Distribution and nesting habitat of green sea turtles (*Chelonia mydas*) in Pangumbahan Turtle Conservation Area, Sukabumi, Indonesia

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Abstract. The shifting of natural beaches from nesting habitat of green sea turtles (*Chelonia mydas*) into commercial land in the public interest is one of the causes of reduced population, limited nest distribution, and limited habitat for *C. mydas* nesting in Indonesia each year. This study aims to analyze the distribution and nesting habitat of *C. mydas* in the Pangumbahan Turtle Conservation Area, Sukabumi, Indonesia. This research employed direct observations in the nesting area and the purposive sampling method. There are 6 stations in the Pangumbahan coastal area that serve as nesting points for green sea turtles. Nesting habitat for *C. mydas* in Pangumbahan is characterized by a wide, sloping beach, far from settlements. *C. mydas* in Pangumbahan choose locations with vegetal coverage and shade, with vegetation such as: *Calophyllum inophyllum* (nyamplung), *Pandanus tectorius* (pandan), *Terminalia catappa* (ketapang), *Kyllinga brevifolia* (jukut), *Ipomoea pres-caprae* (katang-katang). Environmental conditions include wind speed of 2 knots, surface temperature and temperature inside the hive at 27°C, low light intensity, medium-textured sand grains (0.38 mm on average) and metal elements in sand content.
Key Words: distribution, green sea turtle, Pangumbahan, type of nesting habitat.

Introduction. The green sea turtle (*Chelonia mydas*) lives in the Pacific, Atlantic and Indian Oceans. There are six species of sea turtles that live in Indonesian waters, including green sea turtles, hawksbill sea turtles (*Eretmochelys imbricata*), kelp sea turtles (*Lepidochelys olivacea*), flatback sea turtles (*Natator depressus*), loggerhead sea turtles (*Caretta caretta*) and starfruit sea turtles (*Dermochelys coriacea*) (Lutzs et al 2003; Pradana et al 2013). *C. mydas* have a very wide distribution in Indonesia, including on the coast of Java Island, on Sukamande Beach, Pangumbahan Beach, Seribu Island Beach, and Pangandaran Beach.

When spawning, adult *C. mydas* lay eggs on sandy coastal land. Pangumbahan Turtle Beach Coastal Park is one of the favorite habitats of *C. mydas* for laying eggs (Rismawati et al 2021). According to Limpus (1996), *C. mydas* may lay up to 200 eggs in one night at Pantai Pangumbahan. From 1996 to 2016, reproducing *C. mydas* decreased by 98%, reaching only reach 2-5 *C. mydas* in one night (Wicaksono 2014). The decrease in Pangumbahan is caused by excessive use of turtles, which are associated with illegal over-harvesting of carapace, meat and eggs each year (Gifari et al 2018; Nurhayati et al 2020).

According to Nuitja (1992), the destruction of *C. mydas* habitat for spawning and shelter in Indonesia is a major factor inhibiting the development of *C. mydas* populations. The conversion of natural coastal land used by turtles into commercial land for the public interest is one of the main causes of reducing the habitat of *C. mydas* each year (Chen et al 2007). Generally, the preservation of coastal habitats and natural ecosystems in the Indonesian archipelago is key in maintaining *C. mydas* populations. Thus, information is needed regarding the habitat type of *C. mydas* spawning in Pangumbahan and other Indonesian coastlines.

This study aimed to analyse the distribution of *C. mydas* and its habitat types in the Turtle Conservation Coastal Region Pangumbahan, Sukabumi, Indonesia. The information obtained can be a reference for central and local governments in making decisions related to the management of these beaches, of the Turtle Conservation Region in particular, and of various other turtle conservation areas throughout Indonesia.

Material and Method

Description of the study site. This study was conducted in the Turtle Conservation Coastal Pangumbahan, Sukabumi, West Java, Indonesia. Pangumbahan Turtle Beach Conservation Area, West SukabumiJawa is geographically located at 106°19'37"-106°20'07"S, 07°19'08"-07°20'52"E. The Pangumbahan Sea Turtle Conservation Area has 115 ha with a total beach length of 2300 m, and a sea area of 1656 ha. The Pangumbahan Beach area is divided into 6 stations/observation posts, with the average distance between each observation station of 400 m (Figure 1). Females of *C. mydas* who were conducting nesting activities, distribution of nesting nests and *C. mydas* nesting habitat types were observed. Analyses of metal content and texture of sand grains in sand samples were carried out at the Laboratory of Isotope and Radiation Application Centers – BATAN.

Figure 1. Location of the coast in the area of turtle conservation in Pangumbahan Sukabumi, West Java, Indonesia in 106°19'37"-106°20'07"S, 07°19'08"- 07°20’52"E (source: maps.google.com).

To determine the distribution of *C. mydas* nests, every observation station was divided into several zones: the open supratidal zone (>10 m) into the beach forest limit, the open supratidal zone close to the conservation are (0–10 m) into the beach forest limit, the under conservation supratidal zone (0 m), and the intertidal zone (<10 m) (Figure 2) (Herdiawan 2003).

Habitat type. Nest data collection was carried out from 1 to 10 April 2017 by recording the number of *C. mydas* that landed and the number of *C. mydas* that made nests and laid eggs in each observation station. Measurement of weather conditions, direction of sea breeze and moonlight were determined every 1 hour after *C. mydas* began to lay the eggs. Observations were carried out at night, from 8 PM to 4 AM. Measurements of light intensity, surface temperature and base of the nest were carried out shortly after the mother turtle had finished the nesting process around the station. Measurements were conducted on every nest of *C. mydas* every night. 3 nests with the highest scores at each station were selected for re-measuring.

After the egg laying process of the female *C. mydas* was complete, area marking was carried out around the nest with a camera and several stakes with marking ribbons.

In order to not disrupt the egg laying process at night, vegetation structure identification took place in the mornings and late afternoons. In addition to avoiding disturbance of the egg laying process, vegetation listing was also more efficient, easy, and accurate. Vegetation data collection was done using the grid plotting method, on 10x10 m plots, by applying the axis on the egg nest.

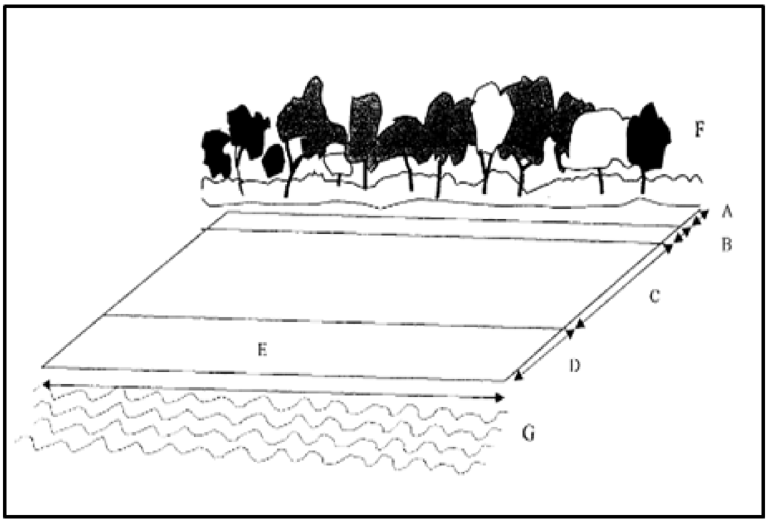

Figure 2. Observation stations on Pangumbahan beach (Herdiawan 2003); A - supratidal area in the shade; B - supratidal area near shade; C - supratidal open area; D - intertidal area; E - length (400 m); G - sea.

Data collection was performed at 18 nests logged in the previous phase. After line plotting was conducted, grid plotting was redone within the previous line plotting in 3 parts based on the type of vegetation, namely: trees in plot 1 (5x5 m) medium size plants in plot 2 (2.5x2.5 m), and small size plants in plot 3 (1.25x1.25 m). During the vegetation logging, plants with similar traits were counted.

Metal detection at the egg laying habitat. Sand samples were collected from 3 nests at each station using a metal flat spoon. The sand was placed into a 10 mL sterile sample tube. Each sample tube was labeled and placed in an ice sheet. The samples were transported to BATAN Lab using a cooling box. Metal identification was carried out using the X-Ray Fluorescence (XRF) method in the Center of Isotope and Radiation Application (PAIR), the National Agency of Nuclear Energy (BATAN), Jakarta, Indonesia.

Results and Discussion

Distribution of C. mydas nests. Observation results show that there were 26 *C. mydas* ashore Pangumbahan Conservation Beach from 1 to 10 April 2017. Of the 26 ashore green sea turtles, 25 females laid eggs and 1 did not. Figure 3 presents the distribution pattern of turtles laying eggs at each station.

Figure 3 illustrates that each station has a different number of nests. The most nests were at station 1 (7 nests) and at station 3 (6 nests). Station 6 had the lowest nest count of only 1. The difference in the number of nests at each station could be caused by the impact of different environmental factors at each station. Low nest numbers are suspected to occur because of rare vegetation, human activity, rocky areas, and low ocean waves at station 6.

The presence of turtles landing on the beach to lay eggs is influenced by several factors like open shore, sloping beach and wave strength. Beaches with abundant vegetation and without disturbances such as predatory activities, settlements, rocks and waste become the attraction of turtles (Yustina et al 2004; Damanhuri et al 2019). According to Nuitja (1992), green turtles choose to nest and lay eggs in sloping coastal areas, close to the shade of vegetation, with low light intensity.

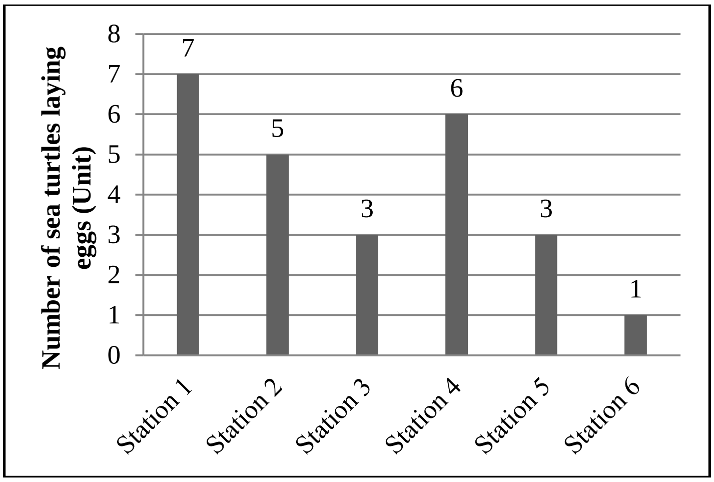

Figure 3. The number of turtle laying eggs at all stations.

Based on the results of the sand texture analysis, five of the stations in Pangumbahan Beach had the same sand texture, while station 6 had a rather coarse sand texture (Table 1).

Table 1

Size of sand grains on Pangumbahan Beach

Station	*Sand grain size (mm)*	*Number of nests*
1	0.27	7
2	0.35	5
3	0.28	6
4	0.41	3
5	0.47	3
6	0.50	1
Average	0.38	25

Sand at the turtle's egg laying habitat in Pangumbahan is textured, with the average sand size of 0.38 mm. From the size of sand grains from each stations, stations 1 to 5 can be categorized as having medium-sized sand with a maximum size of 0.47 mm at station 5. At station 6, sand is still of medium size, but it has a coarse texture and is mixed with gravel and broken shells. According to Fathin (2016), standard smooth coastal sand grain measurements range from 0.125 to 0.25 mm, medium grains range from 0.25 to 0.5 mm, and coarse sand grains range between 0.5 and 2 mm. Medium textured sand that varies in the study site is formed from large particles found at the Pangumbahan Beach, transformed by strong waves. Medium sized sand at the beach habitat may be better for the turtle egg laying process. Sand with overly smooth texture could easily erode as the turtles dig their nest, while the overly coarse sand might cause the turtles to consume more energy as they are digging (Budiantoro et al 2019; Damanhuri et al 2019; Natih et al 2021). The largest size of sand grains was obtained at station 6 and is thought to be influenced by the characteristics of the beach, with large waves, directly adjacent to the mouth of the river and with a large stony and rocky area. According to Nybaken (1996), the size of sand grains on the beach is a measure of the wave function on the beach. Stronger and bigger waves produce rough sand particles and gravel. In addition, a beach with troughs and breakers will produce smaller waves and medium wave speeds, so that fine grains of sand are not filtered or moved by the waves (Damanhuri et al 2019; Yustina et al 2004).

Based on the analysis of the effect of vegetation shade on the distribution pattern of turtle nests in the six stations, out of 25 *C. mydas* nests found, 19 nests were located in the shade of vegetation. Figure 4 shows the distribution of *C. mydas* nests based on the highest tide distance to the coastal forest boundary.

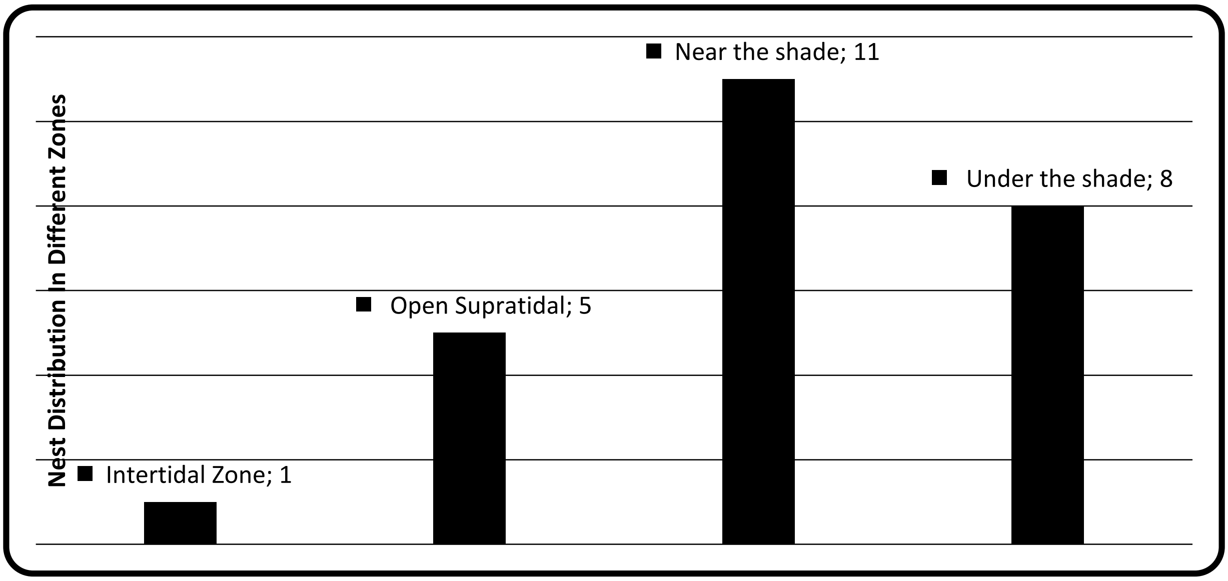

Figure 4. Distribution of *C. mydas* nests based on zoning.

In all six stations, *C. mydas* were interested in making the nest near or under the shade of vegetation. The shade of lush coastal vegetation such as *Calophyllum inophyllum* (nyamplung), *Pandanus tectorius* (pandan), and *Ipomoea pes-caprae* (katang-katang) serves as a shelter for the female *C. mydas* to lay eggs. In addition, the shade of vegetation functions as a barrier against direct sunlight radiation to the nest, so that the temperature and humidity in the nest remain stable. Stable temperature and humidity function to maintain metabolism and the development of eggs. Most sea turtles use areas in the shade of vegetation to nest, while other nests are in vegetation-free areas or in open and long stretches of sand with a gently slope, afar from settlements and agricultural land (Micheli-Campbell et al 2013; Budiantoro et al 2019; Staines et al 2019; Lestari et al 2021).

Turtle egg nests located farther from vegetation tend to have metabolism failure due to excessive light intensity. High temperature and light intensity will cause excessive water evaporation in the sand, rendering it dry. The nesting habitat characteristics of *C. mydas* vary. Nesting beach slopes ranged from 2.75 to 4.6º, with medium sand sediment texture to coarse sand. Temperatures ranged between 27 and 31ºC (Budiantoro et al 2019; Siahaan et al 2020). Overly dry sand substrate can cause the evaporation of liquid from the egg, resulting in the demise of the embryo (Laloe et al 2016; Santos et al 2017). Excessive water levels can trigger growth of bacteria and fungi inside the nest. Bacteria and fungi will grow and cover the pores of the egg shell, which will then disrupt the egg's respiration process, obstructing the egg's growth rate (Rosado-Rodriguez & Maldonado-Ramirez 2016; Gifari et al 2018; Miguel et al 2022).

Egg laying habitat type for C. mydas. The results showed that *C. mydas* on Pangumbahan Beach prefer sandy beach areas (2.5 km) directly in contact with coastal forest vegetation and far from settlements. The habitat for spawning *C. mydas* in Pangumbahan has a gentle slope (30^{o}) and ocean waves of 0.35 m per station. The texture of the nest sand shows that the turtle nesting habitat types have a medium-sized sand texture. However, based on the results of the field research, there are several differences in habitat types for spawning *C. mydas* at each Pangumbahan Beach station (Table 2).

Table 2

Differences in habitat types for *C. mydas* nests

Station	*Vegetation*		*Disorders/ Obstacles*
	Σ Species	*Σ Individual*	
Station 1	8	182	ND/NO
Station 2	7	147	ND/NO
Station 3	6	79	ND/NO
Station 4	6	97	ND/NO
Station 5	6	94	ND/NO
Station 6	1	7	rocks/river estuary

Note: ND - no disorders; NO - no obstacles.

The most species and most abundant vegetation were found in nesting habitats at stations 1 and 2, while the lowest numbers were found at station 6. The large number of species encountered at stations 1 and 2 was thought to be caused by the small width of the beach and coastal forest. Station 6 has rocks and is near a river estuary, so that only certain vegetation can survive in the station area.

The structure and vegetation composition found in Pangumbahan, in the nesting habitats from the selected stations consists of a population of tree-type vegetation, with *Calophyllum inophyllum*, *Pandanus tectorius*, *Terminalia catappa*, and shrubs *Kyllinga brevifolia*, *Ipomoea pes-caprae* (Figure 5). Morphologically, *C. inophyllum*, *P. tectorius*, and *T. catappa* have a large leaf diameter, useful for shade. Shade functions to reduce excessive radiation on turtle eggs by sunlight.

Figure 5. *C. mydas* laying eggs near *Calophyllum inophyllum*.

Other vegetation found in Pangumbahan beach include *Scaevola taccada*, *Hibiscus tiliaceus*, *Crinum asiaticum* and *Spinifex littoreus*. Sea turtles have different interests in vegetation. *C. mydas* nesting beaches are generally dominated by *Pandanus tectorius* species (Nurhayati et al 2020). Vegetation provides protection for turtle nests from predators, being an important variable for the survival of hatchlings (Turkozan et al 2011).

The spikes/thorns from the *P. tectorius* also function to protect the turtle's nest from predatorily attacks (Sepawan 2017). The high density of bush vegetation near turtle's nests functions as camouflage to deceive predators. The leaf morphology with hard and spiky texture of *Spinifex* also helps turtles to avoid predators (Sepawan 2017). The herb and bush species grow in the sand area, not covered by trees, due to their need for more light for growth (Sepawan 2017). The dominant vegetation in the nesting habitat of *C. mydas* in Pandan Island of West Sumatera is *Pandanus tectorius* (Siahaan et al 2020).

Pangumbahan Beach has a sloping stretch of fine white sand beach with a length of 2.5 km. From field observations of the turtle nesting habitats in Pangumbahan Beach, it can be said that stations 1 to 5 have the same physical condition and are suitable for turtle spawning. Those stations were different from station 6, which has a slightly different vegetation and sand texture (Table 3).

Table 3

Environmental physical conditions

Station	*Wind velocity* $m\ s^{-1}$	*Light intensity* (CD)	*Outside nest temperature* (ºC)	*Temperature in nest* (ºC)
1	1.16	0	25.7	27
2	1.16	0	24.1	26.1
3	1.13	0	25.8	26.4
4	1.11	0	26.7	27.1
5	1.15	0	26.2	26.9
6	1.08	0	27	27.3

The egg laying habitat of *C. mydas* turtles in Pangumbahan has stable wind speed, of 1.08 to 1.16 m s^{-1} in each station (Table 3). Sea breeze in April moves at a stable rate from the northeast towards the northwest at a speed of 1.03 m s^{-1} from 08:00 PM to 04:00 AM local time. In April, the weather in Ujung Genteng area had a medium rainfall rate with a soft breeze from the northeast accompanied by clouds (id.meteotrend.com). According to a local official, the wind speed from 1.03 to 1.28 m s^{-1} is suitable for the *C. mydas* to land ashore and lay eggs. The maximum sea breeze speed for turtles is between 1.54 and 2.05 m s^{-1}. Higher sea breeze speed can cause *C. mydas* to spend more energy. The texture of the Pangumbahan Beach sand, easily carried by the wind, becomes the main factor in obstructing the turtle's process of digging their nest, as a higher wind speed will blow the sand and cover the nest.

Light intensity at the egg laying habitat of *C. mydas* was 0 every night. The cloudy weather that lasted for entire nights became the main factor in covering the intensity of moonlight. According to Nuitja (1992), *C. mydas* that prepare to lay eggs posses the natural instinct to avoid areas with high light intensity in order to prevent predators. Therefore, the lower light intensity provides a higher probability for *C. mydas* to lay eggs.

The nest internal and surface temperature was stable and it had proper average values for turtle embryo growth, ranging between 25 and 27ºC. After the egg laying process was done, the temperature of the nest surface tended to be lower compared to the internal temperature. The surface of the sand exposed to solar radiation can increase the temperature of the nest (Booth & Freeman 2006; Laloe et al 2016; Santos et al 2017). The nest temperature suitable for hatching of turtle eggs is 25–33ºC. A suitable temperature for the development of turtle egg embryos is between 24-33ºC (Natih et al 2021).

Identification of metal elements. The results of the identification showed that there were 59 metal elements detected in the nest sand of *C. mydas* on Pangumbahan Beach. Among them are metal elements often found at sandy beaches, such as Al, Sb, Cd, Co, Cu, Fe, Mn, Hg, Se, Ag, Pb, and Cr (Table 4). The stations selected at Pangumbahan Beach had similar metal contents.

The metal content detected in the nest sand is thought to have an influence on the health of the parent turtle when in excess. According to Primasatya et al (2013), the metal content found at the egg laying nest of *C. mydas* in Pangumbahan derived from coal pollution, due to the location of the beach, adjacent to the coal barge transport line. This is also in accord with the research of Zheng et al (2007). The waste often carried by the waves and drifting ashore at the beach can also result in heavy metal contamination. The waste of electronics, plastics and others may cause serious heavy metal pollution to the environment, especially with Cd, Hg, Pb, Cu, Zn, Ni, Ba, and Sb (Widowati et al 2008; Tchounwou et al 2012; Elfidasari et al 2020). Ca, Hg, and Pb have been documented in eggs and hatchlings of sea turtle in concentrations known to cause toxic effects (Tapilatu et al 2020).

Table 4

Metals in sand at the nesting stations

Metal	*Unit*	*Station 1*	*Station 2*	*Station 3*	*Station 4*	*Station 5*	*Station 6*
Al	μg g^{-1}	3.402	2.275	2.421	2.393	2.55	2.445
Fe	μg g^{-1}	2.081	3.358	2.579	2.989	2.058	1.966
Se	μg g^{-1}	<0.5	<0.5	<0.5	0.4	0.8	0.8
Sb	μg g^{-1}	5.8	<1.9	1.7	<1.9	1	<1.9
Ag	μg g^{-1}	103.9	1.7	<0.5	14.6	7.9	<0.5
Pb	μg g^{-1}	21.5	18	24.1	15.5	18.9	16
Cd	μg g^{-1}	<0.3	<0.3	<0.3	0.5	<1.1	<0.3

Conclusions. Nest nesting habitat of *C. mydas* in Pangandaran is characterized by a wide, sloping beach, far from settlements. *C. mydas* in Pangumbahan choose to lay eggs near or under the shade of coastal vegetation such as *Calophyllum inophyllum*, *Pandanus tectorius*, *Terminalia catappa*, *Kyllinga brevifolia*, *Ipomoea pes-caprae*. The environmental conditions are represented by a wind speed of 1.02 m s^{-1} a surface and nest temperature of 27°C, very low light intensity and medium-textured sand grains (0.38 mm) with metal elements.

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Conflict of Interest. The authors declare that there is no conflict of interest.

References

Booth D. T., Freeman C., 2006 Sand and nest temperatures and an estimate of hatchling sex ratio from the Heron Island green turtle (*Chelonia mydas*) rookery, Southern Great Barries Reef. Coral Reefs 25:629-633.

Budiantoro A., Retnaningdyah C., Hakim L., Leksono A. L., 2019 Characteristics of olive ridley sea turtles (*Lepidochelys olivacea*) nesting beaches and hatcheries in Bantul, Yogyakarta, Indonesia. Biodiversitas 20(11):3119-3125.

Chen H., Cheng I., Hong E., 2007 The influence of the beach environment on the digging success and nest site distribution of the green turtle, *Chelonia mydas*, on Wan-an Island, Penhu Archipelago, Taiwan. Journal of Coastal Research 13(5):1277-1286.

Damanhuri H., Dahelmi D., Syandri H., Bengen D. G., 2019 Biophysical characteristics on nesting habitat of green turtle *Chelonia mydas* in the coastal zone of Kasiak, Bindalang and Karabak Ketek Island of West Sumatra, Indonesia. International Journal of Agricultural Science 3(2):44-49.

Elfidasari D., Ismi L. N., Sugoro I., 2020 Heavy metal concentration in water, sediment, and *Pterigoplichthys pardalis* in the Ciliwung River, Indonesia. AACL Bioflux 13(3):1764-1778.

Fathin I. N., 2016 [Analysis of land suitability for the nesting habitat of the olive ridley turtle (*Lepidochelys olivacea*) in Park Pelangi Beach, Bantul]. Universitas Muhammadiyah, Surakarta, Indonesia, 13 p. [In Indonesian].

Gifari T., Elfidasari D., Sugoro I., 2018 The effect of contaminant microorganism towards *Chelonia mydas* eggs hatchery results in Pangumbahan Green Sea Turtles Conservation, Sukabumi, Indonesia. Biodiversitas 19(4):1207-1212.
Herdiawan I., 2003 [Habitat analysis of green sea turtle (*Chelonia mydas* L) at Pangumbahan Beach, Sukabumi Regency]. Institut Pertanian Bogor, Bogor, Indonesia. 46 p. [In Indonesian].
Laloe J., Esteban N., Berkel J., Hays G. C., 2016 Sand temperatures for nesting sea turtles in the Caribbean: Implications for hatchling sex ratios in the face of climate change. Journal of Experimental Marine Biology and Ecology 474:92-99.
Lestari R. F., Kamal M., Wicaksono P., 2021 Analysis of the distribution of sea turtle nesting grounds based on physical characteristics along the coast of Kretek District, Bantul Regency, Yogyakarta, Indonesia. Ecology, Environment and Conservation 27(1):472-480.
Limpus C. J., 1996 Marine turtle populations of Southeast Asia and the Western Pacific region: Distribution and status. Workshop Proceeding Marine Turtle Research and Management in Indonesia, Wetland International, Indonesia Program, pp.37-72.
Lutz P. L., Musick J. A., Wyneken J., 2003 The biology of sea turtles. Volume II. CRC Press, 472 p.
Micheli-Champbell M. A., Baumgarti T., Booth D. T., Campbell H. A., Connell M., Franklin C. E., 2013 Selectivity and repeated use of nesting sites in a freshwater turtle. Herpetologica 69(4):383-396.
Miguel R. A. M. S., Anastacio R., Pereira M. J., 2022 Sea turtle nesting: What is know and what are the challenges under a changing slimate scenario. Open Journal of Ecology 12(1):1-35.
Natih N. M. N., Pasaribu R. A., Al Hakim M. A. G., Budi P. S., Tasirileleu G. F., 2021 Plive ridley (*Lepidochelys olivacea*) laying eggs habitat mapping in Penimbangan Beach, Bali Island. IOP Conference Series: Earth and Environmental Science 944:012038.
Nuitja I. N. S., 1992 [Biology and ecology of turtle conservation]. Institut Pertanian Bogor, Bogor, Indonesia, 128 p. [In Indonesian].
Nurhayati A., Nuruhwati I., Riyantini I., 2020 A bio-ecoregion development potentianl based on *Chelonia mydas* conservation in Pangumbahan Sukabumi, Indonesia. AACL Bioflux 13(1):318-329.
Nybaken J. W., 1996 Marine biology: an ecological approach. Harper Collins College, New York, 579 p.
Pradana F. A., Said S., Siahaan S., 2013 [Habitat of spawning green turtle (*Chelonia mydas*) in the Amusement Park River Twists District Sambas, West Kalimantan]. Jurnal Hutan Lestari 1(2):156-163. [In Indonesian].
Primasatya E., Elfidasari D., Sugoro I., 2013 [Heavy metal content identification in green sea turtles nest sand (*Chelonia mydas*)]. Proceeding Seminar Nasional Matematika, Sains dan Teknologi 4:143-150. [In Indonesian].
Rismawati R., Hernawati D., Chaidir D. M., 2021 [Suitability of egg-laying habitat and its relationship with the number of green turtles (*Chelonia mydas*) that landed on Pangumbahan Beach Sukabumi]. Jurnal Biologi Tropis 21(3):681-690. [In Indonesian].
Rosado-Rodriguez G., Maldonado-Ramirez S. L., 2016 Mycelial fungal diversity associated with the Leatherback sea turtle (*Dermochelys coriacea*) nests from Western Puerto Rico. Chelonian Conservation and Biology 15(2):265-272.
Santos K. C., Livesey M., Fish M., Lorences A. C., 2017 Climate change implications for the nest site selection process and subsequent hatching success of a green turtle population. Mitigation and Adaptation Strategies for Global Change 22:121-135.
Sepawan M., 2017 [The influence of the structure and composition of coastal vegetation on the landing of turtles (*Chelonia*) in Pekon Muara Tembuluh Village Ngambur District, Pesisir Barat Regency]. Universitas Islam Negri Raden Intan, Skripsi, Lampung, Indonesia, 96 p. [In Indonesian].
Siahaan V. O., Thamrin, Tanjung A., 2020 [Habitat characteristics nesting environment of green turtle (*Chelonia mydas*) Pandan Island of West Sumatera]. Journal of Coastal and Ocean Sciences 1(1):1-6. [In Indonesian].

Staines M. N., Booth D. T., Limpus C. J., 2019 Microclimatic effects on the incubation success, hatchling morphology and locomotor performance of marine turtles. Acta Oecologica 97:49-56.
Tapilatu R. F., Wona H., Siburian R. H. S., Saleda S. T., 2020 Heavy metals contaminants in the eggs and temperatures of nesting beaches of sea turtles in Kaimana, West Papua, Indonesia. Biodiversitas 21(10):4582-4590.
Tchounwou P. B., Yedjou C. G., Patlolla A. K., Sutton D. J., 2012 Heavy metal toxicity and the environment. Molecular, Clinical and Environmental Toxicology 101:133-164.
Turkozan O., Yamamoto K., Yilmaz C., 2011 Nest site preference and hatching success of green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) sea turtles at Akyatan Beach, Turkey. Chelonian Conservation and Biology 10(2):270-275.
Wicaksono M. A., 2014 [Microorganism analysis of green sea turtle eggs (*Chelonia mydas*) Pangumbahan Turtle Beach Coastal Park, Sukabumi]. Skripsi, Universitas Al-Azhar Indonesia, Jakarta, 42 p. [In Indonesian].
Widowati W., Sastiono A., Jusuf R., 2008 [Metal toxic effects]. CV Andi Offset, Yogyakarta, Indonesia, 412 p. [In Indonesian].
Yustina, Sewondo, Arnentis H., Yuspen, 2004 [Distribution analysis of green sea turtle *Chelonia* nests at Jemur Island, Riau]. Biogenesis 1(1):31-36. [In Indonesian].
Zheng G., Kuno A., Mahdi T. A., Evans D. J., Miyahara M., Takahashi Y., Matsuo M., Shimizu H., 2007 Iron speciation and mineral characterization of contaminated sediments by coal mining drainage in Neath Canal, South Wales, United Kingdom. Geochemical Journal 41:463-474.
*** http://id.meteotrend.com/forecast/id/Sukabumi
*** https://www.google.com/maps

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