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Analysis of The Conditions of Acropora Transplant Corals in "Liang" Bunaken National Park, North Sulawesi Province

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ABSTRACT: Coral transplantation is the grafting or cutting of live corals to be transplanted elsewhere or where the corals have been damaged, aiming for restoration or the formation of natural coral reefs. Coral transplantation plays a role in accelerating the regeneration of coral reefs that have been damaged and can also be used to build new coral reef areas that previously did not exist. Meanwhile, the objectives of the research are: To describe the initial conditions, artificial coral transplantation in Liang, at the Bunaken National Park location; Analyzing the number of transplanted corals that survived for 3 years; Analyzing the condition of transplanted corals by measuring the length and number of coral branches that survived for 3 years. The results obtained for coral transplantation carried out in "Liang" Bunaken National Park, from 84 transplanted in 7 Modules, 76 coral fragments survived, and only 8 coral fragments died, with a 90% survival percentage. The average value of the increase in height of transplanted coral fragments was 10 cm, and the number of branches that increased in each coral fragment was an average of 11 branches in each surviving coral fragment. This means that from 2018 to 2021, the increase in height and number of branches is around 3 cm per year.

KEYWORDS: Coral, Transplant

INTRODUCTION

Coral reefs are ecosystems that have the highest species diversity, even exceeding the productivity of terrestrial systems such as tropical forests. The main component of coral reefs, namely coral (stone coral) has the highest distribution of at least 590 species of 793 species known to the world followed by more than 1650 species of fish identified only in the eastern part of Indonesia. The combination of mangrove-seagrass-coral reef ecosystems supports thousands of types of organisms from various taxonomies living associating in it.

Indonesia itself has a total area of coral reefs of around 82,200 km2 or about 18% of the total area of the world's coral reefs and 65% of the total area of the coral triangle, which includes Indonesia, the Philippines, Malaysia, Timor Leste, Papua New Guinea and the Solomon Islands. The existence of coral reefs in these 6 countries has earned the nickname the coral triangle (the world's coral triangle) because if you draw a boundary line covering the coral reef areas in these countries, it will resemble a triangle with a total area of around 75,000 km2. With a total area of almost 90,000 hectares, the coral reefs in Bunaken National Park cover an area of 8,010.7 hectares (Mehta et al 1999: Erdmann 2004). Based on research by Devantiar (2006) and Turak (2003), there are at least 63 genera and around 400 types of stony coral (scleractinia) found in Bunaken National Park which support around 1000 species of fish living in coral reef ecosystems. The unique and artistic topography of the reef is supported by various associations of living biota, creating a very important and valuable marine park. Various coral transplantation activities whose benefit is to rehabilitate the condition of coral reefs, are often not paid attention to when the broodstock are cut, this needs to be considered so as not to damage the broodstock. Another thing that receives less attention is after transplantation, there is no control (cleaning of algae, or other things that cause failure or death of the transplanted corals).

METHOD

The location is located in the Bunaken National Park area, precisely in front of Bunaken Island. The observation point or location is located at 124°45'35.9"E and 1°37'04.9" LU, with the name “Liang”, which is a diving or snorkeling point for tourists visiting Bunaken. The following picture is the location of the observations made by being numbered according to the place of observation. Map source taken from (http://petasulawesi.blogspot.com/2017/01/peta-kotamanado.html)

Figure 1. Map of the Research Location "Liang on Bunaken Island

Data Collection Techniques

Data collection was carried out using diving equipment, by observing the coral transplant module which consists of 7 coral modules, each module consisting of 12 coral fragments. The shape of the module is 4 rectangles with a size of 1 x 0.5 meters. The image below is the shape of the coral module and the data collection technique by diving in the research area.

Figure 2. Reef Laying Module and Data Collection Techniques

Data analysis

Changes in coral size and growth rate are calculated using the following formula: β = Lt – Lo

Information:

β = Change in length/width of transplanted coral fragments (cm)

Lt = Average length/width of the fragment at the time of t-observation (cm)

Lo = Average initial length/width of the fragment (cm)Sedangkan laju pertumbuhan karang yang ditransplantasikan dihitung dengan menggunakan formula berikut:

$$\alpha = \frac{L_{i+1} - L_i}{t_{i+1} - t_i}$$

For the method of calculating the survival rate of transplanted corals, the following formula is used (Ricker, 1975):

SR = (Nt/No) x 100%

Information :

SR = survival rate (survival rate)

Nt = Number of individuals at the end of the study

No = Number of individuals at the start of the study

The growth rate of Acropora corals was processed and analyzed and presented in the form of tables, graphs and narration according to the results of the analysis obtained. Processed data is made manually with the help of Microsoft Excel software.

RESULTS AND DISCUSSION

Based on the objectives to be achieved, by using the method described above, the results of the research were obtained which were then discussed on the locations used as artificial coral transplants and evaluation of coral growth. Taking coral seeds on average 5 cm in length. Consists of 7 coral modules, and each coral module consists of 12 coral fragments. The condition of the substrate is generally broken coral fragments. The picture below shows the process of collecting coral seeds and the process of tying corals when released at a predetermined location at the "Liang" Dive Spot in the Bunaken National Park Area in 2018.

Figure 3. Process of collecting coral seeds in 2018

Figure 4. Module Removing and Binding of Coral Seeds at the Study Site

Coral length and initial number of branches: 5 cm and 3-4 branches
Planting Depth : 5 m
Substrate : Reef Fractions, Sand and Seaweed
Total : 7 Modules

The results of research carried out in accordance with the established method, which will then be discussed as the output material achieved are as follows:

After three years since the initial transplantation was carried out, the following results describe the condition of successful surviving artificial corals. The following table displays the condition of water quality at the observation site:

Table 3. Parameters of water quality at the observation site at Liang Bunaken

No	Parameter	Nilai
1	Temperature	29^0 C
2	Brightness	40 cm
3	Salinity	29.00 $^0/_{00}$
4	Dissolved Oxygen (DO)	5.6 ppm
5	Turbidity	5.32
6	pH	7.8
7	Phosphate	0.05 ppm
8	Nitrite	0.04 ppm

In general, this location is a place where coral colonies live that form reefs, so this location is also used as a "Dive Spot" for tourists and researchers. However, over time, the condition of the coral reefs experienced severe degradation/damage, this was due to the

large amount of traffic, ships and high activity at this location. The image below shows the current condition of the artificial reef which is the object of research. It is described that some corals have died, but many have survived (Measurement data in the following table).

Figure 5. Coral growth conditions at 3-year intervals

Table 4. Data on the results of measuring the length and number of coral branches at the Liang Bunaken Dive Spot

Modul 1		Modul 2		Modul 3		Modul 4		Modul 5		Modul 6		Modul 7	
Tall (cm)	number of branches	Tall (cm)	number of branches	Tall (cm)	number of branches	Tall (cm)	number of branches	Tall (cm)	number of branches	Tall (cm)	number of branches	Tall (cm)	number of branches
16	24	14	8	0	0	18	13	25	21	9	7	21	11
10.3	15	10.2	5	17	13	17	9	16	9	19.1	45	12	16
11.1	4	14	9	16	13	8	4	25	28	9	3	10.4	3
20	14	13	12	20.6	16	12	4	21	15	10	4	18	23
22	22	10	55	19	14	15	15	13	32	20	9	22	23
11	6	23.6	15	16	13	6.2	3	14	15	10	53	20	17
22.7	17	22	15	14	12	17	14	17	10	17	17	29.1	26
24	26	12	9	9	6	18.3	16	14	48	11	2	6	2
22.4	29	15	9	9.5	9	12	12	4	2	9	3	7	3
19	22	21	28	19	10	17	8	20	16	13	5	21	8
17	12	17	9	18	12	0	0	21	17	18	33	0	0
12	10	15.1	9	0	0	0	0	0	0	0	0	0	0

Condition of Live and Dead Coral Transplanted Corals

The following results show that the artificial coral transplants carried out in general were able to survive totaling 76 live coral fragments, and only 8 out of 84 coral fragments died, meaning that the condition of the ecosystem in this location really supports these corals to survive. Based on observations of dead coral fragments due to algae covering them. The results described here are the condition of the corals without treatment or left for 3 years with natural conditions. In several trials on artificial reefs, usually every dead coral fragment will be replaced, but this was not done for research. The following figure shows the number of living and dead coral fragments in each existing module.

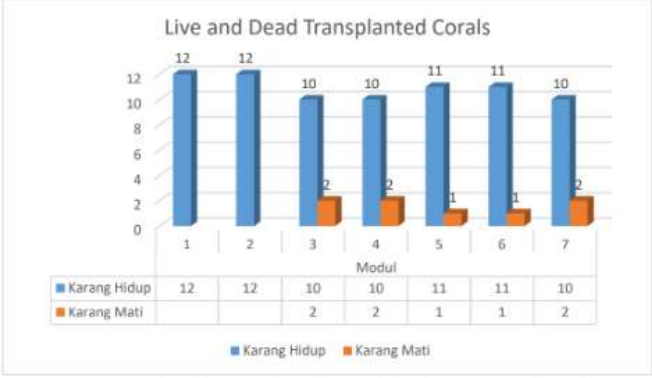

Figure 6. Graph of the number of live and dead corals in each module

Furthermore, to see the survival rate, the following table displays processed data based on a predetermined formula, namely:

Table 5. Survival Rate of Transplanted Coral Fragments in Burrows in Bunaken

Modul	Number of individuals at the start of the 2018 study (No)	Number of individuals alive at the end of the study (Nt)	(Survival rate) (SR)
1	12	12	100%
2	12	12	100%
3	12	10	83%
4	12	10	83%
5	12	11	92%
6	12	11	92%
7	12	10	83%

Overall, the SR value or survival rate of the transplanted corals survived was 90%, and only 10% died.

Increase in Branches and Height of Transplanted Corals

Based on initial measurement data at the time of transplantation in 2018, the coral fragments tied to the module were 5 cm high and the number of branches was 3 – 4. The following table displays changes in height and number of coral branches transplanted.

Table 6. Increase in Height and Number of Coral Branches Transplanted for 3 years

Modul 1		Modul 2		Modul 3		Modul 4		Modul 5		Modul 6		Modul 7	
Tall (cm)	number of branches	Tall (cm)	number of branches	Tall (cm)	number of branches	Tall (cm)	number of branches	Tall (cm)	number of branches	Tall (cm)	number of branches	Tall (cm)	number of branches
11	21	9	5	0	0	13	10	20	18	4	4	16	8
5.3	12	5.2	2	12	10	12	6	11	6	14.1	42	7	13
6.1	1	9	6	11	10	3	1	20	25	4	6	5.4	0
15	11	8	9	15.6	13	7	1	16	12	5	1	13	20
17	19	5	52	14	11	10	12	8	29	15	6	17	20
6	3	18.6	12	11	10	1.2	0	9	12	5	50	15	14
17.7	14	17	12	9	9	12	11	12	7	12	14	24.1	23
19	23	7	6	4	3	13.3	13	9	45	6	5	1	4
17.4	26	10	6	4.5	6	7	9	2	3	4	6	2	6
14	19	16	25	14	7	12	5	15	13	8	2	16	5
12	9	12	6	13	9	0	0	16	14	13	30	0	0
7	7	10.1	6	0	0	0	0	0	0	0	0	0	0
average amount													
12.29	**13.75**	**10.58**	**12.25**	**9.01**	**7.33**	**7.54**	**5.67**	**11.50**	**15.33**	**7.51**	**13.83**	**9.71**	**9.42**

Based on the table above, after 3 years, the average value of the height of the transplanted coral fragments is 10 cm, and the number of branches that increase on each coral fragment is an average of 11 branches on each coral fragment that survives. For 3 years, the increase in height and number of branches is around 3 cm per year.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Based on a series of observations and has produced data which has been discussed further, the authors conclude as follows:

1. For 3 years, coral transplants were carried out in the "Liang" of Bunaken National Park, out of 84 transplanted in 7 modules, 76 coral fragments survived, and only 8 coral fragments died, with a percentage that survived 90% .
2. The average height of the transplanted coral fragments was 10 cm, and the number of branches added to each coral fragment was an average of 11 branches per surviving coral fragment. This means that from 2018 – 2021, the increase in height and number of branches is around 3 cm per year.

Suggestion

1. It is necessary to carry out regular monitoring or monitoring of the coral module, with the intention that the condition of the transplanted corals needs to be cleaned of algae, so that the corals do not die
2. It needs to be moved from the module, because the module frame is only made of PVC plastic, this is because the load of coral fragments will be even greater.
3. Further research needs to be done to control the vitality of the 76 surviving corals, and the dead corals can be replaced with new coral fragments.

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