



(MUDIMA)



Potential and Mitigation Analysis of Nipah Beach Forest Ecosystem Changes, North Lombok Regency as a Sea Turtle Habitat

Maiser Syaputra^{1*}, Endah Wahyuningsih², Pande Komang Suparyana³, Diah Permatasari⁴, Andi Tri Lestari⁵

University of Mataram

Corresponding Author: Maiser Syaputra syaputra.maiser@unram.ac.id

ARTICLE INFO

Keywords: Beach Forest, Sea Turtles, Risk, Mitigation

Received : 3 November

Revised : 20 November

Accepted : 22 December

©2023 Syaputra, Wahyuningsih, Suparyana, Permatasari, Lestari: This is an open-access article distributed under the terms of the [Creative Commons Attribution 4.0 International](https://creativecommons.org/licenses/by/4.0/).



ABSTRACT

The Nipah beach forest in Malaka Village is used as a nesting habitat for sea turtles, which are protected and endangered wild animals in Indonesia. In current conditions, the Nipah Beach forest ecosystem is faced with development, economic growth, and the community's high demand for land so the integrity of the turtle habitat in the area is threatened. Analysis of potential changes in wildlife habitat is important to carry out at Nipah Beach, Malaka Village, and is interrelated with efforts to prepare plans and strategies for handling and protecting turtle biodiversity itself. This research aims to 1). Knowing the characteristics of turtle diversity in the Nipah Beach forest area, North Lombok Regency. 2). Changes potential analyzing for Nipah Beach forest ecosystem, North Lombok Regency as a sea turtle habitat. 3). Develop a mitigation plan for changes in the Nipah Beach forest ecosystem, North Lombok Regency as a sea turtle habitat. Measuring sea turtle diversity was carried out using the observation method, while risk analysis of habitat change in this study was carried out using risk analysis techniques using SNI/ISO 31010, and mitigation plans were prepared using the Mitigation Hierarchy. The results obtained were analyzed using risk analysis based on AS/NZS Australian/New Zealand Risk Management Standard 4360 (2004). The conclusions of this research are: 1). Sea turtle diversity on Nipah Beach consists of three species, namely the Hawksbill turtle (*Eretmochelys imbricata*), Green turtle (*Chelonia mydas*), and Olive ridley turtle (*Lepidochelys Olivacea*). The important habitat for turtles on Nipah Beach is at stations 2, 3 and 5. 2). Potential changes to the Nipah Beach forest ecosystem are divided into five degrees of change, from mild to disaster. The highest degree of change occurs if the important nesting habitat of the Hawksbill turtle (Critical Endangered IUCN) is disturbed/lost on a large scale. 3). Mitigation steps in protecting the Nipah Beach forest ecosystem for sea turtle habitat consist of avoiding, minimizing, rehabilitation and balancing

INTRODUCTION

Analysis of potential changes in wild animal habitat is a step to map the risks, opportunities, impacts of future events and changes on the existence of certain wild animals in an area. According to Hasiah *et al.*, (2016), risk assessment is useful for getting an idea of minor and major risks and helping identify internal controls that can be implemented to prevent a risk from occurring. Analysis of the risk of changes in wildlife diversity focuses on various forms of physical changes in habitat which have a direct impact on reducing or losing the carrying capacity of an area to maintain the survival of a type of wild animal in it.

One type of protected wild animal whose existence is threatened with extinction in Indonesia is the sea turtle (PermenLHK 106, 2018; IUCN, 2022), apart from needing water areas, turtles also need a forest ecosystem, namely beach forests as a place for sea turtles to lay their eggs (Septiana *et al.*, 2019). The presence of sea turtles in beach forests is influenced by the bio-physical conditions of the beach itself. Ecologically, the presence of turtles on a beach is influenced by ecosystem conditions, sand and composition of beach vegetation (Parawangsa *et al.*, 2018; Akbar *et al.*, 2020), while the presence of predators including humans influences the presence, and number of turtle eggs that hatch and the hatchlings that survive. (Setiawan *et al.*, 2018).

On Lombok Island, sea turtles can be found in the Nipah Beach forest area, Malaka Village, North Lombok Regency, West Nusa Tenggara Province, which is included in the Rinjani Geopark area. The Rinjani Geopark area stretches over an area of 2.800 km² bounded 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). Current conditions, the Nipah Beach forest ecosystem is faced with development, economic growth and high community demand for land. Physical development at Nipah Beach is currently unavoidable and several buildings have reached the shoreline, such as restaurants, restaurants and accommodations, this is because Nipah Beach is one of the tourist destinations that is developing in West Nusa Tenggara Province.

Analysis of potential changes in wildlife habitat is important to carry out at Nipah Beach, Malaka

Village, and is interrelated with efforts to prepare plans and strategies for handling and protecting biodiversity for the sea turtles themselves because whether they realize it or not, the human activities mentioned above have the potential to impact the physical area as well as affect the condition of the ecosystem within it. Analysis of potential changes in sea turtle habitat begins with activities to identify the rich diversity of sea turtle species and their distribution in the study area, identify important habitats for these species, risk mapping and continue with studies on mitigation to reduce the threat of extinction.

According to the decision of the Director General of Coasts and Small Islands Number: SK.64A/P3K/IX/2004, mitigation policy in coastal areas is generally a conceptual framework prepared to reduce the impacts caused by a disaster. Mitigation activities include recognition and adaptation to hazards resulting from human and natural activities, and can also be interpreted as sustainable activities to reduce or eliminate short, medium, and long-term risks from an activity.

Good knowledge and understanding of the habitat characteristics, patterns, habits, and behavior of sea turtles are very important as a basis for managing conservation areas (Mursalin *et al.*, 2017; Afandy, 2016), analyzing potential habitat changes and sea turtle extinction mitigation plans on this research was carried out based on the level of presence, habitat suitability and problems faced by these animals in the field. The objectives of this research are 1). To determine the characteristics of sea turtle diversity in the Nipah Beach forest area, North Lombok Regency, 2. To analyze the potential of the Nipah Beach forest ecosystem changes, North Lombok Regency as a sea turtle habitat and 3. Develop a mitigation plan for changes in the Nipah Beach forest ecosystem, North Lombok Regency as a sea turtle habitat.

METHODS

This research was carried out from April to September 2023, located in the Nipah Beach forest, Malaka Village, Selamat District, North Lombok Regency, West Nusa Tenggara Province. The research location can be seen in Figure 1.



Figure 1. Research Location (Source: Google Earth Pro)

The tools and materials used in this research include GPS, camera, recorder, scales, compass, meter, headlamp and the Google Earth application version 7.3.4.8248. The research object is the sea turtle habitat on Nipah Beach.

The study of the potential and mitigation of changes in the beach forest ecosystem in this research was assessed by first dividing Nipah Beach

into several observation stations, between observation stations 300 meters apart (Pane *et al.*, 2020; Rismawati *et al.*, 2021). This aims to ensure that the assessment can be carried out thoroughly and the study area can be monitored effectively. The observed parameters and aspects are presented in Table 1.

Table 1. Parameters and Measurement Aspects

No	Aspect	Parameter	Observation Method	Source
1.	Sea turtle diversity	1. Species 2. Frequency 3. Location 4. Character	Direct observation techniques in the field.	
2.	Potential habitat changes	1. Probability 2. Impact	Potential identification is carried out by determining the probability and level of consequences using risk analysis techniques based on SNI/ISO 31010: 2016. The probability scale is divided into five, namely almost certain (5), highly likely (4), likely (3), unlikely (2) and rare (1). The degree of change uses five levels, namely light (low), moderate (moderate), heavy (heavy), extreme (extreme) and disaster (disaster).	SNI /ISO 31010 (2016), Australian Government (2016)
3.	Mitigation plan	1. Avoidance 2. Minimization 3. Rehabilitation 4. Balancing	A mitigation hierarchy approach is used by sequentially identifying aspects of avoidance, minimization, rehabilitation and balancing. The first two components, namely avoid and minimize, are carried out to prevent impacts from occurring. The next two components, namely rehabilitation and balancing, are carried out to repair the impacts that have occurred.	Australian Government (2016)

Analysis of potential habitat changes was carried out using a risk analysis matrix based on the Australian / New Zealand Risk Management

Standard AS/NZS 4360 (2004) which is shown in Table 2, followed by developing risk management criteria as presented in Table 3.

Table 2. Risk Analysis Matrix

POTENTIAL ANALYSIS MATRIX		Impact				
		Low	Moderate	Heavy	Extreme	Disaster
Description	Likelihood					
Almost certain (90%)		Yellow	Orange	Red	Red	Red
Most likely (70%)		Blue	Yellow	Orange	Red	Red
Maybe (50%)		Blue	Yellow	Yellow	Orange	Red
Less likely (30%)		Green	Blue	Yellow	Yellow	Orange
Rare (10%)		Green	Green	Blue	Blue	Yellow

Information:

- Low: Incidental and local impacts on the natural habitat of sea turtles
- Moderate: Small-scale sea turtle habitat conversion
- Heavy: Large-scale natural habitat conversion or small-scale 'important' habitat

conversion for sea turtles with Vulnerable status

- Extreme: Large-scale loss of 'important' habitat in sea turtles with Endangered status
- Disaster: Large-scale loss of 'important' habitat for sea turtles with Critical Endangered status

Table 3. Risk Management Criteria

Risk Level	Criteria for Risk Management	
1 – 2	Acceptable	With sufficient control
3 – 4	Monitored	With sufficient control
5 – 9	Management Control Required	With sufficient control
10 – 14	Must be of concern to management (urgent)	Acceptable only with excellent control
15 – 25	Unacceptable	Acceptable only with excellent control

According to the Australian Government (2016), mitigation steps in biodiversity management consist of avoid, minimize, rehabilitate and balance, the higher the mitigation hierarchy, the fewer options available and the higher the risks that must be faced.

When possible, avoidance tends to have fixed costs and a higher probability of success than subsequent components. The mitigation hierarchy diagram is shown in Figure 2.

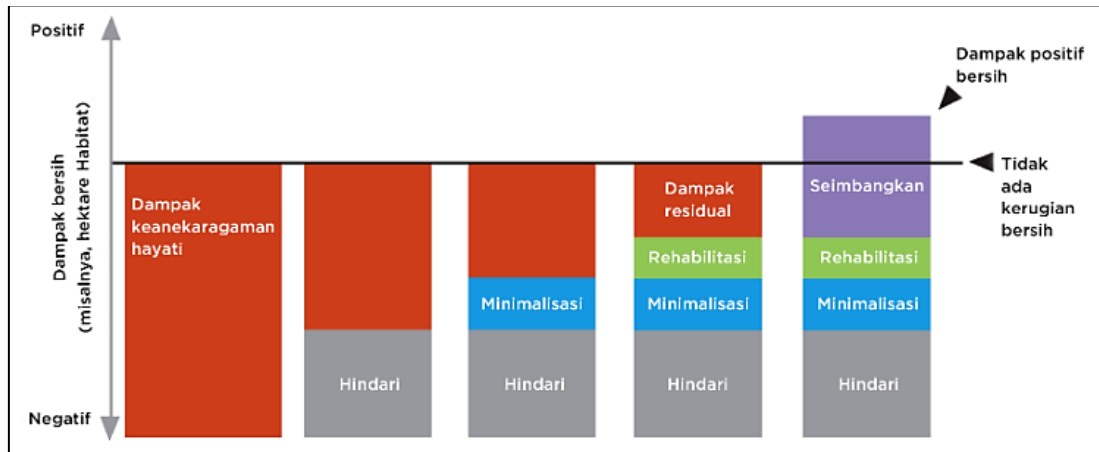


Figure 2. Mitigation Hierarchy Diagram
(Source: Australian Government, 2016)

RESULTS AND DISCUSSION

Characteristics of Nipah Beach and Sea Turtle Diversity

Based on the results of spatial measurements, Nipah Beach has a coastline of 2,800 m. The western and eastern parts of the beach (stations 1 and 6) are dominated by coral rocks, so the sandy areas are only in the middle (stations 2-5). Sand size measurements were carried out at stations 2 to 5, the results of laboratory analysis of the sand size, showed that stations 2 to 5 on average had the same sand size, namely 0.25 mm, based on Alfred *et al.*, (2020) the sand size was classified as suitable as a turtle nesting habitat.

Based on information obtained during observations, it is known that there have been three nesting turtles appearing on Nipah Beach. The type of turtle found was the Olive ridley turtle (*Lepidochelys Olivacea*), there were three increases in Olive ridley turtles including twice at station 2 and once at station 3, making stations 2 and 3 an important habitat for sea turtles on Nipah Beach (red in Figure 3). Apart from these two stations, based on observation results, station 5 also tends to be a good habitat, this location is far from community activities and there is also beach vegetation around it.

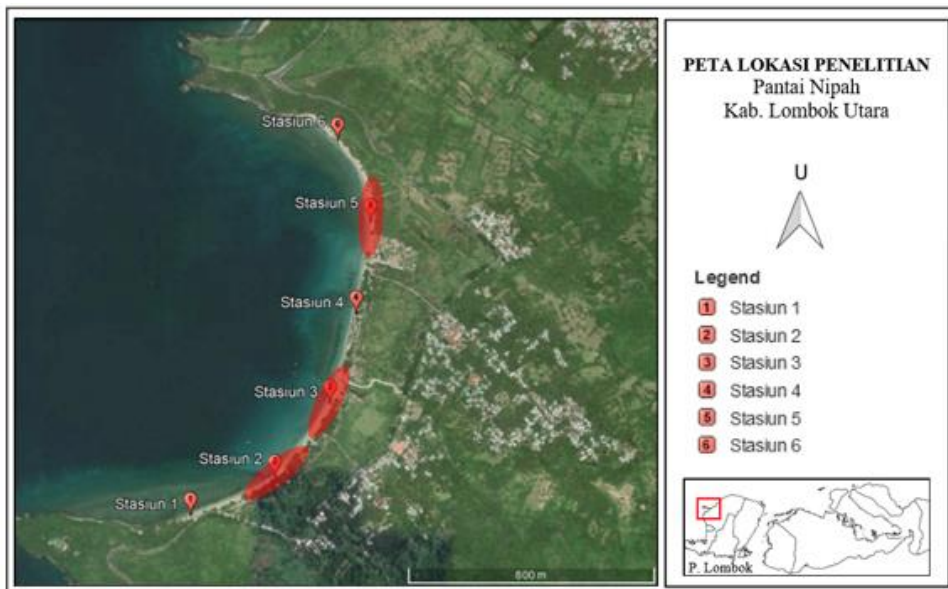


Figure 3. Important Sea Turtle Habitat on Nipah Beach

At station 2, the nesting point for Olive ridley turtles is quite far away, namely 31.7 m and 21.7 m from the tide line. According to Afandy (2016), a nesting location that is too far away will increase the threat from predators and disorientation caused by artificial light for the hatchlings as they head to the sea. At station 3, a turtle nest was found 11.4 m from the tide line.

Apart from the Olive ridley turtle (*Lepidochelys Olivacea*), based on direct observations in the breeding pond and interviews with managers, Nipah Beach is also known to be a habitat for two other types of turtles, namely the Green turtle (*Chelonia mydas*) and the Hawksbill turtle (*Eretmochelys imbricata*), bringing the total turtle diversity on Nipah Beach there are three species. Even though they were not found directly laying eggs on the beach, this information is very important and will later be used in analyzing potential and mitigating changes to the Nipah Beach forest ecosystem.

Station 2 is known to have a beach slope of 12°, station 3 of 11.5° and station 5 of 26.5° when measured from the highest high tide to the lowest low tide. The degree of beach slope is related to the level of ease with which turtles can reach their nesting position. Afandy (2016) stated that turtles tend to avoid laying eggs on beaches that are difficult to access or reach. Alfred (2020) stated that the beach slope that is very suitable for nesting turtles is around 21-30° and refers to the same opinion that the degree of beach slope of 10-20° is classified as suitable, while less suitable slopes are in the range of <10° and >30°.

Turtles also tend to lay eggs around beach forest vegetation. Vegetation has an important role for sea turtles, such as protecting the nest from the hot sun, vegetation is also able to maintain stable environmental temperature and humidity so that there are no sharp fluctuations in nest temperature conditions (Kurniawan *et al.*, 2015). Based on information obtained during the research, the first nest of nesting turtles was located 3.34 m from the

Keranji tree (*Indum dialium*), the second nest was 6.14 m from the nearest vegetation, namely Waru (*Hibiscus tiliaceus*) and the third nest was at a distance of 1 m from the nearest vegetation, Waru (*Hibiscus tiliaceus*). Apart from the roles mentioned above, according to Dewi *et al.*, (2016), the root system in coastal forest vegetation also helps maintain the strength of the nest and prevents sand from collapsing during the excavation process.

Identification of Changes in the Nipah Beach Forest Ecosystem

Identifying changes in the coastal forest ecosystem is a step to map the risks, opportunities and impacts of future changes on the existence of turtles on Nipah Beach. Analysis was carried out on the habitat which is an important part that cannot be separated from the sea turtle itself. Analysis of potential changes to the beach forest ecosystem focuses on various forms of physical changes in the habitat which have a direct impact on decreasing or losing the carrying capacity of the area to maintain the survival of the sea turtles in it.

Analysis of potential changes to the Nipah Beach forest ecosystem is important to prepare plans and strategies for handling and protecting sea sea turtle biodiversity because it is known that community activities carried out at Nipah Beach have an impact on the physical area and influence the condition of the ecosystem within it. Analysis of potential changes to coastal forest ecosystems begins with activities to identify the rich biodiversity of sea turtles, their habitat and distribution, identify important habitats for threatened species and identify problem factors that occur in the field.

Based on the results of observations, almost all stations have potential threats to turtle conservation, the highest combination of threats is at station three with 6 problem factors and station four with 5 factors, thus placing these two stations as areas with the most complex problems, while station six is an area that does not have problems. Threat factors for the sustainability of turtles on Nipah Beach can be seen in Table 4.

Table 4. Threat Factors for Turtle Sustainability

No	Threat Factors	Potential Impact	Category	Station
1	Pets (dogs)	Predation on eggs/hatchlings	D1	3,4
2	Light pollution	Disrupts Turtle navigation	D2	1,2,3,4
3	Changes in vegetation structure	Loss of nest protection	D3	1,2,3,4,5
4	Noise	Prevents turtles from laying eggs	D3	1,2,3,4
5	Fisherman's boat parking	Prevents turtles from laying eggs	D3	3
6	Occupation of semi-permanent buildings	Reduced spawn area	D3	2,3,4
7	Beach fencing / permanent buildings	Loss of spawning area	D4	5

Adapting the Australian Government (2016), assessment of changes in biodiversity can be carried out on biodiversity with certain statuses that are widely recognized such as the IUCN Red List of Threatened Species, where the concern is types of biodiversity with threatened status such as Critically Endangered, Endangered and Vulnerable. According to IUCN (2022), Critical Endangered is a group of species that is at very high risk of extinction and is feared to become extinct shortly, Endangered is a group of species that is at very high risk of extinction and is feared to become extinct in the future, while Vulnerable is a group of species which are vulnerable to extinction.

Identification of rarity criteria based on IUCN status for three species of turtles on Nipah Beach shows that there is one type of turtle with Critical Endangered status, namely the Hawksbill turtle (*Eretmochelys imbricata*), one species with Endangered status, namely the Green turtle (*Chelonia mydas*) and one species with Vulnerable status, namely the Olive ridley turtle (*Lepidochelys Olivacea*). The results of identifying the conservation status of sea turtles according to IUCN and combined with the degree of habitat change which is divided into five classes are presented in Table 5.

Table 5. Degree of Change in Biodiversity

No	Degree of Change	Category	Parameter
1	Light (Low)	Incidental and local impacts on natural habitats (D1)	-
2	Medium (Moderate)	Small-scale changes/disruption of natural habitat (D2)	-
3	Heavy (Heavy)	Small-scale 'important' habitat change/disruption (D3)	The area is inhabited by Olive Ridley Turtles (a species with Vulnerable conservation status)
4	Extreme (Extreme)	Large-scale loss/disruption of 'important' habitat (D4)	The area is inhabited by Green Turtles (a species with Endangered conservation status)
5	Disaster	Large-scale loss/disruption of 'important' habitat (D4)	The area is inhabited by Hawksbill Turtles (a species with Critical Endangered conservation status)

(Source: Modified from Australian Government, 2016)

Risk can be defined as a form or state of uncertainty, where if an undesirable situation occurs it will result in a loss. According to Airmic (2010), risk is a possible situation or circumstance that could threaten the achievement of the goals and objectives of an organization or individual. Analysis of the risk

of habitat change is then carried out based on pairwise comparisons between the opportunity and impact categories of events referring to the Australian Government (2016), opportunities and impacts are given a score between 1 and 5. The results of the analysis are shown in Table 6.

Table 6. Potential Analysis Matrix

POTENTIAL ANALYSIS MATRIX		Impact				
		1	2	3	4	5
Description	Likelihood	Low	Moderate	Heavy	Extreme	Disaster
Almost certain (90%)	5	5	10	15	20	25
Most likely (70%)	4	4	8	12	16	20
Maybe (50%)	3	3	6	9	12	15
Less likely (30%)	2	2	4	6	8	10
Rare (10%)	1	1	2	3	4	5

Information:

■ Critical Risk
 ■ High Risk
 ■ Medium Risk
 ■ Low Risk
 ■ No Risk

An important note based on Table above, critical conditions occur in three scenarios based on the probability of occurrence, impact category, location and species involved. Critical risk is likely to almost certain to occur if the 'important' habitat of the Hawksbill turtle on Nipah Beach is lost or disturbed on a large scale or is likely to almost certainly occur if the 'important' habitat of the Green turtle is lost or disturbed on a large scale or almost certain to occur if the habitat is important Olive ridley turtles are disturbed on a small scale.

The critical risk of having a disaster impact based on field observations occurs in the case of beach fencing at station 5 if it prevents Hawksbill turtles from laying eggs and will have an extreme impact if it prevents Green turtles from laying eggs. Occupation of semi-permanent buildings in the form of beachside restaurants, fishing boat parking activities, noise and loss of coastal forest vegetation

at stations 2, 3 or 5 are critical risks that will have a serious impact if they prevent Olive ridley turtles from laying their eggs.

Permanent buildings that stand on the beach, including fences that are close to the beach, will eventually cause sea turtles to no longer lay their eggs, resulting in the disappearance of sea turtles from that location, this happens because there are no strict rules for building buildings on the beach. The existence of semi-permanent buildings in the form of beachside restaurants, fishing boat parking activities, noise, and changes in beach forest vegetation will also have an impact on reducing the number of turtles present, but according to interview results, turtles can still lay their eggs under or between the boats. There is. Several examples of turtle nesting habitat conditions with risk categories can be seen in Figure 4.



(a)



(b)



(c)

Figure 4. Risk Situations: (A) Critical, Beach Fencing, (B) High, Semi-Permanent Buildings (C) High, Boat Parking

Risk Management

Risk management is a technique used in risk management that is carried out with a coordinated and economical application of resources with a process of identifying, assessing and prioritizing risks so that it can be used to minimize, monitor and

control the frequency of risk events and the impact of risks (Gustini *et al.*, 2014). Based on the type of risk of change in the Nipah Beach forest ecosystem as a turtle habitat that was identified, a management scheme was developed into five criteria which are presented in Table 7.

Table 7. Risk Management Criteria

Risk Level	Criteria	Risk management
1 – 2	Acceptable	With sufficient control
3 – 4	Monitored	With sufficient control
5 – 9	Management Control Required	With sufficient control
10 – 14	Must be of concern to management (urgent)	Acceptable only with excellent control
15 – 25	Unacceptable	Acceptable only with excellent control

Based on previous data and connected with the criteria above, in the case of beach fencing at station 5 and occupation of semi-permanent buildings in the form of beachside restaurants, fishing boat parking activities, noise and loss of beach forest vegetation at stations 2, 3 or 5 becomes an unacceptable or unacceptable problem and very good control efforts are needed to resolve this problem.

Mitigation of Habitat Change

According to the Australian Government (2016), mitigation steps in biodiversity management consist of avoid, minimize, rehabilitate and balance, the higher the mitigation hierarchy, the fewer options available and the higher the risks that must be faced. When possible, avoidance tends to have fixed costs and a higher probability of success than subsequent components. The mitigation hierarchy diagram is shown in Figure 5.

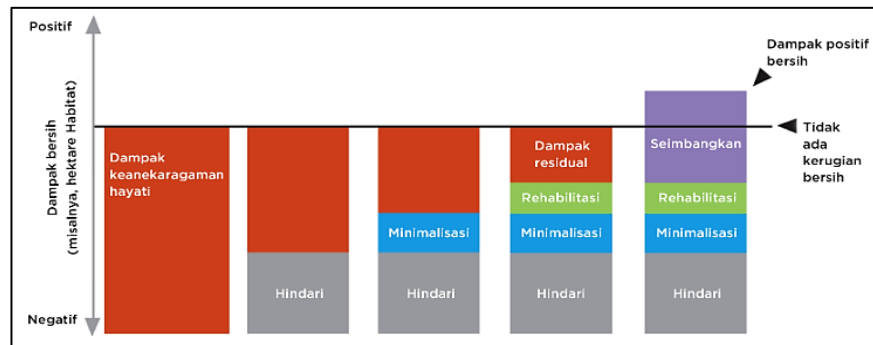


Figure 5. Mitigation Hierarchy Diagram
(Source: Australian Government, 2016)

According to the Australian Government (2016), avoidance can be defined as steps taken to anticipate and prevent negative impacts on biodiversity before actions or decisions are taken that lead to those impacts. Minimization is a method taken to reduce intensity, significance and/or limits that cannot be completely avoided, as far as practicable. Rehabilitation is a step taken to help restore specific functions or biodiversity features

present in an ecosystem that is degraded or damaged due to project impacts and offsets are measurable conservation outcomes, derived from actions taken in areas not impacted by the project, that offset impacts detrimental and significant projects that cannot be avoided, minimized and/or rehabilitated. Referring to the Australian Government (2016), the plan to mitigate the risk of turtle extinction at Nipah Beach can be seen in Table 8.

Tabel 8. Mitigation Plan for the Risk of Sea Turtle Extinction on Nipah Beach

Forms of Mitigation	Type	Effort	Station Location
Avoidance	Avoidance in Site Selection	1. Permanent infrastructure is built in locations far from the important habitat of endangered sea turtles	2,3,4,5
	Avoidance Through Building Design	1. Design fences for hotels that are sea turtle-friendly 2. Design a semi-permanent building for a stilt house for a restaurant	2,3,4,5
	Avoidance Through Scheduling	1. Limit activity schedules that cause noise, such as camping, beach festivals, and restaurant music 2. Limit the schedule of activities that produce light pollution, hotel and restaurant lights 3. Schedule prohibited times for boat parking	2,3,4,5

Forms of Mitigation	Type	Effort	Station Location
Minimization	Physical Minimization	1. Minimize land clearing of beach forest and maximize regrowth potential 2. Minimize habitat fragmentation and loss of connectivity between vegetation	2,3,4,5
	Operational Minimization	1. Control the light source carefully to reduce light 2. Manage patterns and timing of fishing activities at the peak of turtle nesting season	2,3,4,5
	Pollution Minimization	1. Manage marine debris so that it does not hinder sea turtles from climbing 2. Use environmentally friendly designs or technologies, such as low-light lighting, soundproofing and dust control equipment	2,3,4,5
Rehabilitation	Ecosystem Restoration	1. Restoration of seagrass from fishing activities 2. Handling and controlling erosion and sedimentation in estuary areas 3. Tree planting (revegetation) and enrichment of vegetation	2,3,4,5
Balancing	Restoration Balancing	1. Reintroduction of other sea turtle species whose distribution and ecology are suitable for Nipah Beach	2,3,4,5
	Loss Prevention Balancing	1. Increasing the sea turtle release program through captive breeding support from the Nipah Turtle conservation group	2,3,4,5

CONCLUSION

The Conclusions of this Research are:

1. Turtle diversity on Nipah Beach consists of three species, namely the Hawksbill turtle (*Eretmochelys imbricata*), Green turtle (*Chelonia mydas*) and Olive ridley turtle (*Lepidochelys Olivacea*). The important habitat for sea turtles on Nipah Beach is at stations 2, 3 and 5.
2. Potential changes to the Nipah Beach forest ecosystem are divided into five degrees of change from mild to disaster. The highest

degree of change occurs if the important nesting habitat of the Hawksbill turtle (Critical Endangered IUCN) is disturbed/lost on a large scale.

3. Mitigation steps in protecting the Nipah Beach forest ecosystem for turtle habitat consist of avoiding, minimizing, rehabilitating and balancing.

The suggestions from this research are: immediate efforts are needed to deal with risk situations that occur at Nipah Beach, especially at the critical risk level. Turtle conservation groups are intensifying outreach and handling efforts according to the mitigation plan.

REFERENCES

- Afandy, Y.A. 2016. Green Turtle Habitat Suitability Analysis for Determination of the Pangubahan Turtle Coastal Park Zoning System, Sukabumi. Thesis. Coastal and Ocean Resources Management Study Program. IPB University.
- Airmic. 2010. Structured Approach to Enterprise Risk Management (ERM) and The Requirements of ISO 31000. The Public Risk Management Association. London
- Akbar, O.R., Luthfi, O.M. & Barmawi, M. 2020. Suitability of Olive Ridley *Lepidochelys olivacea*, Eschscholtz, 1829 (Reptilia: Cheloniidae) Spawning Ground at Mapak Indah Beach, West Nusa Tenggara. *Journal of Marine Research* 9(2): 137-142. <https://dx.doi.org/10.14710/jmr.v9i2.26125>.
- Alfred, D.O.M., Zangri, K.C., Ermelinda, M.D., Fransiskus, K.D., Vinsensius, A.M. & Andriani, M.N. 2020. Beach Physical Characteristics and Distribution of Olive Ridley (*Lepidochelys Olivacea*) Natural Nests on Sosadale Rote-Ndao Beach, East Nusa Tenggara. *Biofaal Journal* 1(2): 55 – 65. <https://dx.doi.org/10.30598/biofaal.v1i2pp55-65>.
- AS/NZS 4360. 2004. Risk Management Guidelines. Standards Australia/Standards New Zealand. Sidney.
- Australian Government. 2016. Biodiversity Management Leading Practice in the Sustainable Development Program for the Mining Industry. Commonwealth of Australia. Canberra.
- Dewi, A.S., Endrawati, H. & Redjeki, S. 2016. Analysis of the Distribution of Green Turtle (*Chelonia Mydas*) Nests Based on Coastal Vegetation at Sukamade Beach, Merubetiri, East Java. *Oceanografi Marina* 5(2): 115 – 120. <https://dx.doi.org/10.14710/buloma.v5i2.15730>.
- Decree of the Director General of Coastal and Small Islands Number: SK.64A/P3K/IX/2004 concerning Guidelines for Natural Disaster Mitigation in Coastal Areas and Small Islands.
- Gustini, wulandari, D., Afriani, S. 2014. Risk management analysis at PT. Bank bengkulu head office. *Ekombis review*, 2(1): 105-121.
- Hasiah, Arsyad, M., Sukriah. 2016. Design of a Risk Assessment Matrix Model in General Audit Planning. *Jurnal Ilmiah Akuntansi dan Keuangan*, 3(1): 42-60.
- Hery. 2015. Business risk management. Grasindo. Yogyakarta.
- Indonesian National Standards. 2016. IEC/ISO 31010: Risk management – Risk assessment techniques. Badan Standardisasi Nasional. Jakarta.
- International Union for Conservation of Nature. 2022. Sea Turtles. <https://www.iucnredlist.org/search?query=Sea%20Turtles&searchType=species>. [17 December 2022].
- Kurniawan, I., Damanhuri, H. & Suparno. 2015. Ecological Aspects of Sea Turtle Nesting Habitat on Sea Turtle Island, South Coastal District, West Sumatra. Proceedings of Student Seminar Results. Faculty of Fisheries and Marine Sciences, Bung Hatta University. Padang.

- Mursalin, Budhi, S. & Manurung, T. F. 2017. Characteristics of Turtle Nesting Sites and their Relation to the Structure and Composition of Vegetation at Sebus Beach, Paloh District, Sambas Regency. *Hutan Lestari Journal* 5(2), 338–347. <http://dx.doi.org/10.26418/jhl.v5i2.19898>.
- Pane, E.P., Muhamada, I.N. & Wiadnya, D.G.R. (2019). Conservation Management: Case Study of Pangumbahan Beach Turtle Conservation, Sukabumi Regency. Proceedings of the National Seminar on Maritime Affairs and Fisheries VIII. Faculty of Fisheries and Marine Sciences, Brawijaya University. Malang.
- Parawangsa, I.N.Y., Arthana, I.W. & Ekawaty, R. 2018. Characteristic Influence of Sand Beach about Percentage Hatching Success Olive Ridley Sea Turtle Egg on Conservation Effort Sea Turtle in Bali. *Metamorfosa Journal* 5(1): 36-43. <https://doi.org/10.24843/metamorfosa.2018.v05.i01>.
- Regulation of the Minister of Environment and Forestry of Indonesia Number P.106/Menlhk/Setjen/Kum.1/12/2018 concerning Types of Protected Plants and Animals.
- Rismawati, R., Hernawati, D. & Chaidir, D.M. 2021. Egg Laying Activity and Landing Frequency of Green Turtle (*Chelonia mydas*) in Pangumbahan Beach Sukabumi. *Metamorfosa Journal* 9(1): 206-216. <https://doi.org/10.24843/metamorfosa.2022.v09.i01>.
- Septiana, N.O., Sugiyarto & Budiharjo, A. 2019. Characteristics of Sea Turtle Nesting Habitat at Taman Beach, Ngadirojo District, Pacitan Regency, East Java. Proceedings of the IVth National Seminar on Biology and Science Education (SNPBS). Biology Education Study Program, Muhammadiyah University of Surakarta. Surakarta.
- Setiawan, R., Zamdial, Fajar, B. 2018. Study of Turtle Nesting Habitat Characteristics in Pekik Nyaring Village, Pondok Kelapa District, Central Bengkulu Regency, Bengkulu Province. *Jurnal Ilmu Kelautan Kepulauan*, 1(1): 59-70.