Monitoring and Measurement of the Success of Coral Transplantation at The Mokotamba Dive point, Likupang as a Super Priority Tourism Destination

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***Abstract*—This research aimed to monitor and measure the level of success of coral transplants carried out in 2021, including measuring the growth rate of transplanted corals and the survival rate of corals, the number of live and dead fragments and the resistance of the transplant substrate. The measurements were carried out on coral transplants that had been transplanted into 4 media. The sondo-shaped transplants were distributed in the Mokotamba Pulisan dive area, Likupang in the form of sondos at a 5 meters depth . This research was applied research as a continuation of previous research carried out in 2021 by monitoring and measuring the success of coral transplantation. The research resulted monitoring and measuring the success rate of coral transplantation that was carried out at the Mokotamba Pulisan dive point in Likupang. This research used a direct, continuous and detailed field observation method, namely by diving at the Mokotamba dive point using underwater camera equipment, scuba Secchi disc equipment, a thermometer, and a ruler or measuring instrument for measuring the length of coral. Measurement of success level refers to data the results of the previous measurement in 2021 were the measurement data for the initial length of coral fragments in each unit of available growing media. Research in 2021 continued with monitoring and measurement to obtain the growth rate and survival rate of transplanted coral fragments. The results of the research showed significant success in both coral growth and the biota and coral configuration that was created and grew at the Mokotamba dive point.**

***Keywords*—Monitoring, transplantation, corals, Mokotamba, Pulisan, Likupang**

I. INTRODUCTION

This research focused on monitoring and measuring the success of coral transplantation at the Mokotamba dive point, Likupang as a Super Priority Tourism Destination. Measuring the success of Coral Transplantation through monitoring and the results of the coral transplantation program carried out previously by the same team. The method used was a direct field survey at the Mokotamba dive point, Pulisan Likupang. Data collection was carried out by monitoring by diving to monitor the results of the transplantation that was carried out using 4 transplant media in the form of Sondo. The tools used in this monitoring activity were water-borne camera equipment, scuba secchi disc equipment, thermometers and rulers or measuring instruments for measuring coral length. The success rate measurement referred to the data from the previous measurement results in 2021, namely data on the initial length measurement of coral fragments in each unit of growing media that were available. The research had been continued with monitoring and measurement to obtain the growth rate and survival rate of transplanted coral fragments. This research aimed to monitor and measure the level of success of coral transplantation that includes measuring the growth rate of transplanted corals and the survival rate of corals, the number of live and dead fragments and the resistance of the transplant substrate.

Study Sites

Mokotamba Dive Point in Pulisan is located at 1° 68' 0.26" North Latitude and, 125° 13' 8.92", East Longitude. Mokotamba Point is located on Pulisan Beach as a natural beach in North Minahasa Regency, Indonesia. This area is located in the Likupang area as a Special Economic Zone in North Sulawesi Province, Indonesia. Pulisan Beach is well-known as the hidden paradise. This name is given because of the hidden location of this beach. Optimal development and utilization of tourism can improve the tourist area better so that it becomes an attraction for tourists. The development of this tourist area is intended to increase the beauty of tourist attractions without destroying the existing natural ecosystem. Good management is a way to develop tourist areas so that they can be better known by the public. As a Super Priority Tourism Destination in Indonesia, the arrangement and development of tourist attractions including underwater tourist attractions needs to continue to be developed to support the acceleration and sustainability of tourism development in the Pulisan, Likupang tourism dive area as a Super Priority Tourism Destination in Indonesia.

II. THORETICAL BASES

A. Monitoring

Monitoring is required as a control tool to assess the condition of coral fragments and planting material. The transplanted corals will be monitored for a year, from July 2021 to July 2022, with measurements every three months. Monitoring the Effectiveness of Coral Restoration The average duration of monitoring for all coral transplant studies was less than two years (22.52.4 months);

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nevertheless, the majority of studies (53%) were followed for one year or less. Only 5% of studies were observed for more than 5 years, while in 2% of research, the length of monitoring was not indicated. Although these time durations are enough for assessing the viability of transplantation techniques, they are insufficient for determining their utility in reestablishing coral communications. Coral growth and survival were initially low in two long-term trials, but later mirrored observed patterns in onies [1] [2] . Another study found that fish assemblages grew over time when restored areas were inhabited by a variety of fish. All long-term studies highlight significant year-to-year variability in the growth and survival of transplanted coral pieces as a result of disturbances such as storms or bleaching episodes. Overall, the program's official short-term monitoring hinders our understanding of coral restoration effectiveness. All long-term studies highlight significant year-to-year variability in the growth and survival of transplanted coral pieces as a result of disturbances such as storms or bleaching episodes. Overall, short-term monitoring programs impede our understanding of the effectiveness of coral restoration [21]. Monitoring the success of ecological restoration typically entails a two-stage monitoring program that corresponds to: (1) an early establishment phase following transplantation related to the transplant's biological response (e.g. initial post-transplant growth, Fragment fusion to substrata) and (2) a long-term building phase when the transplant grows in size and potentially has broader environmental and socioeconomic benefits [3] Leet et al..

B. Coral Transplant

Coral transplantation is one of the actions that are carried out to restore or rehabilitate coral reefs. According to Anonymous (2015), rehabilitation initiatives aim to recover damaged corals. Young corals are propagated in specific sites before being transplanted. The following are some of the most common coral transplant methods [4] :

- The Beginning Method. The stake method is a transplant procedure that involves sticking waterproof wooden or iron stakes painted anti-rust in the bottom of the pond.
- Netting Technique. The net technique is a mode of transportation that employs nets or ropes of varying sizes.
- Substrate and Mesh Method. This method employs a net equipped with a 10 x 10 cm substrate composed of cement, ceramic, or earthenware.
- The net and frame methods. A stainless steel frame measuring 100 cm × 80 cm with legs each 10 cm long is used in this transplant method. The top is netting-covered..
- Methods of net, frame, and substrate. It is a transplant method that combines the net method with a substrate. The substrate has a diameter of around 10 cm, a thickness of 2 cm, and a stake length of 5-10 cm.

Coral transplantation research is frequently conducted in order to save coral reefs. Coral transplantation is one of the activities carried out to restore or rehabilitate coral reefs. According to [11] , there has been a worldwide shift over the previous three decades, from traditional, typically sustainable, exploitation of coral reef resources to a significant increase in demand, mostly due to demographic change. At the same time, coral reefs in many geographical regions have degraded due to both natural reasons (e.g., tropical cyclones, volcanic activity, tidal disasters). Coral transplantation is one of the actions that are carried out to restore or rehabilitate coral reefs. According to Anonymous (2015), rehabilitation initiatives aim to recover damaged corals. Young corals are propagated in specific sites before being transplanted. Young corals are propagated in specific sites before being transplanted. For a variety of reasons, coral transplantation has been investigated as a potential reef management alternative [5]. The possibility of transplants to aid reef recovery following dynamite fishing has been extensively researched in the Philippines [6][7] [8].

It has been used on Guam to replace coral killed by thermal dilution from power plants [9] , as well as in Singapore to save species threatened by pollution or habitat loss due to reclamation [10] [12] . Hawaiian Transplants were utilized in Kanehoe Bay to reintroduce and evaluate the survival of two coral species in sewage-contaminated areas [13] [14] and in Florida to speed up reef recovery following Wellwoodgrounding [15] [16]. [17] transplanted large coral heads to improve tourism areas in the Gulf of Aqaba, and [18] tested whether transplantation could speed the recovery of coral areas damaged by the crown-of-thorns starfish (*Acanthaster plancii*) at the Great Barrier Reef Marine Park. Transplants die at a high rate in areas with poor environmental conditions [14] [9] , while in areas with good water quality, transplants in relatively low energy surroundings tend to live well. Several regularly utilized coral transplant methods, according to [4] are: The Patok technique. The stake method is a transplant procedure that involves sticking waterproof wooden or iron stakes painted anti-rust in the bottom of the pond.

- Netting Technique. The net technique is a mode of transportation that employs nets or ropes of varying sizes.
- Substrate and Mesh Method. This method employs a net equipped with a 10 x 10 cm substrate composed of cement, ceramic, or earthenware.
- The net and frame methods. A stainless steel frame measuring 100 cm × 80 cm with legs each 10 cm long is used in this transplant method. The top is netting-covered.
- Methods of net, frame, and substrate. It is a transplant method that combines the net method with a substrate. The substrate has a diameter of around 10 cm, a thickness of 2 cm, and a stake length of 5-10 cm.

[19] reveals that the stages of coral transplantation include the following methods:

- Determination of site: GPS (Global Positioning System) can be utilized to determine the transplant site and obtain geographical coordinates.
- Tool preparation: Gather the tools and materials that will be utilized in the transplant.
- Marking: Placing a mark (floating symbol) at the site of the transplant.
- Coral Hunt: Looking for coral to transplant. Coral fragments are collected in a perforated basket and transported to the transplant place from living parent colonies with a diameter of >25 cm using scissors with a Fragment Size of roughly 10 cm. However, it should be highlighted that this study does not use this method, but rather coral that has been injured owing to a variety of factors, such as fishing operations and wave damage.
- Transportation Process: The transportation process must be carefully carried out underwater.
- Frame Installation: Place an iron frame or stakes parallel to the coastline at the transplant location. The transplant frame can be installed at a depth of 1.3 or 10 cm.
- Fastening Coral Fragments: Use prepared cable ties to secure coral fragments to the substrate.
- Sizing Growth Rate: Every two weeks or every month, the growth rate of coral colonies and the physico-chemical parameters of the water can be measured.

Coral transplantation has the advantage of hastening the healing of damaged coral reefs and can also be utilized to create new coral reef regions that did not previously exist. One of the most important applications of coral transplantation is to transfer adult corals to a population in order to enhance larval production in damaged coral reef ecosystems. A concrete container is required as a substrate for the coral to be implanted, branched coral types grow faster and are more adaptable than massive corals, and water locations can be transplanted as long as the hydraulic conditions remain within the tolerance limits of coral growth. Transplanted coral containers do not obstruct current aeration.

III. METHODS

This research used direct, continuous and detailed field observation methods, namely by diving at the Mokotamba diving point using underwater camera equipment (for documentation), scuba diving equipment (equipment for diving), Secchi disc (a tool for measuring water brightness), dive computer (measuring temperature and depth of water), refractometer (tool for measuring salinity/salt content of water), ruler or tool for measuring coral length. This research used direct, continuous and detailed field observation methods by diving at the Mokotamba diving point using underwater camera (for documentation), scuba diving equipment (equipment for diving), Secchi disc (a tool for measuring water brightness), dive computer (measuring the temperature and depth of the water), and a ruler or tool for measuring the coral length.

Figure 1: Initial measurement of coral Fragment to be transplanted (Research Team, 2021)

Success rate of Measurement refers to data from the previous measuremment results, namely the data ini 2021, data consisted of measurement of the initial length of coral fragments in each unit of available growing media (Figure 1). In this 2023 research, measurement continued with monitoring and measurement to obtain the growth rate and survival rate of transplanted coral fragments. The measurement stages are:

- Measuring coral growth was carried out by measuring the length of each coral fragment that was transplanted into the planting medium (4 growing media) that was planted in 2021. Measurement of coral fragments was carried out directly (on site) using a measuring tool and starting from the host or base part that was attached to the planting medium to the tip of the coral. The coral fragments measured were coral fragments that had been previously marked so that researchers can differentiate transplanted coral fragments from naturally attached coral fragments. Every coral fragment measured was documented. Measuring the survival rate of transplanted corals was by calculating the number of coral fragments that were still alive and the number of coral fragments that have died from all transplanted coral fragments.

- Next, measure the water conditions using several parameters determined. Measure the level of brightness, temperature and salinity of the water.Measuring the brightness of the waters was done by lowering the secchi disc from the top of the boat to the bottom of the water until the secchi disc was no longer visible, so that the brightness of the waters will be visible based on the length of the secchi plate string that was lowered. Measuring water temperature using a dive computer directly when measuring coral growth. Measurement of water temperature using Celsius degree. To measure salinity, researchers used a refractometer where the researcher takes a certain amount of water and places it in the refractometer, then the water salinity number will be printed on the tool and the results can be seen immediately.

Data processing fo rmeasuring the growth rate of transplanted coral fragments used the formula [20] :

$$\alpha = Lt - Lo \quad \ldots\ldots 1$$

Description :
α = Achievement of increasing length of transplanted coral fragments
Lt = Average Fragment length after t-th month
Lo = Average Fragment length after o-th month

Next, to calculate the survival rate (Survival Rate) of transplanted coral fragments , [20] was used as below :

$$SR = \frac{Nt}{No} \times 100 \quad \ldots\ldots 2$$

Where :
SR = Survival Rate (Survival rate)
Nt = Final number of individuals
No = Initial number of individuals
Then to calculate the growth rate of transplanted coral is as follows [20] :

$$GR = Lt - Lo\ t \quad \ldots\ldots 3$$

Description :
GR: Growth Rate / Growth Rate (cm/month)

Lt : Coral length at t- time
Lo: Length of initial coral
t : Observation duration.

IV. RESULTS AND DISCUSSION

The results of research on monitoring and measurement of coral transplant results can be seen as follows:

Transplanted coral

This research used transplanted coral species, namely Acropora, Seriatopora, Hydnopora, Meliopora, and montipora. Monitoring and observation results showed that several biota had advantage of the presence of this planting medium by attaching and developing with the transplanted coral, namely, several types of ascidians, soft corals and sponges (Figure 2).

Figure 2: Ascidians attached to the substrate of the transplanted coral growing media
(Researcher Team, 2023)

Novelty of transplant results

The novelty in this research was the implementation of coastal tourism resource conservation efforts, especially diving tourism that relied on underwater beauty including coral reefs and underwater diversity, especially the Mokotamba diving tourism in Pulisan, Likupang.It is done to strengthen, accelerate and sustain, the monitoring and evaluation carried out can be implemented in all destinations in Indonesia with a vision of developing sustainable tourism. Figure 3 showed a visual figure before and after coral transplantation was carried out.

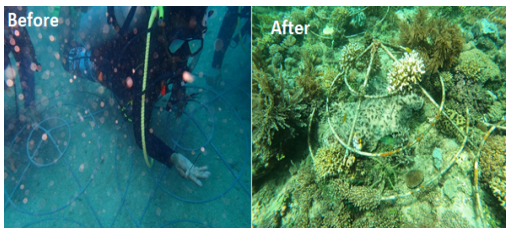

Figure 3: Visualization of transplant result in the form of a sondo
(Researcher Team, 2023)

The novelty in this research is the design of a sondo-shaped transplant media that has actually been significantly successful. The monitoring results showed the success of coral transplants that can be exemplified in conservation efforts in supporting sustainable tourism development in tourist destinations including Likupang as a super priority tourism destination.

Monitoring Result

The application of the this research result is the implementation of monitoring and evaluation of the results of coral transplantation at the tourist destination Mokotamba dive point in Pulisan, Likupang. Monitoring the results of coral transplantation appropriately and accurately to the community in an open manner and can be carried out in an integrated manner by all parties that currently does not exist. Figure 4 showed the configuration of transplanted coral reefs that form a collection of biota around the coral transplants as the main underwater tourism attraction at the Mokotamba Pulisan dive point.

Figure 4. Monitoring results of transplanted coral Fragment ts
(Researcher Team, 2023)

The impact of developing coral configuration through coral transplantation on underwater paradigms, especially on naturally occurring biota such as fish, crabs, shrimp, sea urchins and shellfish. The results of the research that are highlighted showed the application of the efforts to conserve coral reef natural resources as the main attraction of diving tourism. This conservation effort needs to be carried out by all tourism stakeholders in an integrated manner. The value of the novelty and technological breakthrough carried out was the implementation of coral transplantation at tourism destination points in an integrated and comprehensive manner in one marine tourism destination development package.

Measurement Result

Monitoring of transplanted corals was previously planned, namely carried out 4 times (every 3 months). Monitoring was carried out on each coral that was transplanted into four growing media. Measurement was done by using a ruler at the height of each transplanted coral fragment. The monitoring plan is shown in the table below. The planned monitoring had been carried out at

this time, namely in July 2021, October 2021, January 2022, April 2022 and July 2022. The results of the initial size of Fragment 1-13 in July 2021 can be seen in Table 1.

Table 1. Results of initial length measurements of transplanted coral Fragments on July 2021

GROWING MEDIA							
1		2		3		4	
Fragment	Size (cm)	Fragment	Size (cm)	Fragment	Size (cm)	Fragment	Size (cm)
1	7	1	9.5	1	14	1	7.5
2	7.5	2	9	2	8.5	2	9.5
3	7.5	3	6	3	13	3	9.5
4	5.5	4	7	4	6	4	5
5	5	5	6.5	5	6.5	5	7.5
6	6.5	6	6.5	6	8.5	6	14
7	8	7	10	7	7.5	7	5
8	7	8	9.5	8	9.5	8	9.5
9	6.5	9	7	9	8	9	7
10	5.5	10	7	10	8	10	14
11	6	11	8	11	5	11	12
12	12	12	7	12	10.5	12	7.5
13	12	13	8	13	11.5	13	9

Source : Researcher Team, 2021

Table 2 was the result of the first monitoring and measurement carried out in October 2021 that showed the 3rd and 4th growing media several coral fragments had died, namely coral fragments 12 and 13 for the 3rd growing media and coral fragments 5.6. 7,8,10,11,12 and 13 for the 4th planting media (Table 2). The data shown in Table 4 showed that several coral fragments had started to grow after successfully passing the acclimatization period.

Table 2. Results of Transplant Coral Fragment Length Measurement on **October 2021**

GROWING MEDIA							
1		2		3		4	
Fragment	Size (cm)	Fragment	Size (cm)	Fragment	Size (cm)	Fragment	Size (cm)
1	8	1	10.4	1	14.5	1	9
2	8	2	10.1	2	9,5	2	10,5
3	8,5	3	6.7	3	15	3	10,5
4	6	4	7.6	4	6.3	4	5.8
5	6	5	7	5	8	5	-
6	7,5	6	7	6	8,9	6	-
7	8.8	7	11.3	7	8.6	7	-
8	8.5	8	10	8	12	8	-
9	7	9	7.8	9	8.6	9	8.5
10	6	10	8	10	9	10	-
11	6.6	11	8.5	11	6.4	11	-
12	12.4	12	8	12	-	12	-
13	12.3	13	9	13	-	13	-

Furthermore, the second monitoring carried out in January 2022 (Table 3) showed that several coral fragments did not survive in the four growing media.

Table 3. Results of Transplant Coral Fragment Length Measurement on **January 2022**

GROWING MEDIA							
1		2		3		4	
Fragment	Size (cm)	Fragment	Size (cm)	Fragment	Size (cm)	Fragment	Size (cm)
1	9.6	1	12.3	1	16.2	1	10.6
2	10.2	2	-	2	11	2	11.7
3	11	3	8.2	3	16.7	3	11.9
4	8.3	4	-	4	-	4	6.5
5	7.4	5	9.1	5	-	5	-
6	-	6	8.7	6	9.8	6	-
7	10	7	13.2	7	10	7	-
8	10.1	8	-	8	-	8	-
9	-	9	-	9	-	9	10
10	-	10	-	10	-	10	-
11	7.2	11	-	11	8.6	11	-
12	-	12	9.8	12	-	12	-
13	-	13	-	13	-	13	-

The results of the third monitoring in Table 4 showed that the growth of transplanted corals was better.

Table 4.Results of Transplant Coral Fragment Length Measurement on **April 2022**

GROWING MEDIA							
1		2		3		4	
Fragment	Size (cm)	Fragment	Size (cm)	Fragment	Size (cm)	Fragment	Size (cm)
1	10.3	1	13.8	1	18.7	1	12
2	11	2	-	2	13.1	2	12.8
3	12.2	3	10.3	3	18.3	3	12.8
4	9.6	4	-	4	-	4	8
5	8.9	5	11	5	-	5	-
6	-	6	10	6	11.6	6	-
7	11.3	7	14.8	7	11.8	7	-
8	10.9	8	-	8	-	8	-
9	-	9	-	9	-	9	11.7
10	-	10	-	10	-	10	-
11	8.7	11	-	11	9.7	11	-
12	-	12	10.6	12	-	12	-
13	-	13	-	13	-	13	-

Source : Researcher Team, 2023

Table 5 showed the results of the 4th monitoring showed that the coral fragments that were transplanted into the four growing media were increasingly developing and growing well.

Table 5. Results of Transplant Coral Fragment Length Measurement on **July 2022**.

GROWING MEDIA							
1		2		3		4	
Fragment	Size (cm)	Fragment	Size (cm)	Fragment	Size (cm)	Fragment	Size (cm)
1	12.5	1	15.6	1	20.7	1	13.2
2	13	2	-	2	14.8	2	13.6
3	14.7	3	11.8	3	20.5	3	13.9
4	11.6	4	-	4	-	4	10
5	11	5	12.3	5	-	5	-
6	-	6	12	6	13.2	6	-
7	13.6	7	16.3	7	13.5	7	-
8	12.9	8	-	8	-	8	-
9	-	9	-	9	-	9	13.2
10	-	10	-	10	-	10	-
11	11	11	-	11	12	11	-
12	-	12	12.3	12	-	12	-
13	-	13	-	13	-	13	-

Source : Researcher Team, 2023

Initial (2021) and final (2023) Measurement results

Coral length measurement results were also carried out to compare all 4 transplant media in 2021 (intial) and in 2023 (final when monitoring was carried out) at 5 meters depth.

GROWING MEDIA OF 5 METERS DEPTH											
1			2			3			4		
Fragment	Size (cm)	Size (cm)	Fragment	Size (cm)	Size (cm)	Fragment	Size (cm)	Size (cm)	Fragment	Size (cm)	Size (cm)
	2021	2023		2021	2023		2021	2023		2021	2023
1	7	20	1	9.5	22.4	1	14	25.3	1	7.5	24.3
2	7.5	24	2	9	-	2	8.5	19.5	2	9.5	25
3	7.5	25	3	6	20.3	3	13	24.9	3	9.5	24.4
4	5.5	19	4	7	-	4	6	-	4	5	22.1
5	5	19.6	5	6.5	21.1	5	6.5	-	5	7.5	-
6	6.5	-	6	6.5	20	6	8.5	21.2	6	14	-
7	8	22.3	7	10	22.8	7	7.5	21.3	7	5	-
8	7	21.7	8	9.5	-	8	9.5	-	8	9.5	-
9	6.5	-	9	7	-	9	8	-	9	7	23.2
10	5.5	-	10	7	-	10	8	-	10	14	-
11	6	20	11	8	-	11	5	21	11	12	-
12	12	-	12	7	21.5	12	10.5	-	12	7.5	-
13	12	-	13	8	-	13	11.5	-	13	9	-

Source : Researcher Team, 2023

Table 6 presented the monitoring results that showed growing media 1 to 4, there were several coral fragments that died or could not survive. It showed that of the total of 52 coral fragments that were transplanted in 2021, there were 27 coral fragments that

could not survive and died and only 25 fragments were alive, growing and developing. The growth rate of transplanted corals, as shown in table 6 above and it was the average growth rate. (in cm).

Coral Growth Rate

Below we presented the results of monitoring and measurment of the results of coral transplantation at a 5 meters depth with growth rate for each planting medium.

Table 7. Results of Coral Fragments Transplanted in growing media 1

GROWING MEDIA OF 5 METERS DEPTH							
1							
Fragment	July 2021	October 2021	Jan-22	April 2022	July 2022	April 2023	Growth Rate
1	7	8	9.6	10.3	12.5	20	13
2	7.5	8	10.2	11	13	24	16.5
3	7.5	8.5	11	12.2	14.7	25	17.5
4	5.5	6	8.3	9.6	11.6	19	13.5
5	5	6	7.4	8.9	11	19.6	14.6
6	6.5	7.5	-	-	-	-	-
7	8	8.8	10	11.3	13.6	22.3	14.3
8	7	8.5	10.1	10.9	12.9	21.7	14.7
9	6.5	7	-	-	-	-	-
10	5.5	6	-	-	-	-	-
11	6	6.6	7.2	8.7	11	20	14
12	12	12.4	-	-	-	-	-
13	12	12.3	-	-	-	-	-

Source : Researcher Team, 2023

Table 7 showed the results of monitoring. It showed that the growth rate of coral t-fragment in planting medium 1 was as shown in Table 7, namely for coral t-fragment 1 was 13 cm,coral t-fragment 2 was 16.5 cm,coral t-fragment 3 was 17.5 cm, t- coral fragment 4 was 13.5 cm,t- coral fragment was 14.6, coral t-fragment 7 was 14.3 cm, t- coral fragment was 14.7 cm and t-coral fragment 11 was 14 cm. In this 1st planting medium, only 8 coral t-fragments survived.

Table 8. Monitoring Results of Coral Fragment Transplant Media Planting 2

GROWING MEDIA OF 5 METERS DEPTH							
2							
Fragment	July 2021	October 2021	Jan-22	April 2022	July 2022	April 2023	Growth Rate
1	7	10.4	12.3	13.8	15.6	22.4	15.4
2	7.5	10.1	-	-	-	-	-
3	7.5	6.7	8.2	10.3	11.8	20.3	12.8
4	5.5	7.6	-	-	-	-	-
5	5	7	9.1	11	12.3	21.1	16.1
6	6.5	7	8.7	10	12	20	13.5
7	8	11.3	13.2	14.8	16.3	22.8	14.8
8	7	10	-	-	-	-	-
9	6.5	7.8	-	-	-	-	-
10	5.5	8	-	-	-	-	-
11	6	8.5	-	-	-	-	-
12	12	8	9.8	10.6	12.3	21.5	9.5
13	12	9	-	-	-	-	-

Source : Researcher Team, 2023

The monitoring results in Table 8 showed that the growth rate of coral-t fragments in planting medium 2 was as shown in Table 8, namely for coral fragment 1 of 15.4 cm, coral t fragment 3 of 12.8 cm, coral t fragment 5 of 16, 1 cm, coral t-fragment 6 was 13.5 cm, coral t-fragment 7 was 14.8, and coral t-fragment 12 was 9.5 cm. on the planting medium 2. A total of 6 surviving coral fragments.

Table 9. Monitoring Results of Coral Fragment Transplant Media Planting 3

GROWING MEDIA OF 5 METERS DEPTH							
3							
Fragment	July2021	October 2021	Jan-22	April 2022	July2022	April 2023	Growth Rate
1	7	14.5	16.2	18.7	20.7	25.3	18.3
2	7.5	9.5	11	13.1	14.8	19.5	12
3	7.5	15	16.7	18.3	20.5	24.9	17.4
4	5.5	6.3	-	-	-	-	-
5	5	8	-	-	-	-	-
6	6.5	8.9	9.8	11.6	13.2	21.2	14.7
7	8	8.6	10	11.8	13.5	21.3	13.3
8	7	12	-	-	-	-	-
9	6.5	8.6	-	-	-	-	-
10	5.5	9	-	-	-	-	-
11	6	6.4	8.6	9.7	12	21	15
12	12	-	-	-	-	-	-
13	12	-	-	-	-	-	-

Source : Researcher Team, 2023

The monitoring results in Table 9 showed that the growth rate of the coral t fragment in planting medium 3 was as shown in Table 9, namely for the coral fragment 1 of 18.3 cm, the coral t fragment 2 of 12 cm, the coral t fragment 3 of 17.4 cm , Fragment t coral 6 was 14.7 cm, Fragment t coral 7 was 13.3 and Fragment t coral 11 was 15 cm. in this 3 planting medium, 6 fragments of coral survived and the rest died.

Table 10. Monitoring Results of Coral Fragments Transplanted in Growing Media 4

GROWING MEDIA 5 METERS DEPTH							
4							
Fragment	July2021	October 2021	Jan-22	April 2022	July2022	April 2023	Growth Rate
1	7	9	10.6	12	13.2	24.3	17.3
2	7.5	10.5	11.7	12.8	13.6	25	17.5
3	7.5	10.5	11.9	12.8	13.9	24.4	16.9
4	5.5	5.8	6.5	8	10	22.1	16.6
5	5	-	-	-	-	-	-
6	6.5	-	-	-	-	-	-
7	8	-	-	-	-	-	-
8	7	-	-	-	-	-	-
9	6.5	8.5	10	11.7	13.2	23.2	16.7
10	5.5	-	-	-	-	-	-
11	6	-	-	-	-	-	-
12	12	-	-	-	-	-	-
13	12	-	-	-	-	-	-

Source : Researcher Team, 2023

The monitoring results in Table 10 showed that the growth rate of the coral t fragment in planting medium 4 was as shown in Table 10, namely for the coral fragment 1 of 17.3 cm, the coral t fragment 2 of 17.5 cm, the coral t fragment 3 of 16, 9 cm, Fragment t coral 4 was 16.6 cm, and Fragment t coral 9 was 16.7. In this 4th planting medium, only 5 coral fragments survived while the rest died.

Water Condition

The results of several water parameters measurement showed that the water temperature was around 32oC, with water brightness of 25 meters and water salinity of 32 o/oo. It showed that Makatombo water conditions were still suitable for coral growth.

All data and information from monitoring and evaluation of coral transplantation results at the Mokotamba dive point in this research was processed using a coral transplantation conservation approach and an information system that will be used and utilized by all tourism stakeholders appropriately and accurately by the community so it can be openly accessed easily by all parties. This research contributed to knowledge that focuses on models for developing marine tourism through coral transplantation and disseminating information from monitoring results by utilizing information technology in the tourism sector,

especially in super priority tourism destinations. Smart tourism stakeholders will be able to participate directly in the development of the tourism industry, tourism products, tourism marketing and promotion by introducing successful conservation efforts in the form of coral transplantation. It is expected to further strengthen the revitalization and actualization of the value of Indonesia diverse marine tourism resources through stakeholder collaboration and integration. Thus, the sustainable tourism development program can accelerate the acceleration of national tourism development that is coordinated and integrated with high competitiveness both locally, nationally and internationally.

V. CONCLUSION

- Monitoring and mmeasurement results of coral transplantation at the Mokotamba dive point, Pulisan in Likupang using 4 sondo-shaped transplant media at a 5 meters depth, different from transplant media 1 to 4. The results of the study concluded that the success and failure of transplantation depended on important factors, namely:
- The position and depth at the transplant media placed is influenced by the current path.
- Types of coral with the growth rate and speed are different for each type of coral. Branching coral or branching coral grows faster than nonbranching coral. Apart from that, it is known that the acropora type of coral grows faster than the nonacropora type of coral that has branches.
- Sedimentation that occurs at the planting point with coral growth is faster in parts that are free from sedimentation particles compared to areas with fairly thick sedimentation.
- The level of competition for space and food with the predator-free area (bottom) of the transplant media grows faster and fish colonies occur because there is less competition with others at some distance from other fragments.
- Other factors, for instance, when coral transplantation is performed, the coral bonds are not strong enough so they are separated from the transplant media.

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