost the similar sand texture.

Observation on beach vegetation showed that there are six mangrove species consisting of: bintaro, leva (*Cerbera manghas*); pandan laut, screw pine (*Pandanus tectorius*); waru laut, portia tree, umbrella tree (*Thespesia populnea*); ketapang, Indian almond (*Terminalia catappa*); nyamplung, oil nut tree (*Calophyllum inophyllum*); and bebakoan, beach naupaka (*scaevola taccada*). Two vegetations (*Thespesia populnea* and *Pandanus tectorius*) were dominant and almost omnipresent in all sites and sectors.

the nesting process of hawksbill turtle, such as: emerging at the tide line of the beach and searching an appropriate nesting location, digging body and nesting holes, laying, closing nesting hole, closing body hole and making a false or artificial nest, and returning to the sea. The nesting activity of sea turtle is in the night time, generally together with the starting of high tide.

Emerging and Searching Phase (Phase 1)

Direct observation showed that hawksbill turtle emerged from the sea surface and landed on the tide line of the beach to select a nesting location. After landing, the turtle stopped and looked around to recognize the beach or be sure that the beach is appropriate for nesting. In this phase, some disturbanc because the turtle to return to sea without laying eggs. After ascertaining that there is no disturbance, the turtle continued to move forward to the upper part of the beach searching for a nesting location. Sometimes sea turtle stopped suddenly to recall it's imprinting memory. The track of a sea turtle while she was going to the nesting location appeared as tractor track forming zig zag as seen in Figure 3. The zig zag way implies that the turtle might adapt her movement to the physical beach condition. The time required for this phase was about 15 – 45 minutes.

Fig. 3 Hawksbill turtle track

Table 1 The composition of sand fraction in the beaches of Kimar Island

Site	Sand Fraction (%)	Soft Sand Fraction (%)	Dust Fraction (%)	Solid-Land Fraction (%)
West Coast (Site I)	83.7 – 97.6 (94.7)	0 – 0.3 (0.1)	0.6 – 2.7 (1.3)	1.2 – 14.8 (3.9)
North Coast (Site II)	89.5 – 96.2 (94.3)	0 – 0.3 (0.1)	0.2 – 2.7 (1.5)	1.7 – 9.5 (5.1)
East Coast (Site III)	88.5 – 95.9 (93,2)	0.1 – 1.3 (0.3)	0.8 – 7.1 (3.2)	1.4 – 6.9 (3.3)

Digging Phase (Phase 2)
After finding an appropriate location for nesting, the turtle started to dig a nesting medium by using the front flippers until a depth of 60 – 90 cm, the back flippers are less active than the front flippers. The digging process stopped when the whole body of turtle had entered in the hole. All this observation was done from a certain distance so as not to disturb sea turtle during the digging process, because this phase is the most critical phase for sea turtle before laying. The excavated sands were thrown randomly to the air, which is a sign that digging process would be terminated. However, the sea turtle had to search other places because the sand became too dry on certain days. In this condition the sand is very liable to fill up the hole, especially the hole prepared for the eggs.

The digging for the egg hole was carried out after finishing the body hole with the back flipper moving periodically. The back flipper was working as a spade. When the back left flipper was digging the egg hole, the back right flipper did not move until the dug sand accumulated enough to be ejected into the air by the back left flipper. This process was carried out alternately among the back left and right flippers Sometimes the turtle rested for 2 – 3 minutes to gain power before continuing the digging process. The digging was over when the turtle had a good body pit and egg pit. Then both front flippers were held in a position so that the front body position is higher than the back body position. This position is needed to make the egg pit deeper. The egg pit of hawksbill is about 15 cm, this is shallower than that of green turtle of about 30 cm (Yusuf, 2000). All the digging process required about 20 – 45 minutes.

Lying Phase (Phase 3)
Sea turtle started to lay eggs after finishing the crucial phase above. Even though the hawksbill turtle seem to be more sensitive than other species, during the period of laying, some small disturbance are still tolerable, such as direct watching and taking pictures of sea turtle. During the laying process, both back flippers were held in a position close to the tail (Fig. 4). The sticky covered eggs came out from cloaca one, two or three eggs together. This phase required 15 – 30 minutes depending on the number of eggs and the age of turtle. It seems that the younger nester lays relatively less number and smaller size of eggs that those of the older nester.


Fig. 4 The hawksbill turtle laying eggs

Covering the Nest Phase (Phase 4)
The body pit filling process was done by all flippers which moved always in pairs, left front flipper with right back flipper and right front flipper with left back flipper. The body pit covering was done by moving some of the nearest sands to the body pit. The turtle moved slowly and moved the sands to the body hole (Fig. 5). This process was repeated until whole body pit was covered by the sands. This phase required about 15 – 25 minutes.


Fig. 5 The nest covering process by a hawksbill turtle

Filling Body Pit and Concealing Nest Site (Phase 5)
After the nest had been covered by the sand, the hawksbill turtle would make a false nest to safeguard the eggs from any predator. The movement was made randomly, sometimes the turtle turns around the true nest. The making of a false nest was the longest duration of the whole nesting phase process. In this phase, the turtle seems to make an effort to conceal the nest pit with a one which looks like a true body pit. This false body pit serves to avoid a possible predator, so the turtle eggs would be safe from predation. The time needed for this phase which is often called “sand bath” was about 30 – 60 minutes.

Returning to the Sea Phase (Phase 6)
The turtle returned to the sea after all processes above were finished. During the time the turtle

returned back to the sea, she stopped sometimes and remained in the tide line waiting for some waves to push her to the sea. This phase required about 10 – 20 minutes, depending on the distance from nesting location to the sea (Fig. 6).

Fig. 6 The hawksbill turtle returns to the sea after nesting

Length of Turtle Carapace

The measurement of length and width of turtle carapace from 38 individuals showed that the straight carapace length (SCL) varied from 69.9 to 82.8 cm (average of 78.1 cm) and curved carapace length (CCL) ranged about 70.9 – 89.0 cm (average of 81.1 cm).

Number of Hawksbill Turtles landed in Kimar Island

The landed turtles are categorized into two groups such as: landed turtle and nesting, and landed turtle and unnesting. About 138 adult female individuals nested (95 %) and 8 individuals unnested or made a false crawl (5 %) (Fig. 7).

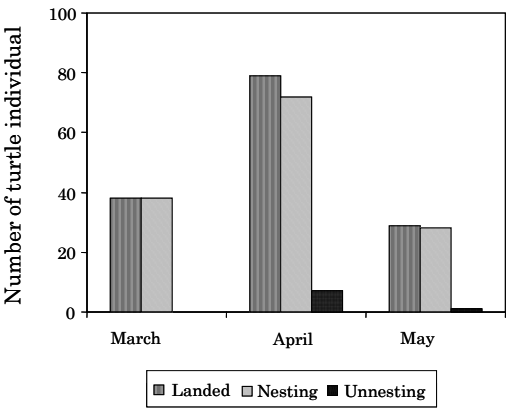

Fig. 7 Number of hawksbill turtles landed in Kimar Island during March to May 1997 showing nested and unnested individuals

In March, all landed individuals nested and about 7 individuals (9 % of 79 individuals) were unnested in April.

The observation on nest distribution in Kimar Island beach was done by dividing the beach into three nesting zones (west coast, north coast, and east coast) with 31 sectors each with a distance of about 50 m (Fitriyanto, 2007). The results of observation showed that the frequency of landed adult female turtles on the beach seems to be different from March to May (Fig. 8). The turtles were only found to land at site I (west coast) in March, meanwhile in April and May the turtles landed at two other sites.

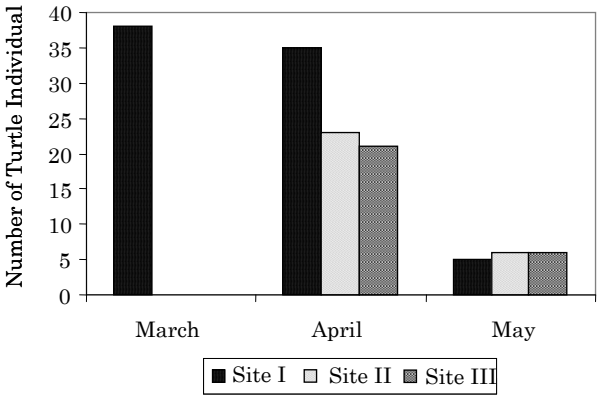

Fig. 8 Variation of landed turtle frequency in Kimar Island during nesting season

DISCUSSION

The observation on hawksbill turtle during a short period from March to May 2007 revealed the uniqueness of this species to nest in Kimar Island. The uniqueness may be seen from the nesting location that is quite remote and still natural. We found that the beach slope was below 13.30^0. and the sand temperature reached a maximum value of 30.2 ^{0}C. These values indicate that the habitat condition of Kimar Island is favorable for hawksbill turtle to nest (Rebel, 1974; Nuitja, 1992; Miller (1997)).

It has been suggested that hawksbill turtle would select a specific sand habitat for nesting. However, our observation found that this species nested in the beach irrespective of the type of the sand. The turtle nested in sand of moderate size (dominant sand type in this work) and also in very crude sand. This result was different from Nuitja (1992) which has stated that the hawksbill turtle nests usually in the soft sand (0.09 – 0.19 mm).

In term of vegetation, *P. tectorius* may attract hawksbill turtle to land in the beach for nesting. Bustard (1972) speculated that *P. tectorius* may influence the hawksbill turtle's instinct to make a nest and lay as found in Herond Island, Australia. This phenomenon was also found in this study. Some turtles nested under vegetation. This phenomenon has been also found by Nuitja (1992)

in Berhala Island beach where the place is dominated by *P. tectorius* and *T. populnea*.

Based on the observations, it was found that the nesting process of hawksbill turtle consisted of several phases. In the phase before laying, the turtle was very sensitive to many factors such movement of human, animal and/or light. The case of 5 % of unnesting turtle was due to the experiencing of the movement and lighting during the observation. These factors may affect the turtle to make a false crawl and directly go back to the sea.

Other false crawls of the turtles were due to some barriers of fallen trees which were spread on the beach. However, in certain conditions the turtle did not care about the barrier and continued to search an approriate nesting place. This condition was noticed when the time was ripe for the turtles to lay eggs.

Nuitja (1992) reported that a range of carapace length of adult female of hawksbill turtle in Indonesia was between 75 – 85 cm. The carapace length (SCL) in the present study (69.9 to 82.8 cm) was comparable to the above observation. Meanwhile the carapace length with CCL ranged from 70.9 – 89.0 cm.

The Kimar Island experiences west moonson to transition period generally from December to May. In fact, this period coincides with the nesting season of hawksbill turtle in and around Kimar Island as noted in some nesting locations between December and June (Wiadnyana, 2003). Information obtained from people in the field also indicates that the nesting season of hawksbill turtle occurs during January to May with a peak between February and March. The change of season in June resulted in termination of nesting season of hawksbill in Kimar Island. Meanwhile other species came up to Kimar Island beaches like three green turtle individuals which nested in the sames beaches of Kimar Island.

The nesting activity of hawksbill seems to have started from the west coast of Kimar Island. This phenomenon could be related to the water condition that was relatively calm during this period. In the west coast of Kimar Island, the weather was quite comfortable in March, and during April and May the water conditon in and around east coast and north coast seems to be better and tolerable for hawksbill turtle to land to the beach. This phenomenon might indicate that sea turtle needs a calm water condition to reach a beach for nesting, besides the favorable beach condition such as beach slope, sand temperature, sand texture, and beach vegetation (Nuitja, 1992; Miller, 1997).

CONCLUSIONS

The current work on hawksbill turtle in Kimar Island, Bitung District concludes that:

1. Kimar Island consitutes a natural nesting habitat for hawsbill turtle which nested in the period from March to May 2007 coinciding to the west monsoon to transition period.
2. Nesting process of hawksbill turtle consisted of six phases, that are: (a) emerging and searching an approriate nesting place; (b) digging for body pit and eggs pit; (c) laying: (d) filling the nest; (e) filling body pit and concealing nest site and (f) returning to the sea.
3. The total number of sea turtle landed in the beach was about 146 individuals, 95 % of them nested, 5 % of the total individuals made a false crawl. This may be due to some barriers and some movement and lighting during observation which might have forced the turtle moved forward to search an appropriate nesting location.

Based on results obtained in the current work, it is suggested that the natural and ideal nesting beach of Kimar Island for hawksbill turtle has to be taken care of by the authorities to protect and conserve the sea turtle population nesting in the area. An important step that has to be taken care of, is to clean the beach from all kinds of debris, such as plastic bottles, cans, trunks, etc.

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REFERENCES

Bustard, R.H. 1972. Natural history and conservation. New York, Taplinger Publishing Company.

Fitriyanto, A. 2007 (In Indonesian). A study on behaviour of hawksbill turle (*Eretmochelys imbricata)* nesting and its conservation effort in Kimar Island, Belitung District. A thesis of Fisheries College, Jakarta.

Nuitja, I.N. 1992 (In Indonesian). Biology and ecology sea turtle conservation. IPB Bogor.

Miller, J. D. 1997. Reproduction in sea turtles. *In*: P.L. Lutz & J.A. Musick (Eds.) *The Biology of Sea Turtles*. CRC Press. p. 51 – 81.

Halim, M.H and A. Dermawan. 1999. Marine turtle research, management and conservation in Indonesia. In: Report of SEAFDEC-ASEAN Regional Workshop on Sea Turtle Conservation and Management. Kuala Trengganu, Malaysia. 328 pp.

Rebel, T. 1974. Sea Turtles: and the Turtle Industry of West Indies, Florida, and
The Gulf of Mexi*co.* University of Miami. Florida.

Sastrosudirdjo, S.S. 1984 (in Indonesian). Mathematic for scondary high school. Ministry of Education and Culture. Jakarta.

Soehartono, T. 1993. Marine turtle conservation in Indonesia. In: Proceedings of the First ASEAN Symposium Workshop on Marine Turtle Conservation. Manila, Philippines. p. 75 – 85.

USDA (United States Department of Agriculture). 1973. Land Capability Classification. USDA-SES. 21 pp.

Wiadnyana, N.N. 2003. Study on population and distribution of two common sea turtles, green turtle and hawksbill turtle in Indonesia. In: N. Arai (Ed.) *Proceeding on the 4th SEASTAR2000 Workshop*, Bangkok – Thailand. p. 44 – 46.

WWF – Bio Regional Wallacea. 1998. Sea Turtles: introduction. WWF, Bali.

Yusuf , A. 2000 (in Indonesian). About Sea Turtle. Alam Lestari Foundation. Jakarta.