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Zonation of Nipah Beach Ecosystem in North Lombok District to Support Sea Turtle Conservation Efforts

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ABSTRACT

Nipah Beach is facing challenges of development, economic growth, and high community demand for land, which may negatively impact the sustainability of sea turtles. To mitigate this issue, the ecosystem of Nipah Beach must be appropriately zoned. The goal of beach ecosystem zonation is to allocate areas around the coast to the community and stakeholders based on the sensitivity of sea turtle habitats. This research aims to 1. Analyze the suitability of Nipah Beach in North Lombok Regency as a sea turtle habitat. 2. Design the zonation of the sea turtle conservation area in Nipah Beach, North Lombok Regency. The study uses an observation method, namely collecting data through direct inspection or careful inspection in the field or research location by dividing Nipah Beach into several observation stations. The results are analyzed using scoring techniques and spatial modeling, resulting in a map. Research results showthat the suitability level of NipahBeach as a sea turtle habitat ranges from 15-46 points, with station two having the highest score and station six having the lowest. Stations two and three, and part of station five are prioritized as protection zone areas, station four and part of station five and one as a captive zone area, and the rest as limited-use zones

INTRODUCTION

Nipah Beach, located in the Pemenang District of North Lombok Regency in West Nusa Tenggara Province, is part of the RinjaniUnesco Global Geoparks area. The RinjaniGeopark ecosystem, covering 2,800 km^2, is bordered by the Bali Sea to the north, the Lombok Strait to the west, the Alas Strait to the east, and the Ampenan-Selong axis road to the south (Nurhanifa, 2020). This region is abundant in biodiversity, one of which can be observed through the presence of sea turtles on the beach. Sea turtles are a type of wildlife from the reptile class living in the sea and coming to the beach to lay their eggs, making land habitats crucial for survival (Septiana*et al.,* 2019). Hence, protecting sea turtles is tied to preserving the integrity of their habitat, including the beach ecosystem.

The beach ecosystem is a type of forest ecosystem in Indonesia that grows on sandy and rocky dry soil, unaffected by climate and above the highest tide line (Tuheteru&Mahfudz, 2012). It serves as a nesting site for sea turtles, where the sand texture and the presence of coastal vegetation as protective plants play a supporting role (Parawangsa*et al.,* 2018; Akbar *et al.,* 2020). Studies have shown that dense sea turtle nests correlate with vegetation coverage ranging from 40.4-85.2% (Tuheteru&Mahfudz, 2012). Additionally, sea turtles lay their eggs at a distance ranging from 30 to 150 meters inland from the coast (Yamamoto *et al.,* 2012; Lizarraga&Mavil, 2013; Hitchins*et al.,* 2003).

Kurniawan*et al.,* (2015) stated that sea turtles choose to lay their eggs under the shade of vegetation due to the roots of the vegetation being able to bind the sand grains properly, preventing the nest from collapsing easily. Furthermore, the temperature and humidity under the shade of vegetation are relatively stable, protecting the eggs from direct sunlight. According to Pradana*et al.,* (2013), vegetation that provides shade for sea turtle egg nests includes spruce (*Casuarina equisetifolia*), sea almond (*Terminalia catappa*), mahang (*Macarangamappa*), teruntung (*Aegicerasfloridum*), waru (*Hibiscus tiliaceus*) and screwpine (*Pandanus tectorius*).

In current conditions, the NipahBeach ecosystem faces development, economic growth, and a high community need for land. Consequently, physical development on Nipah Beach is inevitable, and several buildings, such as restaurants and lodging, have reached the shoreline. This condition exists because Nipah Beach is one of the developing tourist destinations in West Nusa Tenggara Province. However, sea turtle's existence cannot be overlooked. The Minister of Forestry of the Republic of Indonesia has designated turtles as protected animals based on Ministerial Regulation Number 106/MenLHK/GeneralSecretariat /KUM.1/12/2018. According to the Directorate of Conservation and Marine National Park (2009), the current situation harms the preservation of sea turtles. The existence of physical buildings on the coast reduces the chances of turtles going to the beach and laying eggs. Moreover, human presence, lighting, and noise make turtles avoid laying eggs.

One solution to this problem is to establish zonation for beach ecosystems. Zonation is an effort to guide the community and other stakeholders regarding spatial allocation in utilizing the area around the beach based on the sensitivity of sea turtle habitats (Budiantoro, 2017) to balance development, economic growth, and conservation efforts.

Sound knowledge and understanding of sea turtle's habitat characteristics, patterns, habits, and behavior are essential for managing conservation areas (Mursalin*et al.,* 2017; Afandy, 2016). Therefore, the zonation in this study was determined based on the level of habitat suitability and the presence of these animals. This study aims to analyze the suitability of Nipah Beach as a sea turtle habitat. The analysis results are then categorized based on the sensitivity of the sea turtle habitat as a zonation determinant, with the final output presented in the form of a map. The map is divided into protection zones (most sensitive), captive zones, and limited-use zones (BMRRC UMRAH, 2009; Afandy, 2016).

The design of beach ecosystem zonation to support sea turtle conservation efforts was previously carried out in 2016 by Afandy and in 2017 by Budiantoro, both in the western part of Indonesia with different regional characteristics. However, no similar research has been conducted in West Nusa Tenggara Province and other eastern regions of Indonesia until now. This research is expected to become a model for sea turtle conservation management in West Nusa Tenggara

Province and other eastern regions of Indonesia, particularly in Nipah Beach. Rapid development activities and economic growth coupled with the existing problems make zonation design an urgent step that must be taken as early as possible to prevent the extinction of these protected animals.

The objectives of this study are: 1. Analyzing the suitability level of Nipah Beach in North Lombok Regency as a sea turtle habitat. 2. Designing beach ecosystem zonation to support sea turtle conservation efforts in Nipah Beach, North Lombok Regency. The benefit of this research is to provide recommendations on the direction of spatial utilization in Nipah Beach in the North Lombok Regency. This result will help ensure that future development activities, economic growth, and land use consider the existence of sea turtles and that preserving these animals is always maintained.

METHODS

This research was conducted between July and September 2022 in Nipah Beach in Pemenang District, North Lombok Regency, West Nusa Tenggara Province. The tools and materials used in this study included GPS, a camera, a thermometer, a hygrometer, a protractor, scales, a measuring tape, wooden sticks with a length of two meters, plastic samples, stationery, and Google Earth version 7.3.4.8248. The research object is the sea turtle habitat at Nipah Beach.

The condition of the sea turtle habitat ecosystem in this study was assessed using the observation method, namely data collection through direct inspection or careful inspection in the field or research location (Zamzami*et al.,* 2020) by dividing Nipah Beach into several observation stations. The distance between observation stations is 300 meters (Pane *et al.,* 2020; Rismawati*et al.,* 2021). In assessing habitat suitability, the parameters and aspects observed (modified from Afandy, 2016)are presented in Table 1.

Table 1. Parameters and Aspects of Measurement

No	Parameter	Aspect of Measurement	Method of Measurement	Source
1.	Beach Physics	1. Beach width	Beach width is measured using a roll meter from the highest tide point to the nearest forest vegetation.	Prakoso *et al.,*(2019)
		2. Beach slope	The beach slope was measured using a roll meter and a two-meter-long auxiliary stick placed parallel to the shoreline, and the angle formed between them was recorded. The measurements were taken at the top of the shoreline.	Mursalin *et al.,*(2017)
		3. Sand Size	The sand sample was taken as much as 25 grams and stored in plastic, then the sample was analyzed at the Soil Science Laboratory, Faculty of Agriculture, University of Mataram.	Herawaty& Mahmud (2019)
		4. Sand color	The sand sample was taken as much as 25 grams and stored in plastic, then the sample was analyzed at the Soil Science Laboratory, Faculty of Agriculture, University of Mataram.	Herawaty& Mahmud (2019)
2.	Beach Biotics	1. Presence of Sea Turtle	Collecting data through direct observation or careful observation in the field or research location.	Zamzami *et al.,*(2020)
		2. Predator	Collecting data through direct observation or careful observation in the field or research location.	Zamzami *et al.,* (2020)
		3. Vegetation cover	The observation along the research area was combined with image analysis from Google Earth Pro.	Afandy (2016)
3.	Environ-ment	1. Sand temperature	Measurement was conducted using a thermometer at a depth of 50 cm in the sand for 1 minute at 06:00, 12:00, and 18:00.	Septiana*et al.,* (2019); Pradana*et al.,* (2013)
		2. Sand humidity	Measurement was conducted using a hygrometer at a depth of 50 cm in the sand for 1 minute at 06:00, 12:00, and 18:00.	Septiana*et al.,* (2019); Pradana*et*

No	Parameter	Aspect of Measurement	Method of Measurement	Source
				al., (2013)

The level of suitability of beaches as sea turtle habitats were analyzed using a scoring technique (Table 2). Each parameter has a different influence, described through scoring and weighting (modified fromAfandy, 2016). The scores range from one to three, where three indicates a very suitable condition, two indicates a suitable condition, and one indicates a less suitable condition. The weights are obtained from expert discussions.

Table 2. Suitability Scoring of Sea Turtle Habitat

No	Aspects of Measurement	Weight (*)	Score			Source
			3	2	1	
1.	**Beach Physics**					
	1. Beach Width	2	21-30 m	10-20 m	<10 m and >30	Alfred *et al.,* (2020)
	2. Beach Slope	3	21-30°	10-20°	<10° and >30°	Alfred *et al.,* (2020)
	3. Sand Size	3	0-0.2 mm	0.21-0.35	>0.35	Alfred *et al.,* (2020)
	4. Sand Color	1	Black	Yellow	White	Parawangsa*et al.,* (2018)
2.	**Beach Biotics**					
	1. Sea Turtle Presence	3	Laying egg	Present but does not lay eggs	Not present	Harnino*et al.,* (2021)
	2. Predator	2	Not present	Natural predator	Natural predators and humans	Ario*et al.,* (2016)
	3. Vegetation	2	>70%	50-70%	<50%	Nuitja (1992), Witherington (1986)
3.	**Environmental Factors**					
	1. Sand Temperature	2	24-33°	22-24°	<22° and >33°	DCMNP (2009), Goin*et al.,* (1978)
	2. Sand Humidity	2	20-30%	10-<20%	<10 and >30%	Afandy (2016), McGehee (1990)

*Note: Determined by Expert Discussion

The zonation of beach ecosystems on maps was obtained through spatial modeling using overlay analysis and class methods. The spatial definition refers to the UMRAH Beach and Marine Resources Research Center (2009), as presented in Table 3.

Table 3. Spatial Definition of Area Zonation

No	Zone	Function	Definition
1.	Protection	Total protection of the sea turtle's natural habitat	40% representative area of sea turtle habitat that has the highest score
2.	Captive	Semi-natural breeding sites and sea turtle monitoring stations	30% representative area of a habitat sea turtle with a medium score
3.	Limited Utilization	Limites tourist area	30% representative area of a habitat sea turtle with the lowest score

RESULTS AND DISCUSSION

NipahBay has a total length of about 2,800 m, of which not all of this length is a coastal area, especially in the north and south which are always submerged in seawater. This bay has a coastal area of about 1,800 m. Nipah Beach is a tourist attraction that is currently developing, on weekends this area is crowded with tourists. On NipahBeach, there are facilities supporting tourism activities such as restaurants and lodging. To identify conditions and assess the characteristics of NipahBeach in supporting sea turtle nesting habitat, NipahBeach is divided into observation stations with a distance of 300 m (Pane *et al.,* 2020; Rismawati*et al.,* 2021) resulting in six observation stations in this study. A map of the research location and observation stations is presented in Figure 2.

Figure 2. Map of Research Location

Based on the results of observations, almost all stations have potential threats to sea turtle conservation, the most combination of threats is found at stations three and four with five factors, placing these two stations as areas with the most complex problems, while station six is an area that has no problems. Threat factors for sea turtle sustainability on NipahBeach can be seen in Table 4.

Table 4. Threat Factors for Sea Turtle Sustainability on NipahBeach

No	Threat Factor	Cause	Impact Potential	Station
1	Land occupation	Restaurants, lodging, fishing boat parking	Loss of nesting area	1,2,3,4,5
2	Noise	Restaurants, lodging, camping ground	Sea turtles avoid laying eggs	1,2,3,4,5
3	Changes in vegetation structure	Restaurants, lodging	Loss of nest shelter	1,2,3,4,5
4	Light	Restaurants, lodging	Disturbing sea turtle navigation	1,2,3,4
5	Presence of pets (dogs)	Restaurants	Turtle predation	3,4
6	Beach fencing	lodging	Loss of nesting area	5

Buildings that stand on the beach including fences that are close to the beach will gradually cause sea turtles to no longer lay eggs, this happens due to the lack of strict rules regarding building buildings on the beach (Rahman *et al.,* 2021). In addition, the mother sea turtles that will lay their eggs are also very sensitive to things that disturb their peace, if there is disturbance from light, movement, or predators (dogs), the mother sea turtle will not lay eggs and return to the sea, while the vegetation around the beach is disturbed or lost, reducing the feeling of security for sea turtles when laying their eggs (Rismawati*et al.,* 2021). Nipah Beach conditions can be seen in Figure 3.

(a) (b) (c)

Figure 3. Nipah Beach Conditions, (a) Restaurants Along the Beach at Station Two, (b) Lodging and Also Beach Fencing at Station Five, and (c) Fishing Boat Parking at Station Three

Characteristics of Nipah Beach as a Sea Turtle Habitat

Beach Physics

The success of sea turtle landing and nesting is influenced by several factors, including the absence of physical factors that may cause disturbance (Budiantoro, 2017). Therefore, physical measurements were conducted to investigate factors that influence the selection of nesting sites by sea turtles. The factors investigated in this study include beach width, beach slope, beach sand size (Alfred *et al.,* 2020), and sand color (Parawangsa*et al.,* 2018), which are influential.

The observed beach width is the distance between the highest tide line and the nearest vegetation. This area is also often referred to as the supratidal area (Turnip *et al.,* 2020). According to Septiana*et al.,* (2019), sea turtles generally have the instinct to lay eggs characterized by a wide beach width. Putra *et al.,* (2014) added that the width of the beach is related to the hatchability of sea turtle eggs. Beaches with wide characteristics avoid the influence of sea tides so that waves do not reach the area where the sea turtle nests, resulting in the eggs remaining safe. However, if the sea turtle nests are dampened by seawater, the eggs can be damaged and fail to hatch.

According to Alfred *et al.,* (2020), the width of the beach most suitable for the successful hatching of sea turtle eggs ranges from 21-30 m, while widths between 10-20 m are considered suitable, and those outside this range are less suitable. The results of the measurements show that the width of NipahBeach ranges from 0 to 17.2 m. Station three has the highest beach width, while station five has the lowest. Based on this, only stations two and three are considered suitable, while the others are less suitable. Conditions at station six in the field show that seawater directly touches the outer vegetation boundary when the tide occurs, causing station six to lack a subtidal area and become submerged periodically. The beach width data for each station is presented in Figure 4.

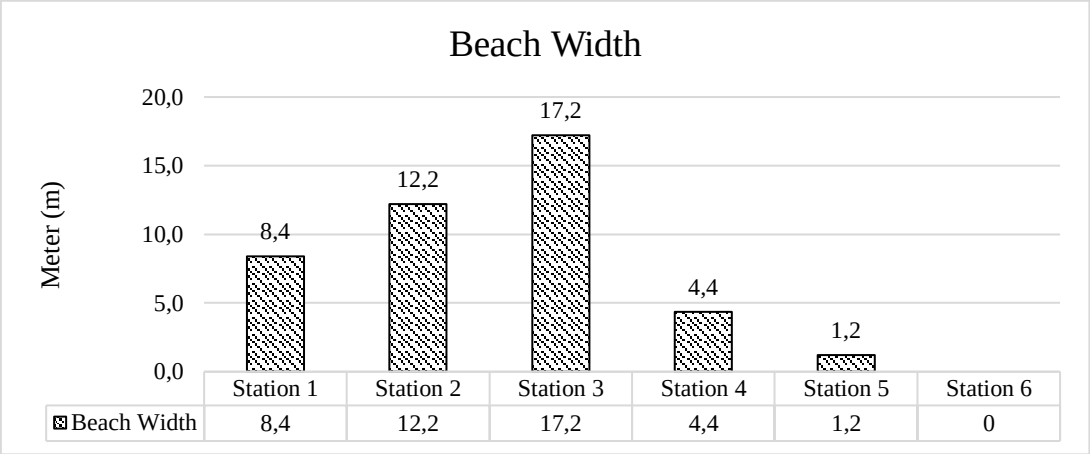

Figure 4. Beach Width at Each Station

The beach slope is the angle formed between the land area and the sloping plane of the beach. According to Alfred *et al.,* (2020), the slope of the beach is measured at the angle of the top beach boundary, assuming that the slope of the beach is at the limit of the highest tide to the lowest tide. The slope of the beach is related to the ease of sea turtles reaching the location. Sea turtles tend to choose beaches that have a sloping contour, making it easier for them to reach the nesting site. Afandy (2016) added that sea turtles tend to avoid or even cancel laying eggs if the contour of the beach, which is the access to the nesting site, is difficult to achieve. Based on observations, the slope of NipahBeach ranged from 11.5° to 26.5°. Station five has the largest beach slope and is the most suitable as a sea turtle nesting habitat and the smallest is station three, while station six does not have a beach area. Beach slope data for each observation station is presented in Figure 5.

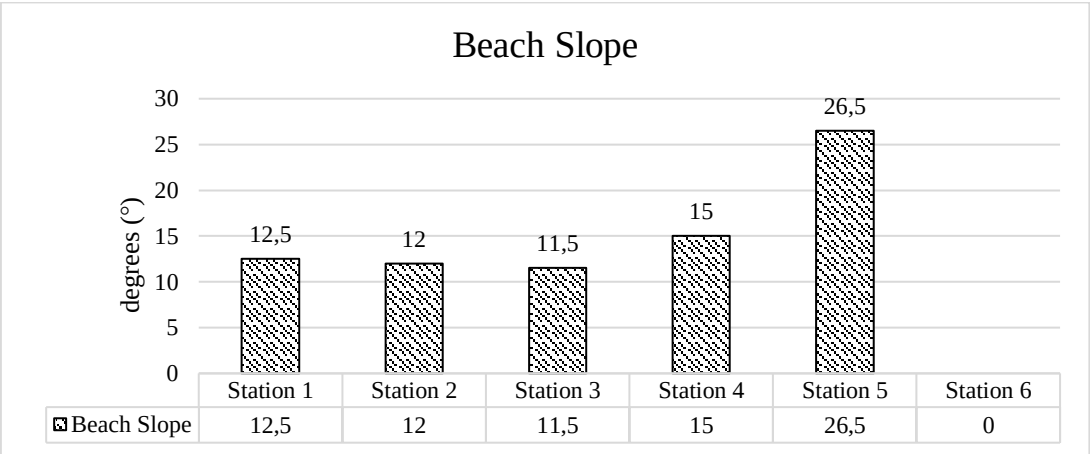

Figure 5. Beach Slope at Each Station

Beach sand also plays a crucial role in selecting sea turtle nesting sites. The sand serves as the substrate for sea turtles to lay their eggs. Sea turtles typically avoid hard sandy areas such as gravel, rocks, and soil (Alfred *et al.,* 2020). Afandy (2016) added that beaches with sandy substrates facilitate easy nest digging by sea turtles and can maintain a stable temperature. In addition, sand can stabilize nest conditions as it absorbs and releases heat slower (Putera*et al.,* 2015). Sand size measurements were conducted at stations two to five as the character of Nipah Beach in the northern part, station one, is made up of coral reefs, while the southern part has no beach, resulting in no measurements at these two stations. The laboratory analysis results of sand size indicate that stations two to five have the same average sand size of 0.25 mm. Based on Alfred *et al.,* (2020), this sand size is classified as suitable for turtle nesting habitat.

Differences in sand color affect its ability to maintain the nest temperature and humidity. Each color has a unique capacity to retain heat (Parawangsa*et al.,* 2018). Additionally, Amalia (2012) stated that black sand has high magnetic mineral content, which can accelerate the incubation period in eggs. Based on laboratory analysis results for each station, except for stations one and six, which are not sandy, the color of NipahBeach sand is white. According to Parawangsa*et al.,* (2018), white sand is classified as less suitable as a habitat for sea turtle nesting.

Beach Biotics

Observations of beach biota were conducted to determine the influence of biological factors that are thought to affect the selection of nesting sites by sea turtles. Factors considered influential in this study include the presence of sea turtles, predators, and vegetation (Afandy, 2016).

During the observation, information was obtained about the presence of Olive Ridley (*LepidochelysOlivacea*) on NipahBeach. At station two, Olive Ridley nesting sites were located at a considerable distance of 31.7 m and 21.7 m from the high tide line. According to Afandy (2016), nesting sites that are too far away increase the threat of predation and disorientation caused by artificial light for hatchlings when heading to the sea. The first nest was 3.34 m away from the tamarind-plum tree (*Indumdialium*), and the second was 6.14 m away from the nearest vegetation, sea hibiscus (*Hibiscus tiliaceus*). At station three, sea turtle nests were found 11.4 m from the tide line and 1 m from the nearest vegetation, sea hibiscus (*Hibiscus tiliaceus*).In parts of West Lombok, sea turtles lay eggs seasonally and the peak occurs in May (Syaputra, 2020).

Predators pose a threat to both sea turtles and their eggs, affecting their egg-laying behavior and the success rate of egg-hatching. According to Ario*et al.,* (2016), sea turtle predators include natural predators, such as monitor lizards and humans. However, humans are a more prominent threat to sea turtle conservation due to their activities, such as taking sea turtle eggs, hunting sea turtles, degrading sea turtle habitats, and exploiting marine natural resources that serve as sea turtle food. Predators identified in the field included long-tailed monkeys (*Macacafascicularis*) at station one, monitor lizards (*Varanussalvator*) at stations four and five, and dogs (*Canis lupus familiaris*) at stations three and four.

Vegetation plays an essential role in protecting sea turtle nests. Vegetation provides shade to the nest, protecting it from the sun and, thus, maintaining stable temperature and humidity conditions, preventing sharp fluctuations in the temperature of the nest environment (Kurniawan*et al.,* 2015). The root system of vegetation also helps maintain the strength of the nest and prevents sand collapse during the excavation process (Dewi*et al.,* 2016). Typical vegetation found along Nipah Beach includes sea hibiscus (*Hibiscus tiliaceus*), screwpine (*Pandanus tectorius*), bayhops (*Ipomoea pescaprae*), lead tree (*Leucaenaleucocephala*), tamarind-plum (*Indumdialium*), and lantana (*Lantana camara*). The observation results show that stations two, three, and six have dense vegetation cover (50-70%), while the rest have less vegetation cover (<50%). Sea hibiscus (*Hibiscus tiliaceus*) is the dominant vegetation species found

on Nipah Beach, with a solid root system that protects sea turtle nests.

Environmental Factors

Environmental factors observed in this study included the temperature and humidity conditions of the sand at each station. The sand temperature influences the success of hatching sea turtle eggs because there is a temperature range tolerance in which the embryo can develop. The sand temperature can also affect the sex of the hatching turtles (Rismawati*et al.,*2021). Sufficient sand humidity will maintain the nest's temperature without becoming too hot during the day or too cold at night while not blocking gas exchange. This condition allows the embryo in the egg to breathe (Afandy, 2016).

Observations showed that the temperature of the sand on Nipah Beach ranged from 28.1°C to 31.1°C, where the temperature range is very suitable for the incubation of sea turtle eggs (DCMNP, 2009; Goin*et al.,* 1978). Herawaty& Mahmud (2019) added that a temperature of 25-35°C will produce a good hatching rate and a relatively short incubation time. The temperature range between 24-33°C is also a good development temperature range for embryos. The humidity of Nipah Beach sand ranged from 70.2% to 75.5%, whereas based on Afandy(2016) and McGehee (1990), the humidity range is less suitable for sea turtle egg incubation. The lowest humidity was recorded at station five, and the highest was at station three. The high value of sand moisture is thought to be due to the influence of rain that occurred at the time of observation, according to Santoso*et al.,* (2021) continuous rain throughout the day can make the humidity of the sand wetter. Vegetation conditions also affect the results of this measurement, where stations two, four, and five are under shade. Temperature and humidity at stations one and six were not measured because the conditions at both stations were not sandy. The temperature and humidity data for the sandy beach can be seen in Figure 6.

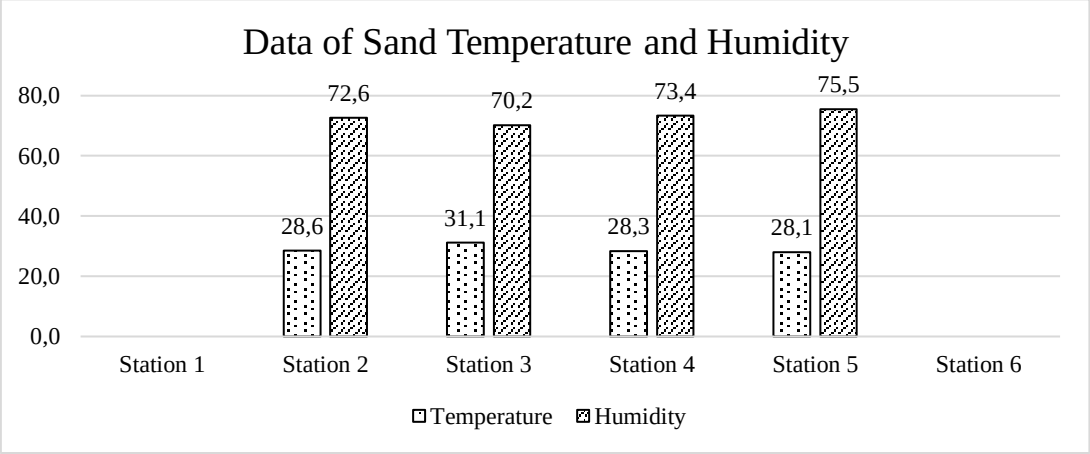

Figure 6. Data of Beach Sand Temperature and Humidity

Suitability of Nipah Beach as a Sea Turtle Habitat

In determining the suitability level of the beach as a sea turtle habitat on Nipah Beach, weighting is carried out based on expert discussions involving forestry experts, conservationists, animal experts, and also the community. The results of the weighting can be seen in Figure 7 regarding the weight of the factors that affect the level of suitability of sea turtle habitat. Based on the results of the discussion, the factors that are said to be very influential include beach sand, beach slope, and the presence of sea turtles. Respondents stated that the presence of beach sand was an absolute requirement for sea turtles to lay their eggs and was reinforced by Alfred *et al.,* (2020), who stated that sea turtles did not like beaches in the form of rocks. The slope of the beach is also a determinant of turtle presence

by respondents, a beach that is too steep will be difficult for turtles to reach when laying eggs, then the record of turtle presence adds strength points to the suitable beach. In addition, based on the results of the discussion, the factors of cover and distance to vegetation, temperature, and humidity of the sand, and the width of the beach are said to be influential factors and the color of the sand is said to be a less influential factor.

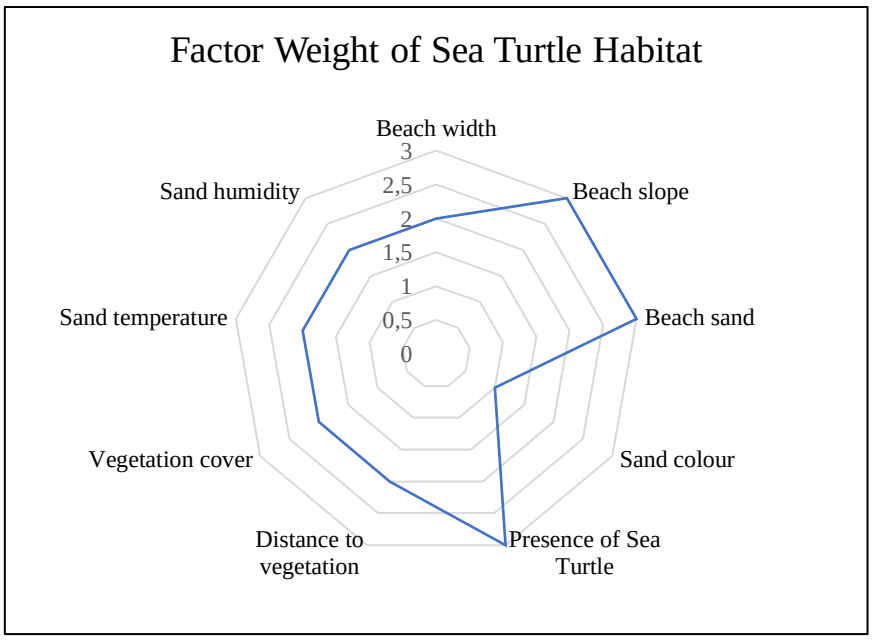

Figure 7. Weight of Factors that Affect the Level of Suitability of Turtle Habitat

The level of suitability is influenced by the weights and scores that have been obtained. Based on the results, it is known that station two has the highest score, followed by station three, station five, and station four. The high score in station two and station three is primarily influenced by the presence of sea turtles that come to lay eggs. Additionally, during the observation period, no natural predators were found in station two, and the vegetation in this area was relatively dense, with a very suitable sand temperature.

Stations one and six received low scores due to their unsuitability as sea turtle nesting beaches. Station one consists of coral rocks and minimal sandy areas, similar to station six, where no beach area was found, and the tide directly touches the outer vegetation boundary. The scoring results carried out at each observation station on NipahBeach can be seen in Table 5.

Table 5. Suitability Scoring of Beaches as Turtle Habitat

No	Location	Physical Factor Value (Score x Weight)				Biotic Factor Value (Score x Weight)			Environmental Factor Value (Score x Weight)		Total	Conclusion
		BW	BS	SS	SC	S	P	V	ST	SH		
1	Station 1	2	6	0	0	3	4	4	0	0	19	Less suitable
2	Station 2	4	6	6	1	9	6	6	6	2	46	Very suitable
3	Station 3	4	6	6	1	9	4	6	6	2	44	Very suitable
4	Station 4	2	6	6	1	3	4	4	6	2	34	Suitable
5	Station 5	2	9	6	1	3	4	4	6	2	37	Suitable
6	Station 6	0	0	0	0	3	6	6	0	0	15	Less suitable

Note= BW: Beach Width, BS: Beach Slope, SS: Sand Size, SC: Sand Color, S: Sea Turtle Presence, P: Predator, V: Vegetation, ST: Sant Temperature, SH: Sand Humidity

Zonation of Nipah Beach to Support Sea Turtle Conservation

The division of zonation refers to the UMRAH Beach and Marine Resources Research Center (2009), which states that 40% of the representative turtle habitat area with the highest score is designated as a protection zone, 30% of the turtle habitat area with a moderate score becomes a captive zone, and the rest becomes a limited-use zone. This zoning system is not much different from the zoning used by PangumbahanSukabumi Beach, where the beach is divided into three zones namely the core zone for the protection of biodiversity, the limited use zone for tourism and recreation, and other zones which are located side by side with the core zone which is designated for activities that following conservation goals (Regent Decree No. 523 of 2014).

Based on this, stations two and three, and part of station five are prioritized as protection zone areas, station four and part of station five and one as a captive zone area, and the rest as limited-use zones. The results of the NipahBeach zonation division analysis based on the designation criteria can be seen in Figure 8.

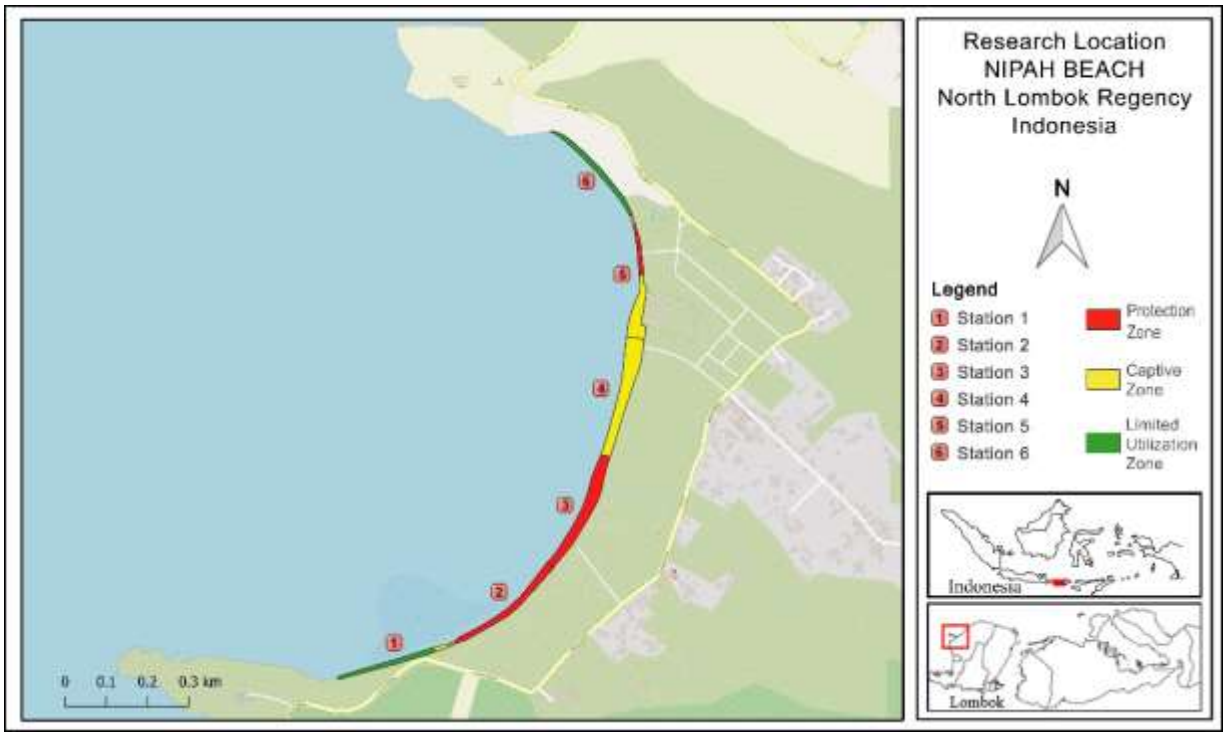

Figure 8. Zonation Map of Turtle Conservation Area at Nipah Beach

The protection zone is intended to maintain and guarantee the preservation of sea turtles and their natural habitat on Nipah Beach, in this zone it is recommended not to change the function of the beach and also not to build physical buildings around the coastal area, carry out routine monitoring, carry out efforts to develop coastal vegetation and protect sea turtles from activities humans and also predators that can harm sea turtles and put up information boards. To support and increase the turtle population on NipahBeach, the captive zone is expected to function as a semi-natural sea turtle habitat development area, as a place to raise eggs and raise hatchlings. The eggs obtained from the monitoring results are relocated to this area to be reared before being released, Therefore, semi-natural habitat areas are equipped with facilities such as rearing ponds. As a form of conservation effort, semi-natural habitat development areas can also be equipped with information centers for visitors or the surrounding community to support educational tourism. Limited

utilization zones can function as areas to support community economic activities, such as the development of mass tourism activities and also the construction of tourism support facilities with the concept of semi-permanent and environmentally friendly buildings.

CONCLUSIONS

The conclusions of this study are:

1. The suitability level of NipahBeach as a habitat for sea turtles ranged from 15 to 46 points based on the scoring results. The highest score was recorded at station two, while the lowest was at station six.
2. Stations two and three, and part of station five are prioritized as protection zone areas, station four and part of station five and one as a captive zone area, and the rest as limited-use zones.

Recommendations from this research are as follows:

1. The results of this study are expected to serve as a basis for decision-making for stakeholders in NipahBeach regarding the area's future development.
2. Carry out the realignment of land and building functions, which are located at stations two, three, and five which are important areas for turtle nesting.
3. Carry out guidance on plant vegetation in areas that have moderate or low vegetation cover.

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