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Distribution and Condition of Coral Reefs in the Waters of Biawak Island, Indramayu Regency, West Java, Indonesia

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ABSTRACT

This research aimed to find out the condition of coral cover and the distribution or spreading of coral reefs in the waters of Biawak Island using coral reef monitoring. Several supporting aspects that were also required to know were the percentage value of coral cover, diversity index, uniformity index, similarity index, dominance index, and the value of coral mortality, to support the activities of the management of coral reef of Biawak Island. This research was conducted in the waters of Biawak Island, Indramayu Regency, West Java. The research was conducted using a survey method through field data collection. Quantitative and qualitative data collection was conducted using the line transect method (Line Intercept Transect / LIT) to collect data on 3 stations at a depth of 3 and 7 feet using 3 replicates per station. Distribution of corals in the waters of Biawak Island was spread evenly, known from the percentage of frequency of coral lifeform converge which was found mostly above 50%, a low dominance index ranged from 0.128 to 0.216, a diversity index ranged from 1.884 to 2.246, and supported also by the similarity index value ranged from 95.24% - 100.00%. The condition of coral reefs in the waters of Biawak Island ranged from a poor to moderate criteria whereas the percentage of coral cover obtained was between to 17.04% to 44.93%.

***Keywords*:** Distribution and Condition, Coral Reef, Biawak Island

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1. INTRODUCTION

Biawak Island is located off the coast of the Java Sea, ± 40 km north of the Indramayu coast which is geographically located at 05º56'002" latitude and 108º22'015" east longitude, or is located 26 miles (50 km) north of Indramayu. The area of the island is ± 120 Ha, consisting of ± 80 Ha of mangrove forests and ± 40 Ha of coastal and terrestrial forests. Biawak Island has a limited protection zone and utilization zone. The coral reef ecosystem on Biawak Island is one of the ecosystems included in the protection zone [1]. Coral reef ecosystems have high biodiversity, have coral reefs that have recovered and because there are several areas of coral reef ecosystems that have been damaged by fishing using bombs [2-4].

The coral reef ecosystem in the coast of Indramayu Regency is very difficult to find, this is due to the many activities of fishermen who catch fish that are not environmentally friendly, pollution, mining activities around the Indramayu coastal area, as well as natural factors such as salinity and water turbidity. Similarly, the conditions on the island of Biawak, which have seen the damage . Damage to coral reefs is caused by fishing using bombs, cyanide (Potassium Cyanide), and nets that are not environmentally friendly. This is the main cause of pressure on the condition of coral reef ecosystems, and this can continue to occur if human activities that damage the environment of the coral reef ecosystem of Biawak Island are not controlled [1, 2].

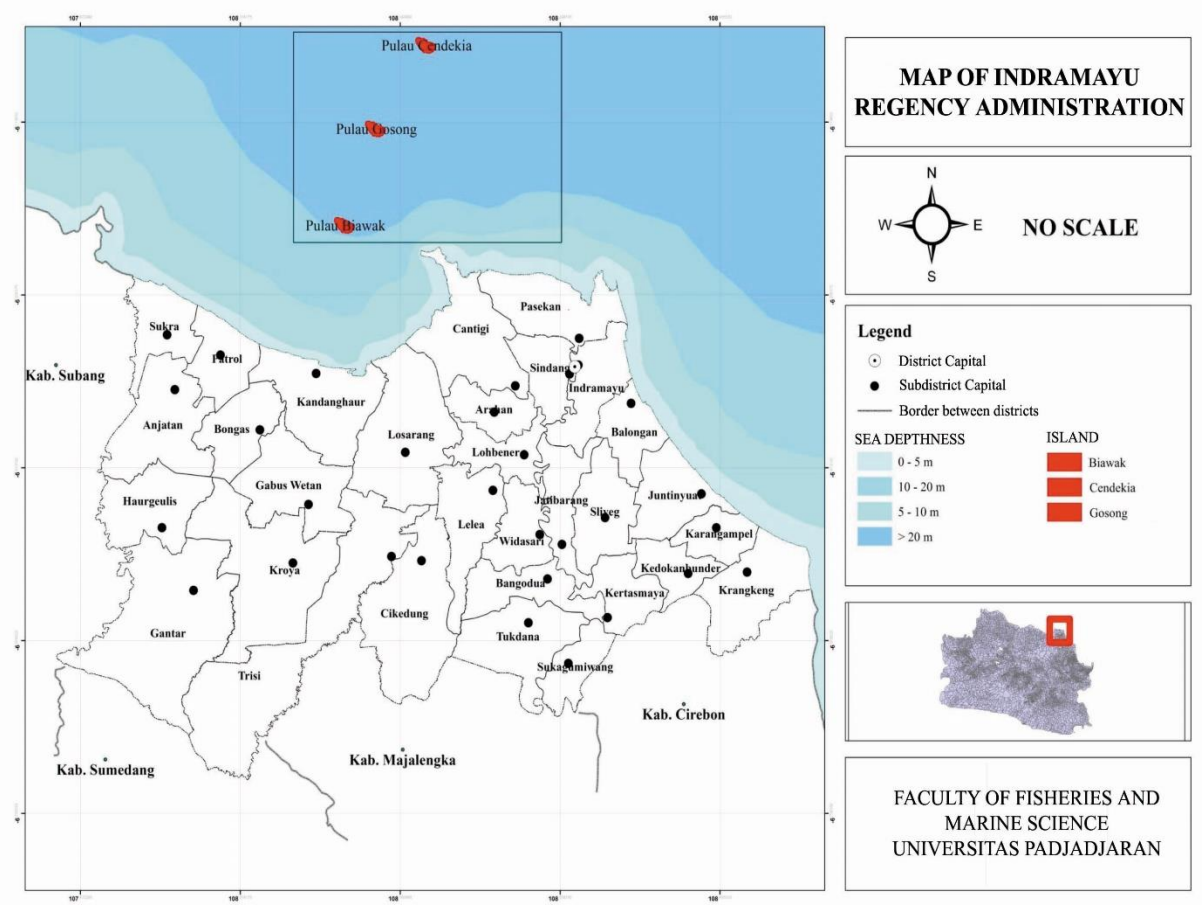

Fig. 1. Map of Indramayu Regency

The selection of Biawak Island as a research location is because Biawak Island is expected to be a potential location in the field of tourism in the northern coastal region of West Java. The selection of Biawak Island compared to other islands namely Cendikian and Gosong Island is due to the fact that Biawak Island is more able to support ecotourism activities with good accessibility for tourists [1]. Several studies on observing the condition of coral reefs have been carried out, one of which was a study conducted by IRO in 2018 obtained the results that the percentage of live coral cover of Biawak Island ranged from 60.2% -83.9%, in order to preserve the coral reefs it was necessary monitoring continues to determine the condition and distribution of coral reefs on Biawak Island. Based on these thoughts, it is necessary to conduct a study to find out how the condition of coral cover in Biawak Island waters, and the distribution or distribution of coral reefs in Biawak Island waters by monitoring coral reefs. Some other supporting aspects also need to be known, namely the percentage value of coral cover, diversity index, uniformity index, similarity index, dominance index, and coral mortality value, in supporting the management of coral reef ecosystems of Biawak Island [1-3].

Coral reef ecosystems surround almost the entire island. The coral that grows in the waters of Biawak Island is mostly massive rock and tabulated. This type of coral reef is a fringing reef. The initial condition of coral reefs associated with reef fish of Biawak Island in general according to the IRO in 2018 is still in good condition which is marked by various forms of coral growth in several locations on Biawak Island. The process of recovering damaged coral can still be recovered, as long as human activity pressure is still low on the coral reef community in the waters of Biawak Island. The percentage of live coral cover on Biawak Island ranged from 60.2% to 83.9%. In general, although the condition of the coral reefs according to the 2018 IRO research is in good condition until now it is estimated that the condition of the coral reef ecosystems in the waters of Biawak Island continues to experience pressure [1-5].

Monitoring coral reef ecosystems in the waters of Biawak Island against various environmental pressures can be determined by conducting a study of the distribution and condition of coral reefs [1]. Distribution is seen based on the distribution of coral species, and conditions seen from the percentage of coral cover. The expected coral specification is a percentage of coral cover based on lifeform (a form of growth). The factors limiting the spread of coral reefs can be seen based on observations of physical data on the quality of waters to determine the quality of the waters and factors supporting the growth of coral reef ecosystems [1-5].

2. MATERIAL AND METHOD

The research uses a survey method by collecting data in the field. Quantitative and qualitative data collection is carried out using the Line Intercept (LIT) method which is a method for estimating coral cover and the cover of benthic communities that live with corals. Data was collected at a depth of about 3 meters to represent shallow water and 7 meters for deep water [1,6-10].

The tools used in this study consisted of tools used to collect coral reef data and water quality gauges, those are GPS, Scuba Set, roll meters, slates and pencils, coral identification books, Underwater cameras, motorboats, thermometers, secchi disk, estimator, flouting droudge, refractometer.

3. RESULTS AND DISCUSSION

The condition of water quality on Biawak Island has characteristics that are almost similar from the 3 stations observed but there are still differences from each station. Water temperatures range between 30 - 31 °C, although the conditions of these waters are slightly higher than the optimal temperature of coral growth, but are still included in the tolerance of water temperatures for the development of coral reefs according to [9-11] ie coral reefs can tolerate temperatures up to 36-40 °C. The results of measurements of the average temperature of seawater are also still in accordance with the standard book quality of marine waters for a variety of biota based on Minister of Environment Decree No. 51/2004 namely 28-30 °C for coral reefs.

One of the main factors in the growth of coral reefs is light intensity, this is very influential on photosynthesis by zooxanthellae, the clearance of the waters determines the intensity of light received by zooxanthellae [12-16]. Water clearance at the time of data collection is quite good, it can be seen from the clearance at stations 1 and 2 whose water clearance reaches 100% due to the clearance of the measured waters to the bottom of the water, but at observation station 3 the water clearance only reaches 46% this clearance including the water quality standard sea for biota (coral reef).

The current velocity in the waters of Biawak Island from observations ranged from 0.13 - 0.24 m / sec. The highest current speed is at station 2 which is 0.24 m / s, this is presumably due to the influence of the west monsoon at the time of observation, thus affecting the current speed at the station. The lowest current speed is at station 1 which is 0.13 m / sec. The influence of monsoons on the speed of the current can be seen from the data and field conditions, station 1 is located at a location protected from the west wind so that the current speed at that location is low.

Table 1. Water Quality Data.

Parameter	Observation Station		
	Station-1	Station-2	Station-3
Temperature (°C)	31	30	30
Degree of Water Clearance (m)	14.5 (100%)	4 (100%)	7 (46%)
Water Depthness (m)	14.5	4	15
Surface Water Flow Speed (m / sec)	0.13	0.24	0.16
Salinity (‰)	29	33	31

Another factor influencing the development of coral reefs is the level of water salinity [15, 17-20]. The level of water salinity at the observation station ranges from 29 - 33 ‰, this salinity level resembles the area of coral reef waters in general [20-22]. There is a fairly low

level of salinity at Station 1 which is 29 ‰, but in general, the water areas at all observation stations are still suitable for areas of coral reef growth and development.

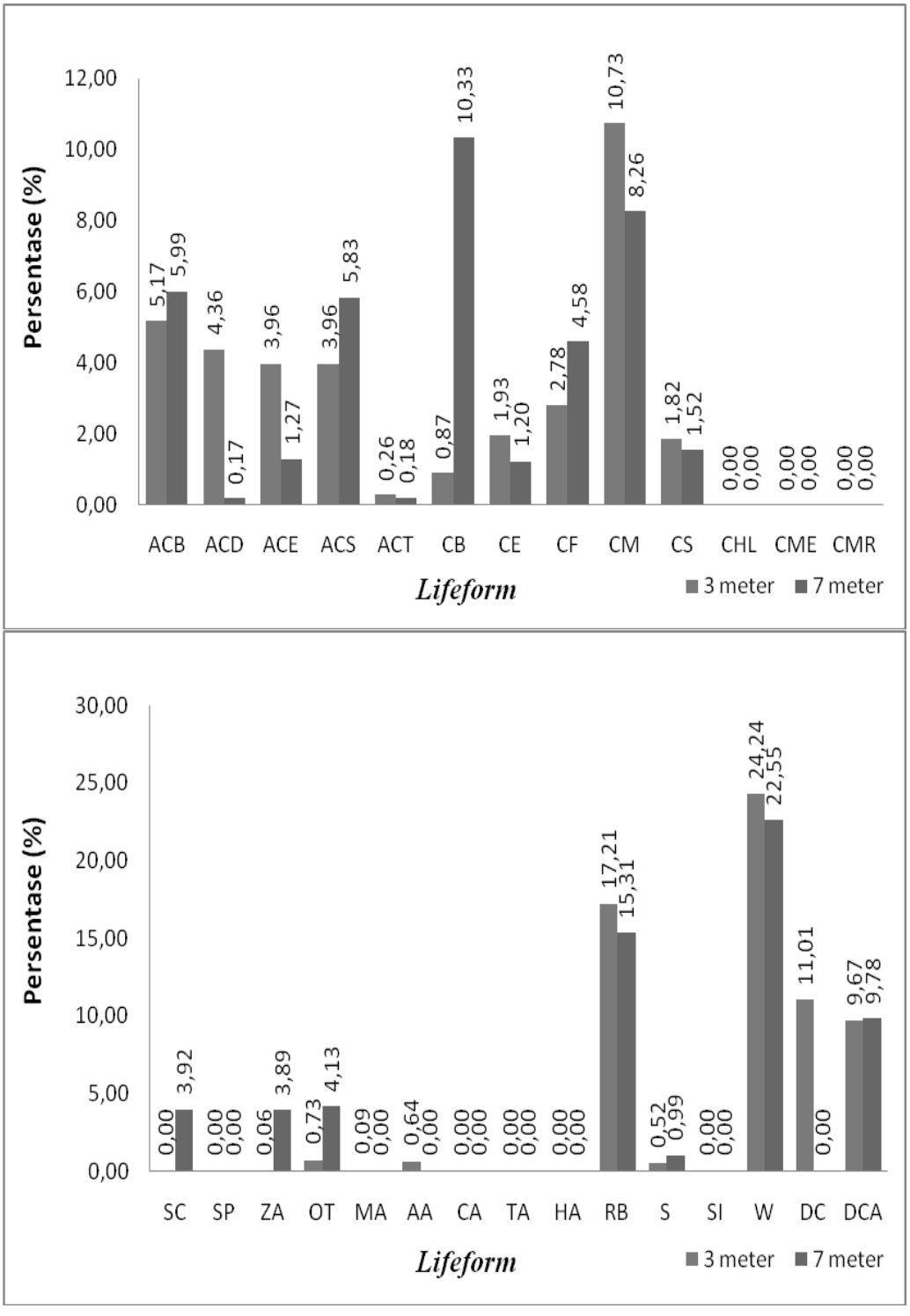

Fig. 2. Lifeform Percentage at Station-1

The percentage of coral cover station 1 was 35.82% at a depth of 3 meters and 39.32% at a depth of 7 meters**.** At a depth of 3 meters the highest percentage of coral lifeform namely Coral Massive (CM) of 10.73%, the high percentage of Coral Massive (CM) or rock coral is estimated due to good water Clearance, according to [21-23] states that areas where sedimentation is low with clear and clean water then the growth of good coral reefs, the lowest percentage of coral lifeform namely Acropora Tabulate (ACT) of 0.26%. At a depth of 7 meters, the highest percentage of coral lifeforms is Coral Branching (CB) of 10.33% and the lowest percentage of lifeforms of corals is Acropora Digitate (ACD) which is 0.17%. At this station also obtained rubble or rubble (RB) data of 17.21% at a depth of 3 meters and 15.31% at a depth of 7 meters. The discovery of coral fractures was allegedly caused by the use of bombs due to padas during observation often found coral fractures in pools. This also causes the percentage of water (W) obtained is quite high, namely 24.24% at a depth of 3 meters and 22.66% at a depth of 7 meters.

The percentage of coral cover obtained from the results of the study when comparing between depths, several types of coral lifeforms namely Acropora Branching (ACB), Acropora Digitate (ACD), and Coral Branching (CB) have much different percentage values at each depth. Acropora Branching (ACB) has a higher percentage at a depth of 7 meters than at a depth of 3 meters, Acropora Digitate (ACD) has a lower percentage at a depth of 7 meters compared to a depth of 3 meters, Coral Branching (CB) has a different percentage at each depth compared to Acropora Branching (ACB) and Acropora Digitate (ACD), Coral Branching (CB) has a percentage of 10.33% at a depth of 7 meters, and 0.87% at a depth of 3 meters, a difference in the existing percentage can be caused by several things, including the estimated due to human activities, the low percentage at a depth of 3 meters because at this depth more vulnerable to human activities.

Observation Station 2 has a percentage of coral cover of 17.08% at a depth of 3 meters and 33.51% at a depth of 7 meters. At a depth of 3 meters, the highest percentage of coral lifeforms namely Coral Massive (CM) was 4.67% and the lowest percentage of lifeforms of corals namely Coral Mushroom (CMR) of 0.13%. At a depth of 7 meters, the highest percentage of coral lifeforms namely Coral Mushroom (CMR) was 7.91% and the lowest percentage of lifeforms of corals was Acropora Submassive (ACS) which was 0.13% (Fig 3a). At this station, the percentage of coral fractures or rubble (RB) was very high at 43.69% at 3 meters depth and 29.21% at 7 meters depth. Dead coral at Station 2 has a high percentage, namely the percentage of Dead Coral (DC) of 13.72% at a depth of 3 meters and 6.58% at a depth of 7 meters, as well as the percentage of Dead Coral Algae (DCA) of 10.07% at a depth of 3 meters and 21.99% at a depth of 7 meters.

Coral lifeforms at this station are generally quite diverse, but at this station, there were no coral lifeforms found in Coral Heliopora (CHL) and Coral Millepora (CME). At this station other components, Sponge and Anemone, also have a higher percentage than other stations, namely 7.37% at a depth of 3 meters and 1.57 at a depth of 7 meters, Station 2 has a higher percentage of algae compared to other stations namely 4.74% at a depth of 3 meters and 0.22% at a depth of 7 meters. One of the lifeforms at Station 2, Acropora Encrusting (ACE), has almost the same percentage between 3 meters and 7 meters depth, which is different from the other lifeforms at this station. Coral Mushroom (CMR) has a difference with Acropora Encrusting (ACE), Coral Mushroom (CMR) has a very different percentage between at 3 meters and 7 meters, which is 0.13% at 3 meters depth, and 7.91% at depth 7 meters, this is

estimated because it can be seen from the conditions at the location that this station is more often found Algae on dead corals so that there are also many found Coral Mushroom (CMR).

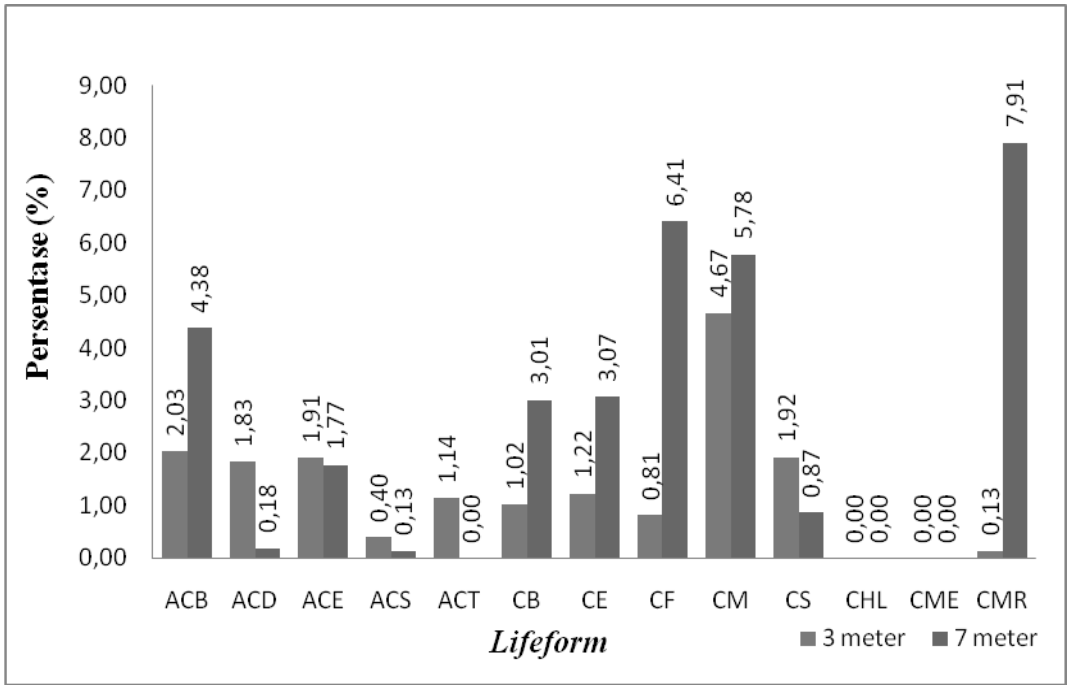

Fig 3a. Lifeform Percentage at Station-2

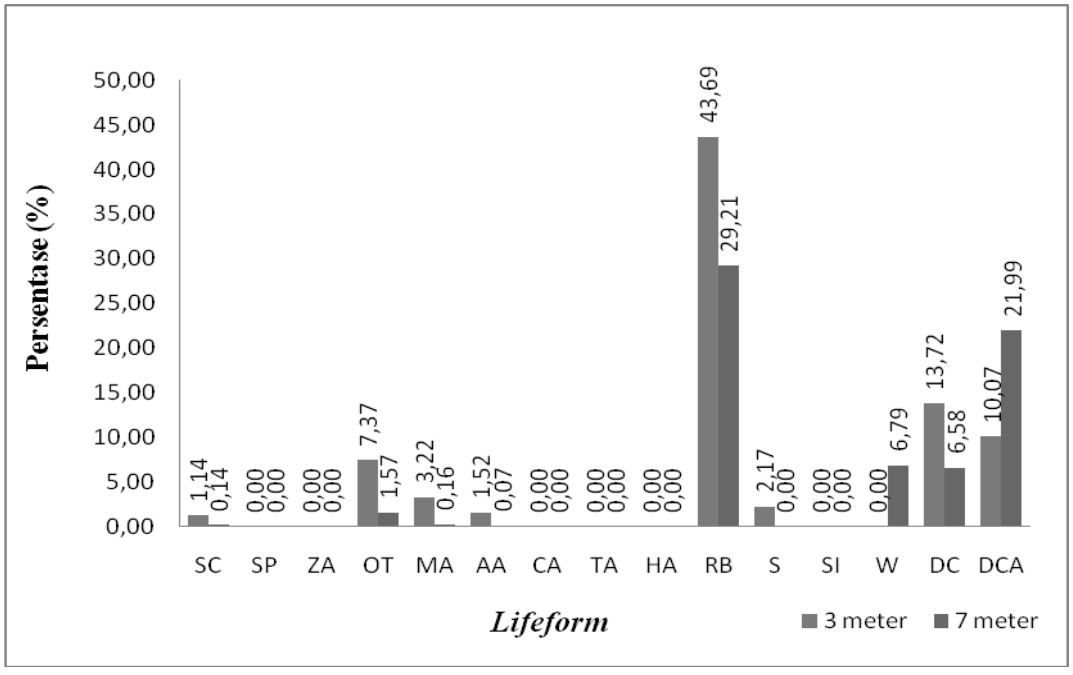

Fig 3b. Lifeform Percentage at Station-2

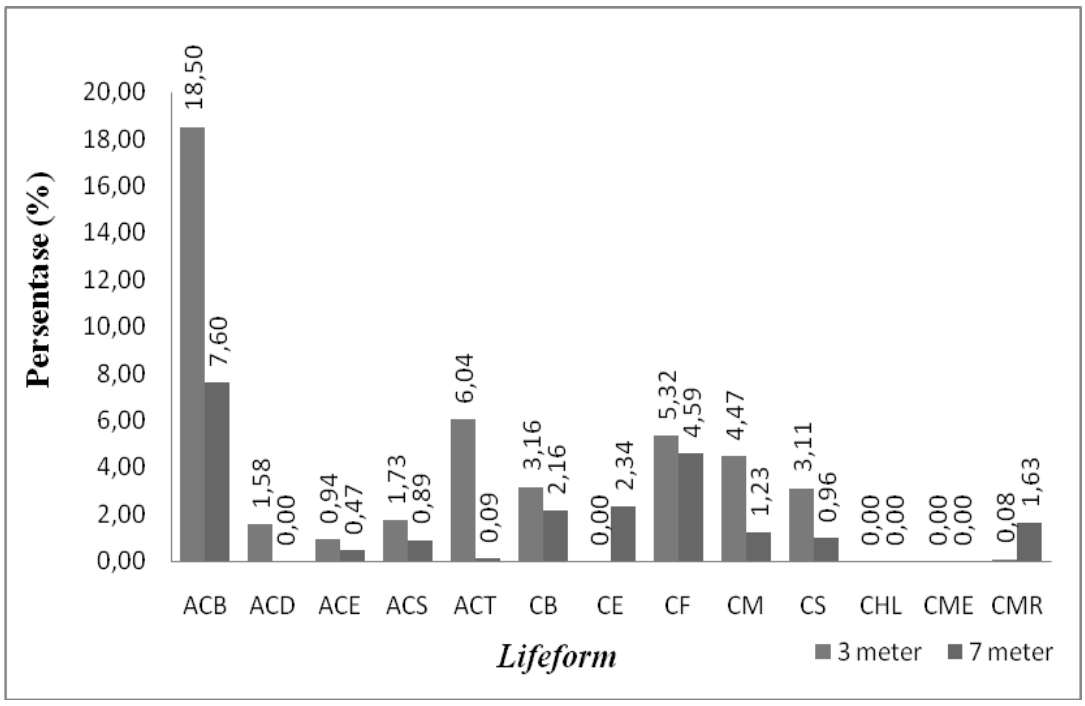

Fig. 4a. Lifeform Percentage at Station-3

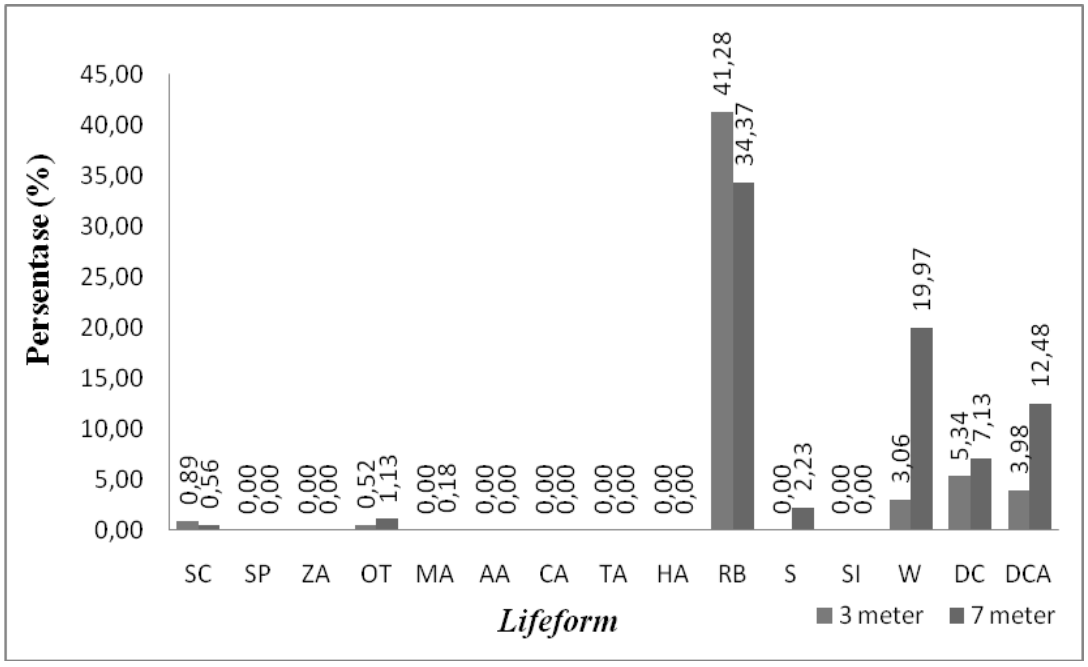

Fig. 4b. Lifeform Percentage at Station-3

The percentage of coral cover of station 3 is 44.93% at a depth of 3 meters and 21.96% at a depth of 7 meters. At a depth of 3 meters, the highest percentage of coral lifeforms namely Acropora Branching (ACB) was 18.50% and the lowest percentage of lifeforms of corals was

Acropora Encrusting (ACE) of 0.94%. At a depth of 7 meters, almost similar to a depth of 3 meters, the highest percentage of coral lifeform, namely Acropora Branching (ACB) was 7.91% and the lowest percentage of lifeform was Acropora Tabulate (ACT) which amounted to 0.09% (Fig 4a). At Station 3 the percentage of coral fractures or rubble (RB) had a higher percentage compared to 2 other observation stations, namely 41.28% at 3 meters depth and 34.37% at 7 meters depth. Dead Coral (DC) dead coral at this station has a percentage of 5.34% at a depth of 3 meters and 7.13% at a depth of 7 meters, while for a percentage of Dead Coral Algae (DCA) of 3.98% at a depth of 3 meters and 12.48% at a depth of 7 meters. At a depth of 7 meters, the percentage of corals is low due to damage to coral reefs by dumping waste from fishing vessels that are anchored, such as disposal of engine oil, so that if the rest of the disposal is not carried by currents it will settle on the coral reefs so that it will disrupt its growth in conducting photosynthesis.

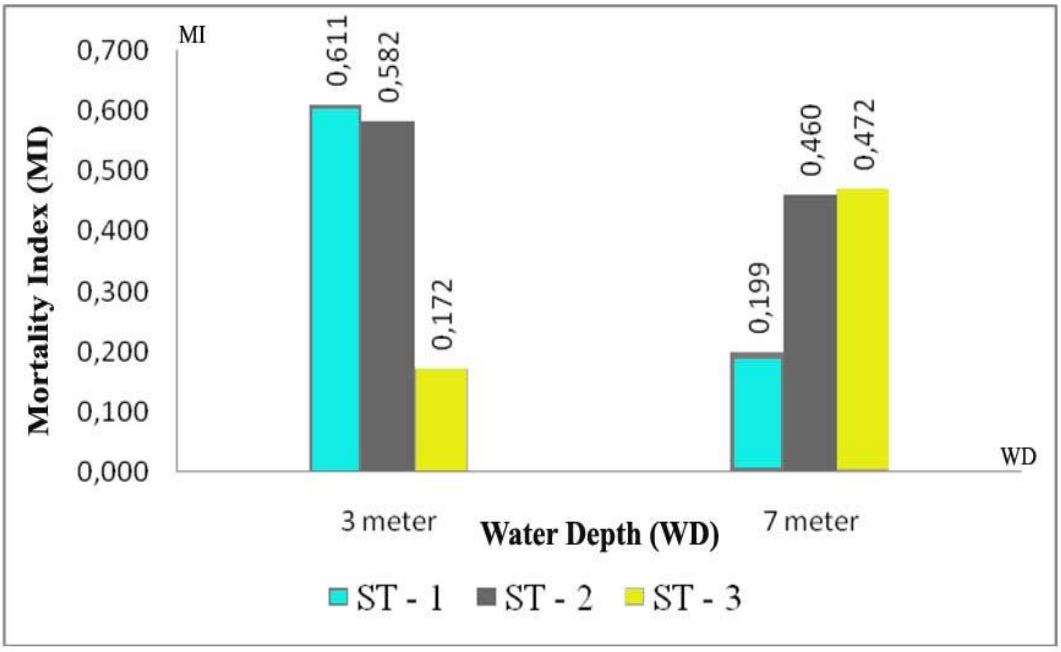

Fig. 5. Coral mortality Index Graph

The percentage of coral cover at Station 3 is different from Stations 1 and 2. At Station 3, the percentage is almost higher at 3 meters depth compared to 7 meters in depth. The highest percentage of coral cover is at Station 3 at a depth of 3 meters with a percentage of 44.93%, while the lowest percentage of coral cover is at Station 2 at a depth of 7 meters with a percentage of 17.08%. The percentage of coral cover at Station 1 has a value that is not much different, which is 32.82% at a depth of 3 meters and 39.82% at a depth of 7 meters, the condition of the coral reef at Station 1 is classified as moderate. For Station 2 the condition of coral reefs at a depth of 3 meters is bad with a percentage of 17.08%, while for a depth of 7 meters is moderate with a percentage of 33.51%. Station 3 has a criterion that is inversely proportional to Station 2, namely with the condition of a moderate coral reef at a depth of 3 meters, and a poor condition of a coral reef at a depth of 7 meters.

Coral mortality index values obtained from field data calculations differ from each observation station and from each depth of data collection. The mortality index of the coral reefs of Biawak Island waters ranged from 0.172 to 0.611. Overall, the results of the coral mortality index on the island of monitor lizard explained that there was a change for live coral into dead coral, but it was not very significant. The observation data of the Biawak Island waters obtained were produced in several ecological index values of coral reefs such as the coral mortality index, diversity index, dominance index, uniformity index, and similarity index.

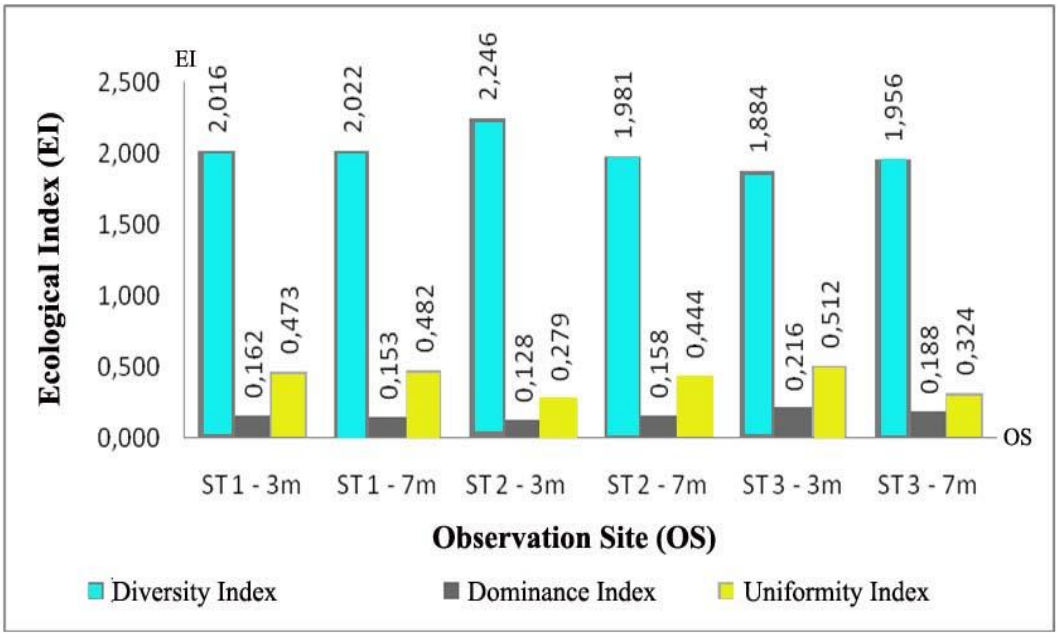

Fig. 6. Ecological Index Graph

The diversity index value of the coral reefs of Biawak Island waters ranged from 1,884 to 2,246. The average value of the diversity index of coral reefs of Biawak Island was 2,017. This value explains that the coral reefs in the waters of Biawak Island are of moderate diversity. Dominance index values obtained from the calculation of field data have differences from each observation station and from each depth of data collection. The dominance index value of coral reefs in the Biawak Island waters ranges from 0.128 - 0.216, the average dominance index value of 0.168 is below 0.5, so there is no dominance of one of the lifeform certain corals in Biawak Island waters. Uniformity index value obtained from the calculation of field data has a value that is almost close to each observation station and from each depth of data collection, the uniformity index value of coral reefs in the waters of Biawak Island ranged from 0.279 to 0.512. The similarity index values between 2 different stations at the same depth explain that what percentage of lifeform similarity found at the 2 observation stations compared.

The 100% similarity index value explains that the number and type of lifeform found are the same, so this causes the similarity index value to be 100%. The similarity value of 90.00% and 95.24% explains that the similarity of lifeforms found between the 2 stations has only 1 lifeform difference with other stations. Judging from the number of frequencies and percentages of meeting lifeforms, mostly above 50%, this illustrates that the distribution of corals in Biawak

Island waters is evenly distributed. The results of observing the number of lifeforms found at the observation point at each station and the depth in an even amount, which is equal to 10-11 lifeforms. The dominance index value obtained from all locations of the study points illustrates that its dominance is low, this supports that the distribution of corals in Biawak Island waters is evenly distributed, as well as the 4 research points that illustrate that the diversity of lifeform species is moderate. Even the distribution of corals on Biawak Island is also supported by the similarity index between locations at the same depth that is 90% - 100 %.

Table 2. Similarity Index Value Data,

Location	Depthness (m)	Station-1		Station-2		Station-3	
		3 meters	7 meters	3 meters	7 meters	3 meters	7 meters
Station-1	3	-	100.00	95.24	-	90.00	-
	7	-	-	95.24	90.00	-	90.00
Station-2	3	-	-	-	95.24	95.24	-
	7	-	-	-	-	90.00	90.00
Station-3	3	-	-	-	-	-	90.00
	7	-	-	-	-	-	-

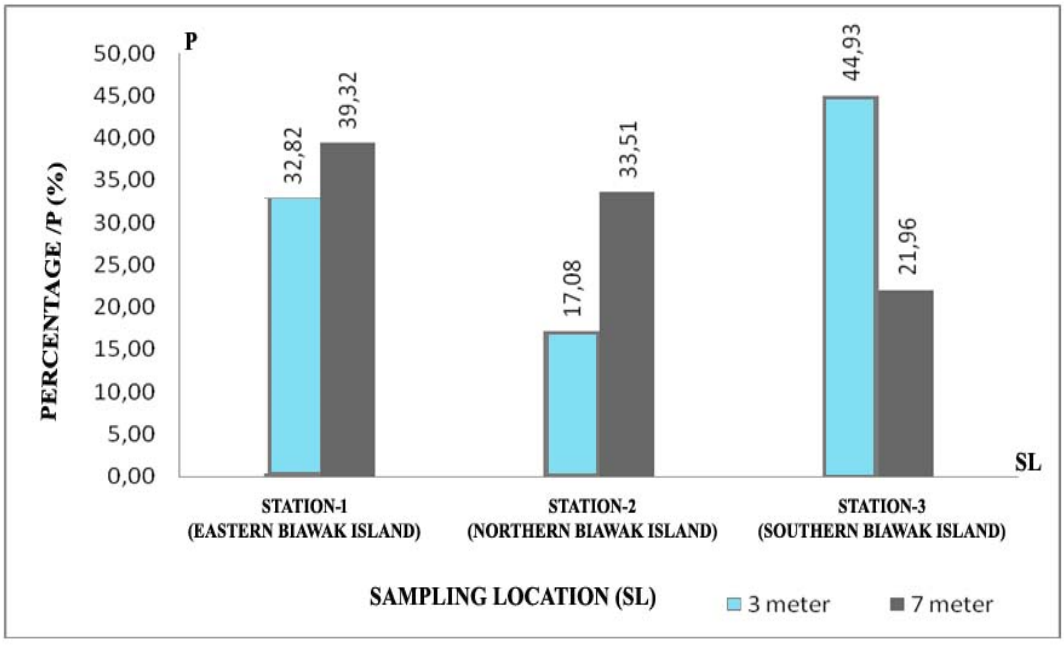

Fig. 7. Percentage Graph of Coral Cover

The current condition of coral reefs in the waters of Biawak Island can be seen from the percentage of coral cover data obtained which ranges from 17.08% - 44.93%. Based on the statement of [24-28] that the criteria for the condition of coral reefs are based on the percentage of coral cover in the waters of Biawak Island, including the criteria of damage to moderate.

Pic. 1. Types of coral reef sightings

The condition of coral reefs in the waters of Biawak Island at this time when compared with the data on the condition of coral reefs in 2018 is experiencing a decline. In 2018 the condition of coral reefs in Biawak Island waters has good to very good criteria, seen from the percentage of existing coral cover data which is 60.2% - 83.9%, and currently, the percentage of coral cover in Biawak Island waters has bad to moderate criteria with a percentage of coral

cover of 17.04% - 44.93%. The condition of the coral reefs of Biawak Island which is included in the criteria of bad to moderate explains that the pressure on the condition of coral reefs really occurs and is seen from the damage that exists in the coral reef ecosystem of Biawak Island today.

Recovery of the condition of coral reefs on Biawak Island can be done with the rehabilitation of coral reefs. The rehabilitation and management program is an effort to prevent and improve the condition of coral reefs that can be carried out non-structurally and structurally, non-structurally through awareness-raising, socialization and increasing public understanding of the benefits of coral reefs, as well as those carried out structurally through transplantation or through planting of artificial reefs [1,2]. Rehabilitation of coral reefs in Biawak Island waters is more appropriate if carried out structurally through coral transplantation. The results of observations during the study, rehabilitation with transplantation techniques were focused on the recovery of coral reefs in locations of damaged coral reefs, such as at station 2 at a depth of 3 meters and station 3 at a depth of 7 meters which coral reefs at this location included in the category of damage, after being in focus on this location then it is then carried out at the location of 4 other observation points that have moderate coral reef condition criteria.

Coral transplantation in the waters of Biawak Island is better done by taking seeds from the coral on Biawak Island itself so that no more time is needed to adapt to the environment if you have to take seedlings from other locations. The type of coral to be transplanted should be large colonies, branching, and corals shaped like leaves, because these species tend to grow faster than massive corals, in [27-31] states that species grow with diameters of 5-10 cm and height 2-5 cm per year, while the type of massive coral grows about 0.2 - 4 cm per year [32-34]. Coral transplantation can be used as a step to rehabilitate coral reefs in Biawak Island waters. The management of coral reef rehabilitation in the waters of Biawak Island will be successful if carried out and supported by all existing stakeholders, the government, non-governmental organizations, as well as the community of fishermen in particular. All must be involved in this management, as well as management that must be based on three aspects of management namely economic, ecological and social aspects [31-40].

4. CONCLUSIONS

The distribution of corals in Biawak Island waters is evenly distributed, as seen from the percentage of the frequency of coral lifeforms meeting with most of the above 50%, low dominance index, moderate diversity index, and also supported by similarity index values of 90 % to 100 %. The condition of coral reefs in Biawak Island waters has bad to moderate criteria with the percentage of coral cover obtained in the amount of 17.08% to 44.93%.

It is necessary to monitor the condition of coral reefs every year in the waters of Biawak Island so that the condition can continue to be known. Seeing the condition of coral reef ecosystems that continue to experience pressure, fishing with bombing, the use of Potassium Cyanide and trawl nets is pursued by the use of environmentally friendly fishing gear such as fishing gear and damage to coral reefs due to ship anchors can be reduced by making buoy mooring in locations that often visited by fishermen

Rehabilitation of coral reefs in Biawak Island waters is more appropriate if carried out structurally through coral transplantation, but with clear procedures and supervision, so that the

coral transplantation process can be carried out in a sustainable manner in accordance with the main goal as an effort to rehabilitate coral reefs in Biawak Island waters.

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