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

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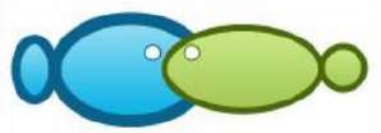

Distribution and type of nesting habitat for green sea turtles (*Chelonia mydas*) in Pangumbahan Turtle Conservation Area, Sukabumi, Indonesia

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Abstract. The shifting of the function of natural beaches as land for nesting habitat of green sea turtles *Chelonia mydas* into commercial land in the public interest, is one of the causes of reduced population, nest distribution, and 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. There are 6 stations in the Pangumbahan coastal area that serve as a distribution point for nesting green sea turtle nesting. Nest nesting habitat for *C. mydas* in Pangumbahan has a habitat type in the form of a wide beach with sloping beach slopes and far from settlements. *C. mydas* in Pangumbahan choose habitat types laying near or under the shade of coastal vegetation of the type of trees and shrubs in the form of *Calophyllum inophyllum* (nyamplung); *Pandanus tectorius* (pandan); *Terminalia catappa* (ketapang), *Kyllinga brevifolia* (jukut); *Ipomoea pres-caprae* (katang-katang), with environmental conditions wind speed of 2 knots, the surface temperature and the temperature inside the hive steady 27 °C and does not have the intensity of light and medium-textured sand grains 0.38mm and identified to contain metal elements in sand content.
Key Words: *Chelonia mydas, Pangumbahan, distribution, type of nesting habitat, green sea turtle*

Introduction. Green sea turtles, *Chelonia mydas* is one of the reptile animals that have carapace and live in the vast sea in the Pacifik Ocean, Atlantic Ocean and Indian Ocean. There are 6 (six) species of sea turtles that live in Indonesian waters including green sea turtles (*Chelonia mydas*), hawksbill sea turtles (*Eretmochelys imbricata*), kelp sea turtles (*Lapidochelys olivacea*), flatback sea turtles (*Natator depressus*), loggerhead sea turtles (*Caretta caretta*) and starfruit sea turtles (*Dermochelys coriacea*) (Lutzs et al., 2003; Pradana 2007). According to Nuitja (1996), *C. mydas* have a very wide spread in Indonesia, including on the coast of Java Island starting from Sukamande Beach, Pangumbahan Beach, Seribu Island Beach, and Pangandaran Beach.

During the laying eggs phase, adult *C. mydas* spend their time laying eggs on sandy coastal land. Pangumbahan Turtle Beach Coastal Park is one of the favorite habitats for *C. mydas* to lay their eggs (Rismawati et al 2021). According to Limpus (1996) at Pantai Pangumbahan, *C. mydas* laying eggs reached 100-200 in one night. Since 1996 to 2016 the *C. mydas* that lay their eggs have decreased by 98% or only reach 2-5 *C. mydas* in one night (Wicaksono 2014). Reduced *C. mydas* laying eggs in Pangumbahan are caused by excessive use of turtles, which are associated with illegal over-harvesting of carapace, meat and eggs each year.

According to Nuitja (1992) the destruction of *C. mydas* habitat to lay eggs, breed, and shelter (coastal and coral forests) in Indonesia is a major factor in inhibiting the development of *C. mydas* populations. The conversion of natural coastal functions as land

to distribution nest and lay eggs into commercial land for the public interest, is one of the main causes in reducing the habitat of *C. mydas* each year. Generally, the preservation of coastal habitats and natural ecosystems in the Indonesian archipelago is key in maintaining *C. mydas* populations, so information is needed regarding the habitat type of *C. mydas* laying eggs in its preservation in Pangumbahan Conservation and other Indonesian coastlines.

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

Material and Method

Description of the study sites. This study was conducted on the Turtle Conservation Coastal Pangumbahan, Sukabumi, West Java, Indonesia. The Pangumbahan Beach area is divided into 6 stations/observation posts, with the average distance at each observation station 400 m (Figure 1). The object of this research is female *C. mydas* who are conducting nesting activities, distribution of nesting nests and *C. mydas* nesting habitat types. Analysis of metal content and texture of sand grains in sand samples was 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 106^0 19'37 "- 1060 20'07" S, 07^0 19'08 "- 07^0 2052" E (maps.google.com)

To determine distribution point of the *C. mydas*'s nest, every observation station is divided into several zones aligning with the ocean, which is the open supratidal zone (> 10 meters) into the beach forest limit, the open supratidal zone close to the conservation (0 – 10 meters) into the beach forest limit, the under conservation supratidal zone (0 meter), and the intertidal zone (< 10 meters) into the high water level (Figure 2) (Herdiawan 2003).

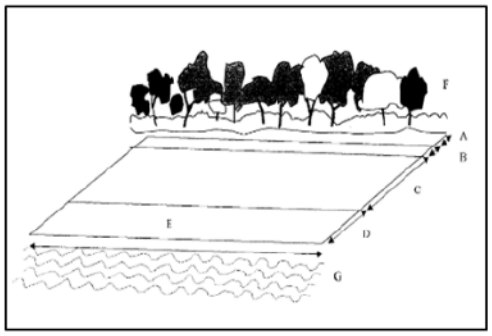

Figure 2. Observation station on Pangumbahan beach (Herdiawan 2003).

Information : A = Supratidal in the shade (0) meters
B = Supratidal near shade (0-10) meters
C = Supratidal is open (> 10) meters to the coastal forest boundary
D = Intertidal (<10) meters to HWL (High Water Level)
E = Length ± 400 meters
G = Sea

Habitat Type

Nest data collection is carried out every day by recording the number of *C. mydas* that land and the number of *C. mydas* that make nests lay eggs after each observation station. Measurement of weather conditions, direction of sea breeze and moonlight every 1 hour when *C. mydas* begin to lay down the egg laying process, observations are carried out at night from 8 pm to 4 am. Then the measurements of light intensity, surface temperature and base of the nest were carried out shortly after the mother turtle finished the nesting process and made nest eggs around the station / observation post.. Measurement is conducted to every nest of *C. mydas* that lays eggs every night, and 3 nests with the highest scores at each station are identified for re-measuring.

After the egg laying process of the female *C. mydas* is complete, area marking is done around the egg laying nest with a camera and several stakes with marking ribbons. In order to not disrupt the *C. mydas*'s egg laying process in the night, vegetation structure identification at the egg laying habitat takes place in the mornings and late afternoons. Besides providing no disturbance to the *C. mydas*'s egg laying process, vegetation listing will also be more efficient, easy, and accurate when performed during light. Vegetation data collecting is done using the grid plotting method with 10 x 10 m length width measurements by applying the axis on the egg nest.

Data collecting is performed at 18 nests those have been logged in the previous phase. After line plotting is done, grid plotting is redone within the previous line plotting as many as 3 parts based on the type of vegetation namely : data of trees at plot 1 (5cm x 2,5cm), data of medium sized plants at plot 2 (2,5cm x 2,5cm), and data of small sized plants at plot 3 (1,25cm x 1,25cm). During the vegetation type logging, the plants with similar traits are counted in and summed per individual plant. From results of measurement and identification, the values of; diversity, dominance, relative dominance, relative frequency, density, relative density and ENP (Significant Value Index), will be acquired.

Metal detection at the egg laying habitat

Sand samples were taken from 3 nesting turtles nesting at each station using a sudip, then sand was sufficiently inserted into a 10 ml sterile sample tube. After that, each sample tube was given an identification label and incubated in an ice sheet at 30°C. Then the sample was taken to BATAN Lab using cooling box. Metal identification, carried out using the X-Ray Fluorosence (XRF) method in the PAIR BATAN Lab.

RESULT AND DISCUSSION

Distribution of *C. mydas* Laying Nests

Pangumbahan Turtle Beach Conservation Area, West SukabumiJawa is geographically located at 106^0 19'37 "- 106^{0}20'07" LS, 07^0 19'08 "- 07^0 20'52" East. Pangumbahan Sea Turtle Conservation consists of a land area of 115 ha with a total beach length of 2,300m, and a sea area of 1,656 ha. Observation result shows that there were 26 of *C. mydas* which ashore at the Pangumbahan Conservation Beach around the dates 01 – 10 April 2017. Of the 26 ashore green sea turtles, it was found that 25 female of *C. mydas* laid eggs and 1 did not. The following is the diagram of distribution pattern for turtle laying eggs at each station :

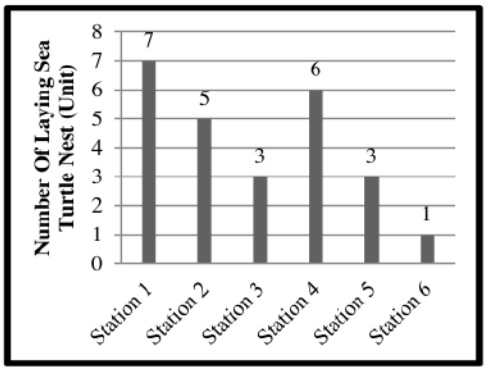

Figure 3. Graph of the number of turtle nesting eggs at all stations

The diagram above illustrates that the distribution of *C. mydas* egg laying nest at each station has different number of nests. The most *C. mydas* egg laying nest is found at station 1 for 7 counts and station 3 for 6 counts. Then respectfully at station 2 for 5 nests, station 4 and 5 each 3 nests, while station 6 had the least nest count of only 1. The difference in the number of nest distributions at each station is caused by the impact of different environmental influences and coastal characteristics at each station. Low population suspected of vegetation, rocks rock, as well as the low ocean waves at station 6, a factor that causes the *C. mydas* are not interested in land and building nests.

Table 1.

Size of sand grains on Pangumbahan Beach

Station	Sand Grain Size (mm)	Number of nests (Pieces)
1	0.27	7
2	0.35	5
3	0.28	6
4	0.41	3
5	0.47	3
6	0.50	1
Averange	0.38	25

According to Yustina (2004) The presence of turtles that land on the beach to make nesting eggs is influenced by several open, sloping and wave strength factors that help turtles to land easily on the beach. Characteristics of beaches that have a lot of vegetation and avoid various kinds of disturbances such as predatory activities, settlements, rock and garbage become the attraction of turtles who will lay eggs on a beach. According to Nuitja (1992) green turtles choose to nest and lay eggs in coastal areas the sloping, close to the shade of lush vegetation, and has no light intensity.

Based on the results of the sand texture analysis, it was shown that five of the y station plants in Pangumbahan Beach had the same sand texture, while station 6 had a rather coarse sand texture (Table 1).

Sand at the turtle's egg laying habitat in Pangumbahan is textured at medium with the average sand scale of 0.37 mm at every station. There is a correlation between the size of sand grains and the number of nests at each station, which shows that the more rough and large the size of the grain, the fewer *C. mydas* that are interested in landing and laying eggs on the beach. From the size of sand grains obtained in each nest which are from stations 1 to 5 can be categorized as medium-sized sand with a maximum size of 0.47 mm at station 5. At station 6 sand is still of medium size. however, it has a rather coarse texture and sand at station 6 mixed with gravel and broken shells.

According to Fathin (2016), standard of smooth coastal sand grain measurement ranges from 0.125 – 0.25 mm, medium grain ranges around 0.25 – 0.5 mm, while coarse sand grain ranges between 0.5 – 2 mm. Medium textured sand measurement that varies are formed from large particles found at the Pangumbahan Beach, impact from strong waves causes the sand particles to form into different scales. Medium sized sand at the beach habitat may provide ease or the turtles in their egg laying process, due to the fact that it is not too coarse nor too smooth. Sand with overly smooth texture could easily erode as the turtles dig their nest, while the overly coarse sand might cause the turtles to let out immense energy as they are digging.

The largest size of sand grains obtained at station 6 is thought to be influenced by the characteristics of the beach which has large waves and is directly adjacent to the mouth of the river and the high area of the rock. According to Nybakken (2004) the size of sand grains on the beach is a measure of the wave function on the beach. The bigger and stronger waves hit the beach, the sand particles will become rough and in the form of gravel. Besides the characteristics of the beach that has troughs and breakers will produce waves and medium wave speeds, so that fine grains of sand are not filtered by waves (Yustina 2004).

Based on the analysis of the effect of vegetation shade on the distribution pattern of turtle nesting nests in the six stations, it was shown that out of 25 *C. mydas* nests found 19 *C. mydas* nests were located in the shade of vegetation. The following is a graph of the distribution of *C. mydas* nesting nests based on the highest tide distance to the coastal forest boundary (Figure 4).

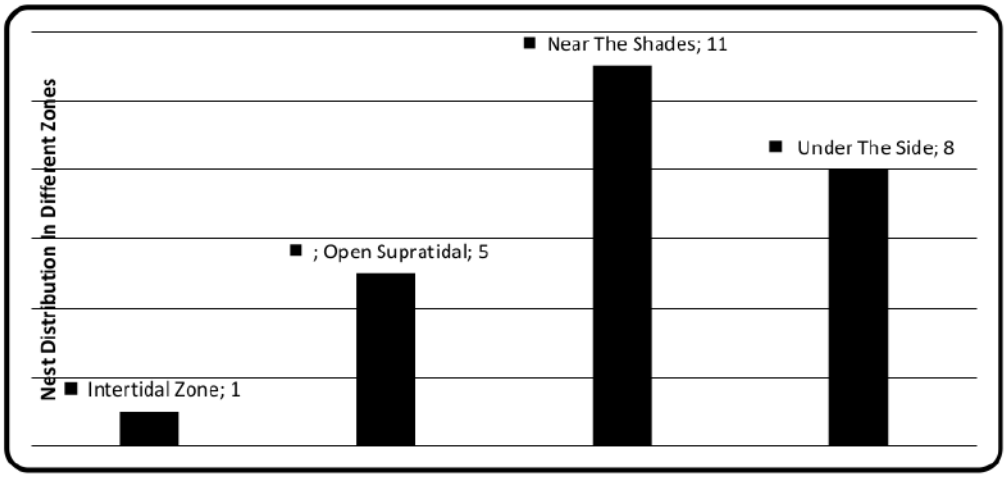

Figure 4. Graph of spreading nest of *C. mydas* nesting based on zoning

Of all nests found in the six stations, the average *C. mydas* that landed at each station was interested in making the nest lay near or under the shade of vegetation. The shade of

lush coastal vegetation such as *Calophyllum inophyllum* (nyamplung), *Pandanus tectorius* (pandan), and *Ipomoea pres-caprae* (katang-katang) serves as a shelter for the female of *C. mydas* to do the laying process. Besides the shade of vegetation also functions as a barrier to direct sunlight radiation to the nest egg, 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 an open and long stretch of sand with gently sloping ground and far distance to built-up and agricultural land (Lestari et al 2021)

Turtle egg nest located distant from vegetation tend to undergo more metabolism failure due to excessive light intensity. High temperature and light intensity will cause excessive water level evaporation to the sand, rendering the sand substrate to experience dryness. The nesting habitat characteristics of *C. mydas* vary between nest with each other. Nesting beach ramps ranged 2,75-4,60º with medium sand sediment texture to coarse sand. Temperatures nest ranging between 27-31ºC (Siahaan et al. 2020).

According to Mustika (1987) overly dry sand substrate causes the liquid substance from the egg to evaporate, thus resulting in demise of the embryo. Excessive water level also causes the increase of humidity, which may trigger growth of bacteria and fungus inside the nest. Bacteria and fungus will grow and cover pores of the egg shell which will then disrupt the egg's respiration process, obstructing the egg's growth rate (Solomon & Baird 1980).

Habitat Type *C. mydas* Egg-Laying

The results showed that *C. mydas* on Pangumbahan Beach have habitat types laying on sandy beach areas (2.5 km) that are directly in contact with coastal forest vegetation and far from settlements. The habitat for spawning *C. mydas* in Pangumbahan has a gentle slope (± 30º) and ocean waves that are currently ± 0.35 m per station. The results of the texture analysis of *C. mydas* nest sand show that their nesting habitat types have a medium-sized sand texture. However, based on the results of the research in the field, it shows that there are several differences in habitat types for spawning *C. mydas* at each Pangumbahan Beach laying station. The following is a table of differences in habitat for spawning *C. mydas* on Pangumbahan Beach:

Table 2.

Differences in habitat types for *C. mydas* eggs

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	Coral Rock/ River estuary

Description: ND: No Disorders.
NO: No Obstacles.

The most species and population of vegetation were found in nesting habitats at station

1 and station 2, while the smallest species and populations 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 from location of nesting eggs, so that it has a diverse diversity of populations and species. The type of beach station 6 which is directly in contact with rock and river estuary makes the land and physical condition of the coast to be extreme, so that only certain vegetation can only survive in the station area.

The structure and vegetation composition found in Pangumbahan *C. mydas* nesting habitat consists of a population of tree-type vegetation, *Calophyllum inophyllum*; *Pandanus tectorius*; *Terminalia catappa*, and shrubs *Kyllinga brevifolia*; *Ipomoea pres-caprae* (Figure 5). Morphologically the *Calophyllum inophyllum*, *Pandanus tectorius*, and *Terminalia catappa* plants have a wide and long diameter of leaf size which is useful as a shade that helps the process of the parent *C. mydas* to lay eggs. Shade in coastal plants function in reducing excessive radiation in turtle eggs by sunlight.

Types of vegetation found on the Pangumbahan beach include *Calophyllum inophyllum, Scaevola taccada, Hibiscus tiliaceus, Crinum asiaticum, Ipomea pes-caprae* and *Spinifex littoreus*. Sea turtles have different interests in vegetation. *C. mydas* nesting beaches are generally dominated by pandanus type of vegetation (Nurhayati et al., 2020). Vegetation provides protection of turtle nests from predators, being an important variable for the hatchlings survival (Turkozan et al 2011).

The spikes/thorns from the *Screwpine* also function to protect the turtle's nest from predatorily attacks (Sepawan 2017). The high density between bush vegetation individuals in between turtle's nests function as camouflage to deceive predators. The leaf morphology with hard and spiky texture on the *Spinifex* also helps the turtles in avoiding predators (Sepawan 2017). Population of the herbs and bush vegetation types grow in the sand area that is not covered by tree types due to their need for immense sunray for their growth (Sepawan 2017). The dominant vegetation in the *C. mydas* Pandan Island Of West Sumatera area is a nesting plant pandan laut (*Pandanus tectorius*) (Siahaan et al. 2020)

Physically Pangumbahan Beach has a physical environment in the form of a sloping stretch of fine white sand beach with a length of 2.5 km. From the results of physical analysis of nesting habitats in Pangumbahan Beach, it can be said that physically the six laying stations have the same physical condition and are suitable for spawning for turtles (Table 3).

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

The egg laying habitat of *C. mydas* turtles in Pangumbahan is accompanied with stable wind speed, no less than 2.1 knots and no more than 2.2 knots at each station. Sea breeze in April moves at a stable rate from the Northeast towards the Northwest at the speed of 4 km/hour or 2 knots from 08:00 PM to 04:00 AM local time. According to Meteo (2017) in April the weather in Ujung Genteng area has medium rainfall rate with soft breeze from the Northeast accompanied with conceiving clouds. According to the information result of interview with a local official, it was said that the wind speed of about 2,0knots to 2,5knots is the suitable wind speed for the *C. mydas* to land ashore and lay eggs. The maximum sea breeze rate for turtles to lay eggs is at 3-4 knots or 0.9 km/hour – 12 km/hour. Higher sea breeze speed rate relatively causes the *C. mydas* to let out more energy in the egg laying process. Texture of the Pangumbahan sand that is easily carried by the wind becomes the main factor in obstructing the turtle's process in digging their nest, as the higher the acquired wind speed the easier it is for the sand to cover the dug up turtle nests.

Light intensity at the egg laying habitat of the *C. mydas* is at 0 values for every night. The cloudy weather that lasted for the entire night becomes the main factor in covering the intensity of moonbeam at night. According to Nuitja (1992), *C. mydas* about to lay eggs posses the natural instinct to avoid areas with high light intensity in order to prevent predator monitors. Therefore, the lower light intensity provides the higher percentage of probability for *C. mydas* to perform egg laying process.

The egg laying habitat of *C. mydas* in Pangumbahan has stable and proper average value of nest internal and surface temperature for the turtle embryo growth, ranging between 25ºC to 27ºC. When temperature was taken a moment after egg laying process was done, the temperature of nest surface tend to be at a lower rate compared to the internal temperature. Egg laying habitat of *C. mydas* proves the comparison of low surface temperature against the inside of the nest. According to Holman (1995), sand surface exposed to UV.

Physical and biological factors consisting of beach width and slope sand texture and temperature, and vegetation at each landing station on Pangumbahan beach are still suitable as *C. mydas* nesting sites. The correlation analysis, the beach slope factor and the vegetation density factor have a very strong and significant relationship with the number of turtles that landed. As for the other factors have a fairly -strong relationship. Both of physical and biological factors from the beach, affect the number of green turtles that land, as evidenced by the relationship between the two variables (Rismawati et. al., 2021)

Tabel 3.

The measurement of environmental physical conditions

Station	Wind Velocity (Knot)	Light Intensity (CD)	Outside Temperature Nest (ºC)	Temperature In Nest (ºC)
1	2.27	0	25,7	27,0
2	2.27	0	24,1	26,1
3	2.20	0	25,8	26,4
4	2.17	0	26,7	27,1
5	2.23	0	26,2	26,9
6	2.10	0	27,0	27,3

Identification of Metal Elements

The results of the identification showed that there was a metal content detected in the nest sand of *C. mydas* laying on Pangumbahan Beach. As many as 59 metal elements

detected from the sand sample taken from the entire egg laying habitat of *C. mydas*, among them are metal element group which is often found at sandy beaches, those are Al, Sb, Cd, Co, Cu, Fe, Mn, Hg, Se, Ag, Pb, and Cr. There was no significant comparison between the detected metal content at each station, therefore the egg laying habitat at Pangumbahan Beach has similar metal element volume.

The metal content detected in nest sand laying *C. mydas* does not have a direct influence on the activity of *C. mydas* laying eggs, but is thought to have an influence on the health of the parent turtle if it has excessive metal content. According to Primasatya (2013), the metal element content found at the egg laying nest of *C. mydas* in Pangumbahan derived from coal pollution, due to Pangumbahan Beach's location that is adjacent to the coal barge transport line. This is also in accord to the research conducted by Zheng (2007) which elaborated that the metal concentration in sediments or sand derives from coal contamination. Besides deriving from coal, the waste that is often carried by the waves and drift ashore at the beach can also result in heavy metal content when reacted with the environment. The waste of electronics, plastics and others may cause serious heavy metal pollution to the environment. Such as the metal pollution of Cd, Hg, Pb, Cu, Zn, Ni, Ba, and Sb (Elfidasari et al 2020; Tchounwou et al 2012; Widowati et al 2008).-Cadmium, mercury, and lead have been documented in eggs and hatchlings of sea turtle in concentrations known to cause toxic effects in other vertebrates (Tapilatu et al 2020)

Table 4.

Data on the identification of metals in sand.

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

Conclusions.
Nest nesting habitat for *C. mydas* in Pangandaran has a habitat type in the form of a wide beach with sloping beach slopes and far from settlements. *C. mydas* in Pangumbahan choose habitat types laying near or under the shade of coastal vegetation of the type of trees and shrubs in the form of *Calophyllum inophyllum* (nyamplung); *Pandanus tectorius* (pandan); *Terminalia catappa* (ketapang), *Kyllinga brevifolia* (jukut); *Ipomoea pres-caprae* (katang-katang), with environmental conditions wind speed of 2 knots, the surface temperature and the temperature inside the hive steady 27 °C and does not have the intensity of light and medium-textured sand grains 0.38mm and identified to contain metal elements in sand content.

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