

Coral Transplantation and Monitoring Planning at Mokotamba Dive Point Pulisan as Conservation Efforts and Tourism Sustainability

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Abstract—The purpose of the research is to specify the growth rate and survival rate of coral fracture Fragments transplanted into plant media in the Mokotamba Pulisan area, North Sulawesi. The determination of planting media placement is based on field observation. The method used was the skeletal method that glues naturally fractured coral Fragments to metal pieces to the sondo shape with each Fragment transplanted to the direction of the sun rays. The results of the initial research were carried out by measuring the initial length of coral Fragments in each unit of planting media and then it was measured periodically every four months so that the growth rate and survival rate of transplanted coral Fragments obtained. Monitoring was carried out on each coral transplanted on the four growing media.

Keywords—coral transplantation, monitoring, conservation, tourism sustainability, Mokotamba, Likupang

I. INTRODUCTION

Coral reefs are aquatic ecosystems that generally live in tropical areas with a diversity of biota living in this ecosystem. This ecosystem is very important for the life of living things considering the function and role for the survival of living things in the world. Coral reefs have various functions among others: as an area to withstand coastal abrasion, a source of medicines

from the sea, as a tourism area and various other functions.

The survival of coral reefs is strongly influenced by natural factors and human factors (anthropogenic). Natural coral damage is usually caused by storms and waves, predation from predators and global warming. Global warming is very important factor in the coral reefs destruction. High human activities and not environmentally friendly in coastal areas, especially the coral primary function Coral reef degradation has a significant influence.

Currently in Indonesia, it is estimated that only 5.23% of coral reefs are in excellent shape and 31.17% are in damaged condition. Therefore, if it is not anticipated, the wealth and potential of coral reefs will be lost (Rudianto, 2007 in Yunus et al., 2013). One of the methods and efforts used to restore the condition of coral reefs is to use transplantation techniques. Sadarun (1999) in Yunus et al. (2013) states that coral transplantation technology is one of the alternative efforts to restore coral reefs through grafting or cutting live coral to be planted elsewhere or in places where corals have been damaged, aiming for restoration or formation of coral reefs. natural coral reef. Makatombo waters, located in Pulisan Village, the coral reef area, suffered little damage caused by natural and human factors. There are many living coral fragments that separated from their broadstock

scattered about. Seeing the occurred, it is necessary to make efforts to restore or restore by means of coral transplants. This study aimed to make a monitoring plan for coral transplantation in the Mokotambo conservation area, Likupang Indonesia.

II. LITERATURE REVIEW

2.1 Coral Transplantation

One of the activities carried out to restore or rehabilitate coral reefs is to carry out coral transplantation activities. Anonymous (2015) stated that rehabilitation activities are to restore damaged corals. Young corals are propagated in certain locations that are then retransplanted. Some methods used to transplant coral are: [1]

1. Peg Method. The peg method is a transplant method using waterproof wooden or iron stakes painted by anti-rust and then plugged into the bottom of the water.
2. Net method. The net method is a transportation method using a net or rope that sized according to the needs.
3. Method of Mesh and Substrate is a method that uses a net equipped with a substrate made of cement, ceramic or earthenware with a size of 10 x 10 cm.
4. Method of nets and frames. It is a transplant method using a stainless steel frame with a size of 100 cm x 80 cm with the ends of which are legs with a length of 10 cm each. At the top is covered by a net.
5. Method of mesh, frame and substrate. Is a transplant method in the form of a combination of the net method with the substrate. The diameter of the substrate is approximately 10 cm with a thickness of 2 cm and a stake of 5-10 cm.

Research on coral transplantation is mostly done to save coral reefs. One of the activities carried out to restore or rehabilitate coral reefs is to carry out coral transplantation activities. Clark and Edwards (1995) explain over the last three decades, there has been a global shift — from traditional, generally sustainable, exploitation of coral reef resources to a significant rise in demand, primarily due to demographic change.

At the same time, coral reefs have been damaged in diverse geographic regions as a result of both natural and man-made factors (eg tropical cyclones, volcanic activity, tidal disasters). One of the activities carried out to restore or rehabilitate coral reefs is to carry out coral transplantation activities.

Anonymous [1] stated that rehabilitation activities aim to restore damaged corals. Young corals are propagated in certain locations which are then retransplanted.

Young corals are propagated in certain locations that are then retransplanted. For a number of reasons, coral transplanting has been investigated as a viable reef management strategy [2]. The potential for transplanting to help reef regeneration following dynamite fishing has been extensively researched in the Philippines [3]. On Guam, It has been utilized in an effort to replace corals destroyed by thermal diluents from power plants [4], as well as to preserve species threatened by pollution or habitat loss due to reclamation both there and in Singapore. [5] [6]; Newman and Chuan 1994 respectively). In Kanehoe Bay, Hawaiian Transplant was used to reintroduce and study the survival of two coral species in waste-polluted areas [7][8] and in Florida to accelerate reef recovery after Wellwoodgrounding [9][10]. In the Aqaba Gulf, Bouchon et al. [11] transplanted large coral heads to increase tourism areas, and in the Great Barrier Reef Marine Park, [12] Observed to see if transplanting coral sections injured by crown of thorns starfish may speed up recovery (*Acanthaster planci*). Transplantation has a relatively high death rate in areas with poor environmental conditions.[7] [4], However, where the water quality is good, transplants in low-energy settings tend to thrive.

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3. Method of Mesh and Substrate is a method that uses a net equipped with a substrate made of cement, ceramic or earthenware with a size of 10 x 10 cm.
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5. Method of mesh, frame and substrate. Is a transplant method in the form of a combination of the net method with the substrate. The diameter of the substrate is approximately 10 cm with a thickness of 2 cm and a stake of 5-10 cm.

Rahmania further explained [13] the stages of coral transplantation include the following:

1. **Determination of Location:** Determination of transplant location to determine the location coordinates can be used GPS (Global Positioning System).
2. **Preparation of Equipment:** Prepare the tools and materials to be used in the transplant.
3. **Giving Signs:** Giving a sign (floating sign) at the transplant site.
4. **Coral Search:** Searching for transplanted coral. Coral fragments were taken from surviving parent colonies >25cm in diameter using scissors with a Fragment Size of about 10 cm and collected in perforated baskets and transported to the transplant site. However, it should be noted that this research does not use this method but uses damaged corals caused by various things, such as fishing activities and the damage caused by waves crashing.
5. **Transportation Process:** The transport process must be carried out under water with care.
6. **Installation of Frames:** Installing iron frames or stakes at the transplant site parallel to the shoreline. Installation of the transplant frame can be done at a depth of 1.3 or 10 cm.
7. **Bonding Coral Fragment:** Bind coral Fragment to the substrate with the prepared cable ties.
8. **Growth Rate Measurement:** To measure the growth rate of coral colonies as well as water physico-chemical parameters, it can be done every two weeks or every month.

The benefit of coral transplantation among others :

Play a part in speeding the regeneration of damaged coral reefs and can also be utilized to create new coral reef regions that did not previously exist. One of the important use of coral transplantation is it may add the adult corals to a population so that it may increase larval production in damaged coral reef ecosystems. Some provisions of coral transplantation are the container in the form of concrete is needed as a coral substrate to be implanted, branched coral species grow faster and become more adaptable than massive corals, basically water locations can be transplanted on condition that hydraulic conditions are still within the tolerance limits of coral growth, transplanted reef containers do not impede aeration by currents.

2.2 Monitoring

Monitoring needs to be done as a control material to see the condition of coral fragments and the growing media. Transplanted corals were monitored annually from July 2021 to July 2022, and their size was adjusted every three months.

Monitoring the effectiveness of coral restoration Most studies (53 percent) were followed for less than a year, with a mean of 22.524 months. As shown in Figure 3, only 5% of the research were monitored for more than 5 years, and the monitoring period was not established in 2% of the studies (Figure 3).

For transplantation procedures, these time limits are appropriate, but not adequate for evaluating their efficacy in restoring coral communication. It was shown that coral growth and survival rates were initially poor but gradually matched the reported pattern of onies in two long-term studies (Garrison & Ward 2012; Forrester et al. 2014). Fish populations grew over time in another research when the restored region was inhabited by a range of species. Tous les long-term research on coral transplantation point out the importance of year-to-year fluctuations in growth and survival owing to disturbances such as storms and bleaching episodes. Localized short-term monitoring programs restrict our understanding of coral restoration's success.

As a result of disturbances, such as storms or bleaching episodes, all long-term studies have found significant differences in the development and survival of transplanted coral pieces from year to year.

Generally, short-term monitoring programs hinder our understanding of coral restoration's efficacy. When transplants develop and have potential environmental and economical advantages, this period is associated with the biological reaction to transplantation (e.g. early post-transplant growth, Fragment fusing to the substrate). [14]

III. METHODS

3.1 Research Location

Mokotamba Dive Point in Pulisan is located at 1° 68' 0.26" N and 125° 13' 8.92", E. Mokotamba Point is located on Pulisan Beach as one of the natural beaches in North Minahasa Regency, Indonesia. This area is located in the Likupang area as a Special Economic Zone in the North Sulawesi Province, Indonesia.



Figure 1 Research Location

Pulisan Beach is known as "the hidden paradise". This name is given because this beach is hidden. The development and utilization of tourism optimally may improve the tourist area to be better, it becomes the attraction for tourists. The development of this tourist area is intended to add to the beauty of tourist attractions without damaging the existing natural ecosystem. One way to develop tourist areas is good management. It may this beach known best by public. Some big cities in Indonesia utilize and develop the natural and marine tourism sector as an attraction and asset for regional income. Good handling is needed to develop tourism objects in Indonesia to boost the economic growth. Tourism actors start to take development actions with research, observation of tourist objects in Indonesia. This step is carried out to find out the potential and problems that in each object and then find a solution.

3.2 Data Processing

Data Processing of transplanted coral Fragmentts using the [15] formula.

$$\alpha = \frac{L_t - L_0}{t} \quad 1$$

α = The increase of transplanted coral Fragmentt length
 L_t = Average Fragmentt length after t- month
 L_0 = Average Fragmentt length after 0-month

Furthermore, to calculate the survival rate (Survival Rate) of transplanted coral Fragmentts using the Ricker (1975) formula in Prameliastari et al (2012):

$$SR = \frac{N_t}{N_0} \times 100\%$$

Where :
 SR = Survival Rate
 Nt = Number of final individuals
 No = Number of initial individuals

To calculate the growth rate of transplanted coral is as follows: [15].

$$GR = \frac{L_t - L_0}{t} \quad 3$$

Description :
 GR = Growth Rate (cm/month)

L_t = Length of coral at t-time
 L_0 = The length of the initial coral
 t = Length of observation

4 RESULTS AND DISCUSSION

4.1 The Creation of Growing Media

The growing media were made of iron (Size 12 and 9 meters). They were made in the form of a circle resembling a 'sondo' shape. Sondo is the local name of a tool for filtering fried products and other foods.



Figure 2. Growing media and Coral Fragment gluing process

The shape of sondo was taken because of its attractive shape to be used as growing media on the seabed and its attractive shape after being assembled up to 8 sondo units to form coral reef. This form has never been made by other researchers.

4.2 Deploy of Growing Media

Growing media is lowered one by one to the bottom of the sea. Each diver brought their respective planting media and arranged close to each other at a depth of 5 meters.



Figure 3. Deploy of Growing Media to the bottom of the sea, Mokotamba, Pulisan

4.3 Monitoring Planning

Monitoring of transplanted corals was planned to be carried out four times in three months. Monitoring was carried out on each transplanted coral in the four planting media. The measurement uses a ruler or a sewing meter. The measurement was carried

out on the height of each transplanted coral fragment. The monitoring plan is shown in the table below.

Table I. Monitoring Planning

Time	Media	Fragment Length	Coral Type	Description
July 2021	1,2,3,and 4			Initial Monitoring
October 2021				Monitoring 1
January 2022				Monitoring 2
April 2022				Monitoring 3
July 2022				Monitoring 3

After that, it was performed the measurement of transplant area condition such as water temperature, salinity and water brightness

Table II. Growing Media

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

4.4 Result expected from the monitoring

The expected result of monitoring activities is to obtain data on growth rates and survival rates. Coral fragments are also expected to provide benefits for the conservation and sustainability of coral reefs.

4.5 Conservation Effort and Tourism Sustainability

One of the conservation efforts is coral transplantation to return to being a good and attractive dive point for tourists to dive at that point (tourism sustainability) [16] [17]

V. CONCLUSION

This research was conducted in Mokotamba Pulisan conservation area, Likupang, Indonesia. This research resulted in coral transplantation and monitoring planning. Research on coral transplantation showed that the four growing media used were made of iron (with the size of 120 centimeters long and 120 centimeters wide). Made in the form of a circle resembling a 'sondo' shape. Sondo is the local name of a tool for filtering fried products and other foods. The shape of the sondo was taken because of the attractive shape used as a planting medium on the seabed and its attractive shape after assembling more than 4 sondo units to form coral reefs. This form has never been made by other researchers on coral reefs. The results of the research on the monitoring plan showed that the monitoring of transplanted corals was planned to be carried out four times every three months. Monitoring was carried out on each coral transplanted on the four growing media. Measurements using a ruler or sewing meter can also be used. Measurements were made on the height of each transplanted coral Fragment.

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