Reclamation/rehabilitation of the former sea tin mine PT Timah Tbk

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Key words: reclamation/rehabilitation, former sea tin mine, environment, ecosystem

SUMMARY

Tin mining activities both on land and at sea, beside of generating financial benefits from the economic value of tin ore, have also some negative impacts on the environment around ex-mining areas. The reclamation/rehabilitation of ex-mining on land is relatively easier to see in terms of its condition if compared to the reclamation/rehabilitation at the bottom of the sea waters. The impact of opening the tin mining at the bottom of the sea waters apart from leaving land in the form of stretches of land, sand dunes and pits, is also very likely to give some affects of condition of the surrounding ecosystem.

The aim of this research is provide guidance to parties (local government & private sector) regarding concrete steps for Marine Reclamation/Rehabilitation at Underwater Tin post-mining sites and the methods used : the first, the application of surveying and mapping technology to identify location of former tin mining areas at sea or offshore, the second is to implement The coral transplantation and fish shelter methods within the identified areas

The result of coral transplantation and fish shelters have been implemented quite successfully in all sea water of Bangka Belitung except in the sea waters of Pulau Permis, South Bangka Regency, where there are still many tin mining activities at sea by the community (Floating TI) and where the water conditions are more turbidities. The Indicators of success, seen from the index value of the mainstay fish species diversity (H') **1.412 - 3.232** from the standard expected value **H' > 1.5.** Where, the highest **H'** value was found in the Rebo Melantut, Rebo Sungailiat with the number of fish species found as many as 54 species.

RINGKASAN

Kegiatan penambangan timah baik di darat maupun di laut, selain menghasilkan keuntungan finansial dari nilai ekonomis bijih timah, juga menimbulkan dampak negatif terhadap lingkungan sekitar bekas tambang. Reklamasi/rehabilitasi bekas tambang di darat relatif lebih mudah dilihat kondisinya jika dibandingkan dengan reklamasi/rehabilitasi di dasar perairan laut. Dampak pembukaan tambang timah di dasar perairan laut selain meninggalkan daratan berupa hamparan tanah, gumuk pasir dan lubang, juga sangat mungkin memberikan beberapa pengaruh terhadap kondisi ekosistem di sekitarnya.

Penelitian ini bertujuan untuk memberikan arahan kepada pihak-pihak (Pemda & Swasta) mengenai langkah konkrit Reklamasi/Rehabilitasi Laut di lokasi pascatambang Timah Bawah Air dan metode yang digunakan : pertama, penerapan teknologi survei dan pemetaan untuk identifikasi lokasi kawasan bekas penambangan timah di laut atau lepas pantai, yang kedua adalah menerapkan metode transplantasi karang dan penampungan ikan di dalam kawasan yang sudah teridentifikasi lokasinya.

Hasil transplantasi karang dan penampungan ikan telah dilaksanakan dengan cukup berhasil di seluruh perairan Bangka Belitung kecuali di perairan laut Pulau Permis Kabupaten Bangka Selatan yang masih banyak kegiatan penambangan timah di laut oleh masyarakat (TI Terapung) dan dimana kondisi air lebih keruh.

Indikator keberhasilan dilihat dari nilai indeks keanekaragaman jenis ikan andalan (H') 1,412 - 3,232 dari nilai standar harapan H' > 1,5. Dimana nilai H' tertinggi terdapat di Rebo Melantut,Rebo Sungailiat dengan jumlah jenis ikan yang ditemukan sebanyak 54 jenis.

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1. INTRODUCTION

Tin mining activities both on land and at sea, in addition to generating financial benefits from the economic value of tin ore, also have a negative impact on the environment around the post-mining area. Post-mining reclamation/rehabilitation on land is relatively easier to see in terms of conditions compared to reclamation/rehabilitation on the seabed.

The impact of opening a tin mine at the bottom of the sea apart from leaving land in the form of expanses of land, sand dunes and holes, is also very likely to have some effect on the condition of the surrounding ecosystem. The results of tin mining cause some damage to coastal landscapes and ecosystems such as mangroves, coral reefs, seaweed and sedentary species.

Changes in the landscape, reduced richness of biodiversity on land and in the sea and reduced potential for water resources are environmental issues that are of concern to various parties.

Based on the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia Number 1827 K/30/MEM/2018 concerning Guidelines for Good Mining Practices, every mining company is required to carry out reclamation/rehabilitation activities at Production Sites. Stages of operations at sea, including management of seawater quality, prevention and control of coastal abrasion and/or silting, and protection of biodiversity.

Therefore, efforts are needed to restore, repair, and prepare ex-mining land so that it can be reused according to its designation. Rehabilitation efforts basically aim to minimize damage caused by mining activities and are expected to rehabilitate ecosystems and various underwater biota. PT TIMAH Tbk as a tin mining company that has been carrying out offshore mining activities for a long time, of course feels responsible for the life of underwater biota, especially after its production equipment operates in coastal areas.

2. METHODS
3.

This study aims to provide direction/guidance to parties (local government & private sector) regarding concrete steps for Marine Reclamation/Rehabilitation at Underwater Tin post-mining sites and the methods used: first, the application of survey and mapping technology to identify former tin mining locations at sea or offshore, the second is implementing coral transplantation and fish protection methods within the identified area as well as a mangrove planting scheme.

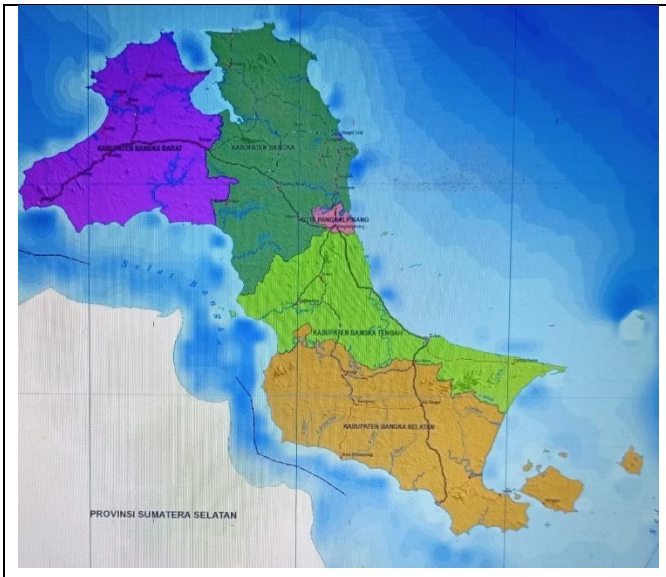
2.1 The Surveying and Mapping Tecnology

The application of survey mapping technology is to determine the condition of post-mining waters and several monitoring activities are also needed to see the condition of the ecosystem around the mining operation area.

This survey activity covered the condition of coral reefs, fish, benthic biota and mangroves as well as conditions around the tin mining area on Bangka Island. Surveys and mapping of water conditions at the location of former tin mining lands at the bottom of the sea and surrounding locations will provide useful information.

Former tin mining land in the form of expanses, sand dunes, and under the former mines at the bottom of the waters is the result of open pit mining on the seabed. Thus, the condition of coral reefs will be heavily affected by sedimentation due to mining activities.

Natural and artificial restoration processes will be able to help coral reefs continue to grow well. From the results of this survey and mapping, we can determine what method is right for reclamation/rehabilitation activities on former tin mining lands on the seabed. West Bangka, South Bangka, Central Bangka. Some of the objects/parameters observed in the survey and mapping are the situation/state of the seabed starting from the condition of the bottom substrate cover, coral fish, and benthic biota.



Administrative Map of Bangka Island

Legend

After knowing the condition of the basic ecosystem of the waters of the former sea tin mine, the next step is to determine the right reclamation/rehabilitation program. What method will be used by PT TIMAH Tbk in determining the location of the reclamation/rehabilitation

activities of this former marine tin mine. So that the application of coral transplantation techniques, and placement of fish shelters, as well as planting mangroves can be easily carried out.

2.1.1 The coral transplantation and fish shelter serta penanaman mangrove.

In determining the type of activity, the reclamation/rehabilitation activities will start from considering the carrying capacity of the environment regarding the prevailing conditions, such as the existence of coral reef ecosystems, the level of diversity of fish species and other aquatic biota. Meanwhile, the determination of the location for the reclamation/rehabilitation activities of former marine tin mines begins based on consideration of the impact of mining activities.

In contrast to reclamation activities on land, reclamation/rehabilitation of former sea tin mines is carried out at ex-mining locations because the carrying capacity of the environment is still very low and is still affected by mining activities in the vicinity. Therefore, on the basis of these considerations, for the implementation of reclamation/rehabilitation of former marine tin mines it is best to select a location based on the following criteria:

- In Mining Business Permit (IUP),
- Outside the IUP and within the boundaries of the Environmental Benefit and Risk Analysis study (AMDAL)
- In accordance with the agreement between stakeholders

So based on the consideration of the results of the survey and mapping of the situation at the former marine tin mining site on Bangka Island, the type of program that is right to do is transplanting coral reefs, sinking and placing fish shelters and planting effective mangroves.

2.1.2 Coral Reef Transplant

In the rehabilitation of coral reef ecosystems around the IUP Area through the coral reef transplantation method using coral broodstock sources around the activity location (in situ). Equipment that can be prepared includes: SCUBA diving equipment, calipers/calipers, GPS, underwater stationery (slate), buckets/baskets, ropes, underwater cameras, transplant media. The transplant media is a place for the transplanted coral seedlings to attach and become a new habitat for corals to grow and develop. Where the selection of coral transplant designs is based on the characteristics of coral reefs waters and the proper coral transplant design for use in Bangka waters are as follows:

Figure 1 Coral Reef Transplant Design in Bangka waters

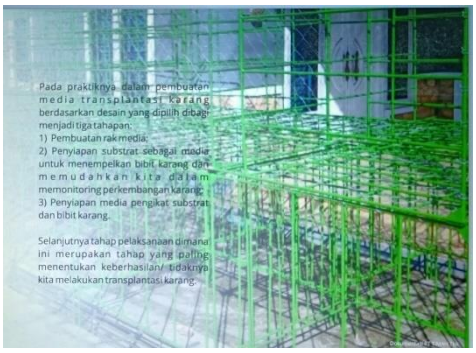


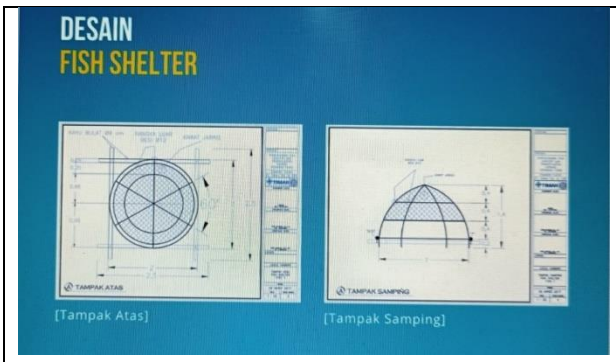
Figure 2 Physical Realization of Coral Reef Transplant Media

Captions in Figures 1 and 2: In practice, the manufacture of coral reef transplant media based on the selected design is divided into three stages, namely: *1) Making media racks; 2) Prepare the substrate as a medium for attaching coral seeds to make it easier for us to monitor coral development; 3) Preparation of substrate binding media and coral seeds.*

2.1.1 Drowning and Placement of fish shelters

A fish shelter is a building designed to attract fish around the placement site, and is expected to become a place for fish development and increase the abundance and diversity of fish and coral reefs. This fish shelter is also intended as a substitute for coral reefs as artificial shelters for fish.

Preparation for sinking and placement of fish shelters is the same as preparation for transplanting corals. The sinking concept/scheme needs to be worked out first. After that, implementing the method to be used, here we can immediately prepare the necessary resources, including: SCUBA diving equipment, GPS, underwater stationery (slate), weights, ropes, underwater cameras.



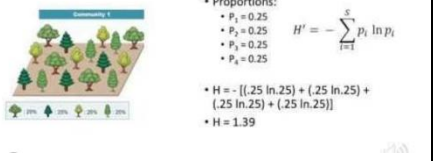
Gambar 3

Gambar 4

Information in Figures 3 and 4: Similar to the design of coral reef transplantation media, there are also many examples of fish shelter building designs and can be seen on the internet or research journals and this design is from one of the Bangka Belitung University researchers. *This design uses a design like a serving hood which is a symbol/characteristic of the Bangka Belitung Islands.*

This fish shelter building is made of 10 mm thick iron frame which is designed to resemble a serving hood. Some things that need to be considered are the building weights that function as building anchors so that the building is not carried away by strong water currents. If the anchors are not strong enough to hold the building then the building will move from one place to another, this will damage the building and most importantly it will be difficult to monitor and evaluate.

Drowning and placement of fish shelters using conventional methods with the help of fishing boats pulled to the sinking location. Furthermore, the fish storage media is submerged and arranged at the bottom of the waters to facilitate monitoring and evaluation activities. After the immersion and placement activities have been completed, the next most important thing to do is Monitoring and Evaluation. *A fish shelter can be said to be successful as a new habitat if the Diversity Index (H') value is between 1-3*. The most widely used diversity index is the Shannon Wiener Index (Odum, 1971) with the formula:

The Shannon diversity index (*H*) $H = -\sum_{i=1}^{s} p_i \ln p_i$	Sample calculation for community 1  • Proportions: • $P_1 = 0.25$ • $P_2 = 0.25$ • $P_3 = 0.25$ • $P_4 = 0.25$ $H' = -\sum_{i=1}^{s} p_i \ln p_i$ • H = - [(.25 ln.25) + (.25 ln.25) + (.25 ln.25) + (.25 ln.25)] • H = 1.39
Figure 5	Figure 6

Information in Figures 5 and 6: Application of the Shannon Wiener Diversity index formula, where: H = Diversity index, Pi = Comparison of the proportion of fish to i, S = Number of benthic biota found, Natural logarithm (In) is used for benthic biota communities because benthic are biota that move passively, have a low relative abundance and certain habitat preferences.

The diversity index is classified according to the following criteria: **2 < H' ≤ 3** : *Moderate diversity*, fairly balanced ecosystem; **H' > 3** : *High diversity*, stable ecosystem. In addition to the diversity index, dominance and uniformity indices can also be used as complementary data on the success rate of fish shelters. In addition, measuring the level of fish abundance and natural recruitment of biota around the fish shelter can be used as the basis for the success of the fish shelter.

2.2.3 Mangrove Planting

This activity is widely known by the community and in this research we will share knowledge and experiences related to planting mangroves in locations close to mining activities. Things that need to be considered in preparing for mangrove planting are the suitability of the type and location. The suitability of mangrove species in locations affected by mining activities is the main thing for the success of planting activities. Some types of mangrove plants require certain growing conditions.

Mangroves and coastal plants are planted as an effort to protect the coast from abrasion. Some efforts to protect the coast from abrasion are carried out by planting coastal plants (*Sea Conifers and Ketapang*) on the coast.

Reclamation activities are carried out using a potting system. This is done to control the availability of nutrients in the soil. In addition to planting mangroves, the planting is carried out in areas where there are mangrove communities so that the existence of mangroves in these locations is maintained. Various tools used in sea reclamation activities include: *shovels, hoes, wheelbarrows, and equipment for the construction of retaining embankments.*

In coastal areas that experience of abrasion, the types of plants chosen as a form of reclamation activity are mangrove plants such as *Rhizophora sp (mangrove), Sonneratia sp (quadruple plant), Avicennia sp and coastal plants such as Casuaria equisetifolia (Circa at sea) and Terminalia catappa (Ketapang).*

An initial survey at the planned planting location is necessary to determine whether or not it is appropriate to plant coastal plants and mangroves at that location.

How to plant beach plants is done with a spacing of 4 x 4 meters. Meanwhile, mangrove planting can be done in two ways depending on the conditions at the planting location. This method includes:

1. *Planting Distance Method (2 m x 1 m)*

• At the planting stage, mangrove species are grouped by type. Mangrove seedlings are planted at the planting site using a mangrove planting technique using stakes. The use of stakes is useful for keeping the mangrove seedlings from falling when hit by waves. Spacing 2 m x 1 m.

• Mangroves are planted by making holes near the stake, with a size larger than the size of the polybag and with a depth twice the length of the polybag. The seeds are planted vertically into the planting hole by carefully removing the seeds from the polybag and not damaging the roots. Between the holes around the seed, covered with soil. Seeds that have been planted, the stems are tied with stakes, so that they do not easily fall when the tide occurs (Figure 7)

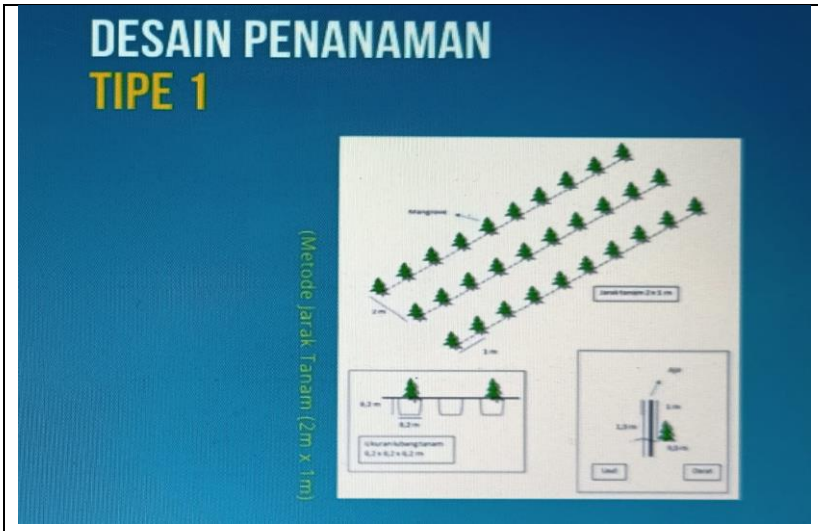
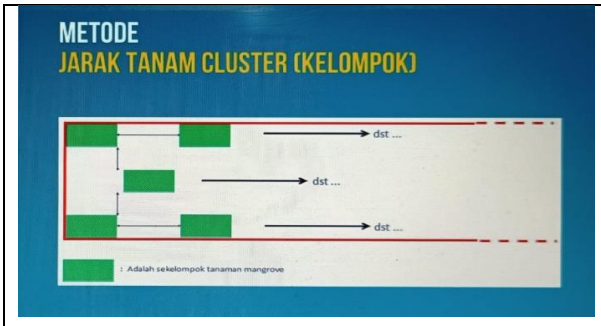


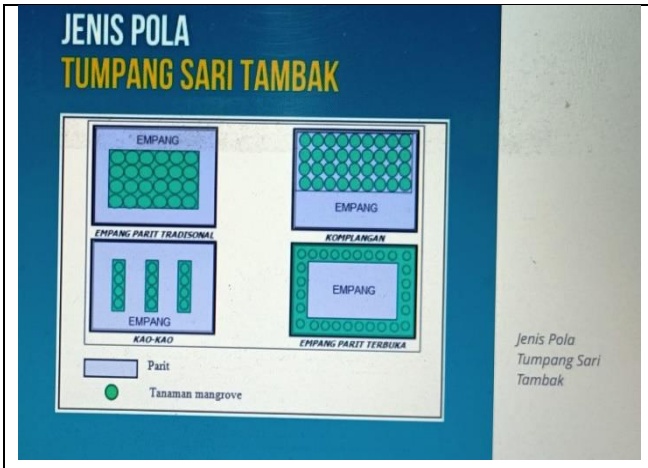
Figure 7 Mangrove Planting Design TYPE 1

2. *Cluster/Group Method*



At the planting stage, mangrove species are grouped by type. Mangrove seedlings are planted at the planting site using the mangrove planting technique in groups (clusters) where the mangroves planted are within the scope of the marker. The use of stakes is useful for keeping mangrove seedlings from falling when hit by waves (Figure 8).

Figure 8 Cluster Spacing (Group)

	In addition to this method of planting mangroves, planting mangroves can be done using an intercropping pond system to optimize and support capacity building and community empowerment and help protect biodiversity. In several locations in the Kundur area there is potential for mangrove planting activities with this system which can be used as pilot locations. In addition to maintaining the existence and improving the mangrove ecosystem, this activity will later be integrated with fish/crab farming activities. (Picture 9)
Figure 9 Intercropping pattern of ponds	

3. RESULTS

3.1 Results of survey and mapping of the state of the seabed in a former marine tin mine

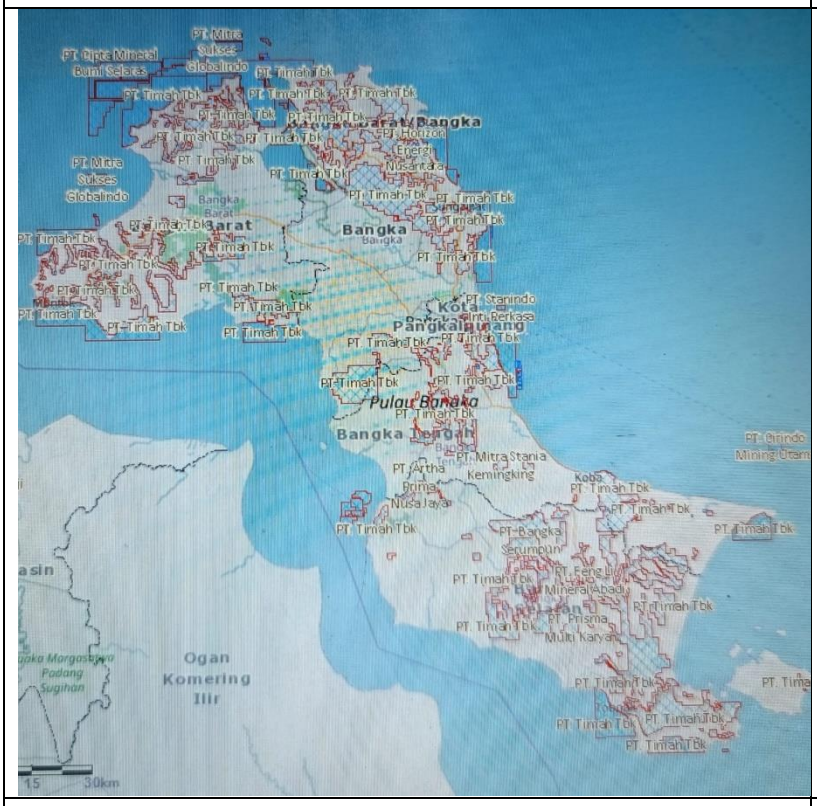
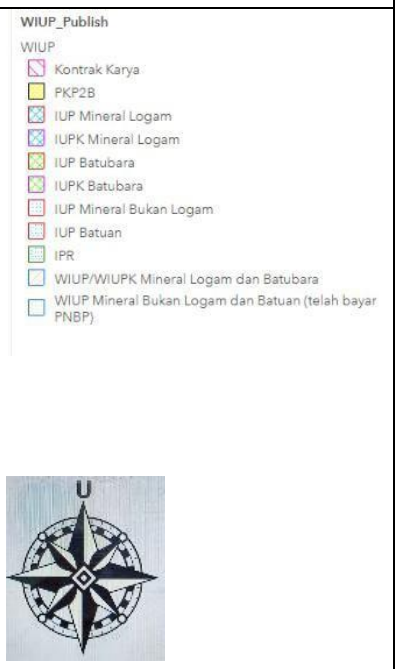
in the areas of Bangka Island, West Bangka, South Bangka, Central Bangka so far this has only been done to identify the best location area to penetrate and analyze the *Basic Substrate Cover Conditions, Condition of Reef Fish and Condition of Benthic Biota.*

As a condition to prepare the implementation of coral transplantation activities and fish shelters as well as planting mangroves that are environmentally friendly

3.2 The coral transplantation and fish shelter

Making coral reef transplant media based on the selected design is divided into three stages:

Making media racks; Prepare the substrate as a medium for attaching coral seeds to make it easier for us to monitor coral development; Preparation of substrate binding media and coral seeds.

Distribution marine reclamation/rehabilitation activities at former marine tin mines in the areas of Bangka Island	Figure 10
	
Location IUP (Mining Bisnis Permit) PT Timah Tbk	Legend

Implementation of marine reclamation/rehabilitation activities at former marine tin mines in the areas of Bangka Island, West Bangka, South Bangka, Central Bangka, the location selection was based on the following criteria :

In Mining Business Permit (IUP); Outside the IUP and within the boundaries of the Environmental Benefit and Risk Analysis Study (AMDAL) ; In accordance with the agreement between stakeholders

So based on the consideration of the results of the survey and mapping of the situation of the former marine tin mining location on Bangka Island, the type of program that is appropriate to carry out includes transplanting coral reefs, sinking and placing fish shelters.

The indicator of success, seen from the mainstay fish species diversity index :

(**H'**) **1.412 - 3.232** from the standard expected value **H'> 1.5**.

Fish shelters have been quite successful in being implemented throughout the waters of Bangka Belitung except in the waters of Pulau Permis, South Bangka Regency, where there

are still many tin mining activities at sea by the community (Floating TI) and where the water conditions are more turbid.

The highest **H'** value was found in the Rebo Melantut &Rebo Sungailiat with the number of fish species found as many as 54 species,"

3.3 Planting mangroves

In areas commensurate with the coast of the former sea tin mine on Bangka Island, West Bangka, South Bangka, Central Bangka which experienced of abrasion, the types of plants chosen as a form of reclamation activity were mangrove plants of the types *Rhizophora sp (mangrove plant), Sonneratia sp (plant quad). , Avicennia sp and beach plants such as Casuaria equisetifolia (Sea cypress) and Terminalia catappa (Ketapang).*

CONCLUSION

1 The Success Implementation of a coral transplantation system and fish shelter in former tin mining areas at sea or offshore in the Bangka Belitung Islands. Becoming an effort of sustainable reclamation so that the ecosystem can grow and bring sustainable economic benefits
2 The Coral transplantation and fish shelter methods will be implemented in Bangka, West Bangka, Central Bangka and South Bangka Regencies.
3 Especially in South Bangka Regency, only the fish shelter program, while in other districts it is complete for fish shelter and coral transplants. Several areas where fish shelters have been placed, will become *fishing and catching locations* for fishermen.
4 The Empowerment of fishing communities in ten points of the reclamation/rehabilitation area namely Player Island, Gunung Namak Beach, Mattress Waters, Karang Kering Rebo,

Karang Melantut, Pulau Putri, Pulau Panjang, Karang Aji, Karang Tanjung Ular,andTanjung Melala.

5 Meanwhile, for coral transplants, not all of them have been successful because corals have a high sensitivity to decreasing water quality.

6 The condition of the waters which are still affected by the impact of mining in the sea is not optimal for coral growth, especially the changing currents and waves.

7 Some of the transplanted corals grew well, but many of them died covered in fine mud sediments and were lost/dislodged due to currents.

8. Many of the coral transplant modules in the waters of Tanjung Melala, Parit Tiga District, West Bangka Regency, were damaged by strong waves during the west monsoon.
9. The Coral transplants in several areas have been quite good, including on Pulau Panjang, Regency of Central Bangka, Tanjung Melala, Regency of West Bangka, Karang Batu Putih, Pulau Putri, and Karang Melantut, Bangka Regency.
10. PT Timah as the initiator of sea reclamation can already be an example for local governments and private companies that carry out mining activities in the sea.
11. The method of reclamation/rehabilitation after offshore mining will become a reference and input for local governments in preparing technical guidelines regarding reclamation/rehabilitation activities at the Production Operations stage at sea.
12. PT TIMAH, Tbk will always be committed to continuing to be friendly with marine or sea by maintaining its biodiversity which includes covering the condition of coral reefs, fish,benthic and mangrove biota as well as the local communites, by sharing knowledge and experience in carrying out marine reclamation/rehabilitation activities.

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