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Status of coral reefs in the biawak island marine protected area west java province

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Abstract
This study aims to analyze the status of the coral reef in Biawak Island Marine Protection Area (MPA). This study used the survey method and analyzed in description. The time range for analyzing from 2004 to 2018. The parameters used in the analysis are coral coverage. The results indicated that coral reefs in Biawak Island MPA are generally spread in the north, west, south and east. The condition of the coral reefs in the west and south is better than the north and east. The condition of coral reefs from 2004-2018 experienced a trend of change that varied in each location with a positive tendency. In 2004 coral cover in the north had a fairly low percentage, while the south part had a high percentage. In 2010, there were negative trends. However, in 2011, 2016, 2017 and 2018, there was a positive tendency to increase coral reef cover in all stations. In other words, the status of coral reef in the Biawak Island MPA tends to improve.

Keywords: coral reef, conservation, status, Biawak Island

1. Introduction
West Java Province is geographically located between 5°50'-7°50' S and 104° 48'-104° 48' E and has a sea area of 18,860.04 km^2 [1] and has a coastline along 848,63 km divided into 416.31 km of coastline in the area of West Java in the south and 432.32 km in coastline in the northern part of West Java [2].
West Java Province has a relatively large potential of coral reef biodiversity but is experiencing the threat of environmental degradation both due to natural factors and human activity factors. Natural factors include variations in seasonal climate, currents or sea water masses that are influenced by two oceans, as well as the diversity of habitat types and ecosystems contained within them. Human activities, patterns of utilization of natural resources and patterns of development are blamed as important causes of ecosystem damage [3].
One of the waters in West Java that has the potential of important coral reef resources is the Biawak Island Waters Region. Biawak Island waters have been determined as marine Protection Area in West Java (MPA) [4].
Coral reef ecosystems are part of the marine ecosystem that is important because it is a source of life for a wide variety of marine life. In this coral reef there are more than 300 species of coral, which consist of around 200 species of fish and dozens of species of mollusca crustaceans, sponges, algae, seagrasses and other biota. Coral reefs have a very important function as a place to spawn, find food, care for marine biota and as a source of germplasm. Coral reefs are also a source of food and raw materials for bioactive substances that are useful in pharmaceuticals and medicine. In addition, coral reefs also have a function that is not less important, namely as a coastal protector from degradation and abrasion [5].
The condition of coral reefs in the waters of Biawak Island is thought to change from time to time in accordance with changes in the environment around it. Changes in the condition of coral reefs will ultimately have an impact on the condition of other resources associated with coral reefs. The impact of coral damage on fisheries can follow the general theory of interactions between fish habitat and coral reefs. Several factors that contribute to the composition of the fish community on coral reefs are all related to the physical structure and complexity of the coral reef itself [6].
Researchers and managers of coral reefs in recent years have been very concerned about the decline in the condition of the world's coral reefs. It is estimated that around 50 - 70% of coral reefs are potentially threatened by human activities [7].
To find out how the development of the condition of coral reefs in Biawak Island MPA. It is necessary to study time series about the status of coral reefs from time to time. This is also related to the extent to which the success of the coral reef management program has been carried out by stakeholders so far.

2. Method
In general, this research uses survey methods. The definition of a survey is generally limited to research whose data is collected from a sample or population to represent the entire population. Thus, survey research is a study that takes samples from one population and uses a questionnaire as a basic data collection tool [8].
Data is collected, processed and analyzed to provide an overview of the object of research. Data collected in the form of data series. Time Seris data is collected from primary data in the form of surveys and field observations as well as secondary data in the form of data obtained from agencies and related agencies.
Determining the location of data collection is done by searching for stations that have coral reefs that are poor, moderate and good. This is done by the Point Intercept Transect (PIT) method [9].
The parameters used to assess the status of the condition of

the coral reef ecosystem at Biawak Island MPA are coral cover (coverage). The percentage of coral community closure was calculated using the following formula. Criteria for the percentage of coral community cover are formulated such as: Percentage of Coverage [10] = (Total points of a life form) / (Total points) X 100%

a. Bad Category: 0,0 - 24,9%
b. Medium Category: 25.0 - 49.9%
c. Good Category: 50.0 - 74.9%
d. Very Good Category: 75.0 - 100%

The method used in this research is the method of description analysis, which is a method that serves to describe or give an overview of the object under study through data or samples that have been collected as they are without doing analysis and making conclusions that apply to the public [11].

3. Results and Discussion

3.1 Condition of Coral Reefs in 2004

The coral reef formation found on the Biawak Island and its surroundings generally consists of frigging reefs, and barrier reefs. Fringing coral reefs are on Biawak Island, Candikian Island, Gosong Island. Barrier reefs generally spread and do not appear on the surface at the lowest tide. Coral reefs grow from a depth of approximately 1 meter to> 25 meters. The water temperature ranges from 26-27 0C and the water brightness ranges from 1-10 meters. The type of coral that can still be found is the type of leaf (Foliase), Mushroom, Digitate, Brancing, Tabulate, Milepora, Heliopora, Encrusting, Submassive, Soft coral Zoadithids and Sponge.

On the south side of Biawak Island, there are lots of stones (± 15 pieces) with a diameter of 2-3 meters which are covered by massive coral. Most of the branches are branching, sub-massive and digitata have become ruins that are seen to cover the seabed, only in some places the coral condition is still good with the percentage of live coral cover lower at 23.09%. At a depth of 10 meters it is dominated by dead and abiotic corals, which cover the area of 39.96% and 35.9% respectively. Tabulate coral species are rarely found, generally small (± 40 cm in diameter), but there is one table coral with a diameter of up to 150 cm which has bleaching conditions (Table 1).

Table 1: Percentage of Biawak Island Coral Cover 2004

Depth (m)	Coverage (%)		Abiotic	Algae	Other Biota
	Life	Dead			
3	52,42	12,7	32,18	2,55	-
10	23,09	39,96	35,9	-	1,05

Coral growth is strongly influenced by bio-physical factors up-welling, solar light, water clarity, depth, water temperature, salinity, precipitation, flow, and substrate [12].

a. Up-Welling. Naturally, a stable water body has high maternity karasteristics and low temperature in a deeper layer. As a result of the dynamics of water masses caused by currents, bathymetry conditions and other factors cause upwelling phenomena. This up-welling current carries a mass of cold water from the bottom layer to the layer of the coral reef. If the temperature of the mass of water below the tolerance threshold for the survival of the metabolism of coral reefs will certainly disrupt the growth of coral reefs.
b. Sunlight. Sunlight is the main energy source in this nature,

as well as coral reefs. Sunlight is needed by zooxanthella which is a single celled microscopic algae to produce oxygen for the growth of coral reefs. The intensity and quality of light that can penetrate seawater is very important in determining the vertical distribution of rock corals that contain it. The deeper the sea, the less light intensity is gained or achieved, which means that the coral reef population in the area decreases.

c. Water clarity. Rock corals that live beneath the surface of the water require sea water that is clean from dirt - dirt, because the objects contained in the water can block the entry of eye light the day needed to live zooxanthella. In addition, the sludge or sand contained in the water will be deposited by the currents so that it can cause death on the coral reef.

d. Depth. The depth of a coral substrate will determine the distribution of the coral reef population itself. The deeper the position of the substrate from the surface of the water, the smaller the penetration of sunlight and the temperature of the mass of the water so that the coral growth at that location also decreases. Walter stated that the internal depth for the growth of coral reefs was around 20 m and could still live to a depth of no more than 40 meters.

e. Water Temperature. The lowest temperature where rock corals can live is 15º C, but most are found at water temperatures above 18º C and grow very well between 25º C - 29º C. Maximum temperature where the coral reefs are still alive is 36 ºC. The best temperature for rock coral growth is 25º C - 31ºC and it can still live at a temperature of 15ºC, but breeding, metabolism and liming will be disrupted.

f. Salinity. Salinity where rock corals can live is 27-40%, but they live best at normal salinity of sea water which is 36%. Coastal waters will continue to experience regular freshwater inflow from the river flow, so that the salinity decreases which will result in the death of coral reefs, which also limits the distribution of coral locally.

g. Sedimentation. Deposits that are in water or on corals have a negative influence on coral reefs. Heavy deposits will cover and clog the feeding structures that exist in coral reefs. Deposition in water causes light to photosynthesis to decrease so that coral reef growth decreases or disappears.

h. Water Flow. The movement of water or flow is needed for the availability of a supply flow of food for microorganisms and oxygen as well as the avoidance of corals from deposits. In the area of daytime coral reefs oxygen is obtained from photosynthesis zoonxanthella and from the oxygen content present in the mass of the water itself, while at night it is very necessary to have strong currents that can supply sufficient oxygen for fauna on coral reefs. In the open sea the oxygen supply is always sufficient, but in waters that are somewhat closed the growth of rock corals is hampered by food shortages. Therefore the growth of coral reefs in places where the water is always mixed with wind, currents and waves is better than the calm and protected ones.

i. Substrate. Rock coral planula can only be attached to hard and strong substrates such as shells, dead corals and skeletons from other organisms.

3.2 Condition of Coral Reefs in 2010

Observation of data in 2010 was carried out at 3 (three) points /stations on Biawak Island [13], where the coordinates of each station are presented in Table 2.

Table 2: Coordinating Coral Reef Observation 2010

Station	Location	Coordinate
1	West	05˚55'43.38" S 108˚22'14.3" E
2	South	05˚56'16.9" S 108˚22'54.5" E
3	North	05˚55'27.3" S 108˚22'52.5" E

At the location of the western part of Biawak Island, at a depth of 3 m the percentage of live coral cover varies between 31.4-47.8%, and at a depth of 10 m varies between 19.4-39.4%. At the location of the southern part of Biawak Island, at a depth of 3 m the percentage of live coral cover varies between 32.6-51.4%, and at a depth of 10 m varies between 23.8-64.9%. At the location of the northern part of Biawak Island, at a depth of 3 m the percentage of live coral cover varied between 16.9-13.0%, and at a depth of 10 m varied between 9.8-40.2%.

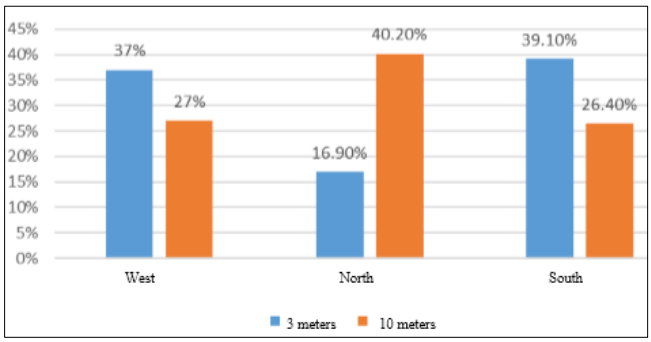

Fig 1: Condition of the Coral Reef of Biawak Island 2010

Based on data from each sampling point per station, the average value of the percentage of coral cover at each station was determined for depths of 3 m and 10 m. From the results of the data calculation, it is known that in general the condition of coral cover at each observation station is classified as bad to moderate, with the range of live coral cover varying between 22.7 ± 5.9% - 45.7 ± 13.2%.

The percentage of dead coral varies between 10.4 ± 8.0% - 58.9 ± 23.2% at a depth of 3 m and 2.5 ± 1.7% - 32.0 ± 16.6% at a depth of 10 m. One of the factors that can cause coral death is the high level of pollution. Water pollution is an unwanted change in physics, chemistry and biology in aquatic ecosystems that will cause losses to the source of life, living conditions and industrial processes [14]. Sea pollution is defined by the inclusion or inclusion of living things, substances, energy, and / or other components into the marine environment by human activities so that the quality drops to a certain level which causes the marine environment to no longer match the standard quality and / or function [15]. Marine pollution is a change in the marine environment including estuaries which cause adverse consequences so that it can harm marine living resources, endanger human health, disruption to marine activities including fisheries and sea use reasonable, reduce the quality of sea water, the quality of its uses and benefits [16].

Based on observations it is known that Biawak Island MPA is an area of ship transportation lines that is prone to the influence of ship exhaust oil spills, and also the oil spill that occurred in 2005 in the waters around Biawak Island. Oil spills have caused damage to the surrounding reefs. Oil is a pollutant that has great potential to pollute seawater. Oil pollution is the main cause of marine pollution which can endanger marine ecosystems because the sea and aquatic biota are very vulnerable to oil [17]. The short-term effect of oil pollution is damage to the cell membranes of marine biota by oil hydrocarbon molecules that result in the release of cell fluids and seep into the cell. Various types of shrimp and fish will smell of oil, which causes a decrease in quality. Direct oil can cause 11 fish deaths due to lack of oxygen, carbon monoxide poisoning, and direct poisoning by toxic substances. The long-term impact of oil pollution is experienced by young marine biota. Oil can be adsorbed and consumed by marine biota, some will accumulate in fat and protein compounds. The nature of this accumulation can be transferred from one organism to another organism through the food chain [18]. Oil pollution has become the most direct and most serious threat facing ecosystems [19]. The condition of coral reef cover at Biawak Island MPA in 2010 is presented in Table 3.

Table 3: Percentage of Biawak Island Coral Cover 2010

Location	Depth (m)	Life coral (%)	Dead Coral (%)	Algae (%)	Soft coral (%)	Fault coral (%)	Sand (%)	Others (%)
West	3	37,0±9,3	44,0±11,7	3,8±6,5	-	4,2±6,7	10,9±2,4	0,2±0,3
	10	27,4±10,6	2,5±1,7	1,4±1,5	0,3±0,5	68,4±10,6	-	-
South	3	39,2±10,6	15,3±3,6	-	9,5±4,8	36,0±12,5	-	-
	10	42,3±20,9	31,0±22,6	-	0,3±0,5	20,3±6,5	-	-
North	3	26,4±10,7	10,4±8,0	-	1,0±1,0	62,3±15,0	-	-
	10	24,9±15,2	32,0±16,6	0,1±0,2	0,1±1,0	41,5±18,9	0,2±0,3	1,2±1,2

In addition to the percentage of dead corals, coral fractures also have a high percentage value. This can be seen from the percentage of coral fracture at each station which ranged from 4.2 ± 6.7% - 62.3 ± 15.0% at a depth of 3 m and 20.3 ± 6.5% - 68.4 ± 10.6% at a depth of 10 m.

This damage occurs due to the existence of human activities that are not environmentally friendly to coral reef ecosystems such as fish bombing, use of environmentally friendly fishing nets and disposal of anchors anchored in the conservation area of Biawak Island and its surroundings. Damage to coral reefs can be caused by anthropogenic (human activities) and non-anthropogenic (ecological changes, natural factors), among others: fishing using fish bombs; arrow; nets; bubu; coral extraction for building materials and aquarium decorations; and wall decoration [19].

3.3 Coral Reef Conditions in 2011

The choice of location for data collection is done by selecting locations based on the following criteria [20]: has typical ecological criteria, having specificity of resource utilization (tourism), locations have been observed before for the sake of temporal comparison, and aasily accessible

Based on these considerations, the selection of data collection

locations was carried out at 3 stations representing the waters of Biawak Island, namely:

- Station 1 (05 ° 55 '49.7 "S and 108 ° 23' 25.20" E)
  Station 1 is an area around the east of Biawak Island which is directly adjacent to the high seas, it is estimated that this region is highly influenced by the physical factors of the waters which are flowing due to the influence of the season.
- Station 2 (05 ° 55 '24.27" S and 108 ° 22 '51.12" E)
  Station 2 is an area around the north of Biawak Island, in this region it is estimated that there is very little human activity.
- Station 3 (05 ° 56 '17.1 " S and 108 ° 23' 08.10" E)
  Station 3 is an area around the south of Biawak Island, this area is the area around the dock of Biawak Island and tourist activity area.

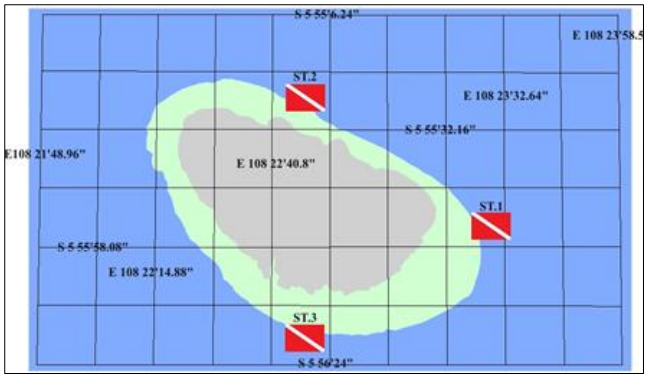

Fig 2: Point of Observation Station 2011 [21]

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. The observation station 2 has a coral cover percentage of 17.08% at a depth of 3 meters and 33.51% at a depth of 7 meters. The percentage of coral cover station 3 was 44.93% at a depth of 3 meters and 21.96% at a depth of 7 meters.

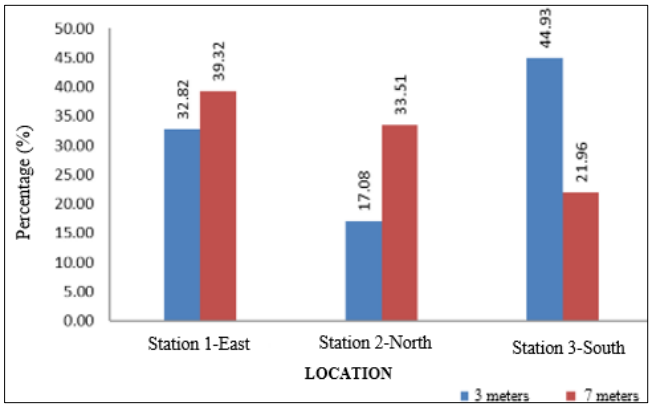

Fig 3: Condition of Biawak Island Coral Reef 2011

The condition of the coral reefs in the waters of Biawak Island included in the broken criteria is found at station 2, namely the northern region of Biawak Island at a depth of 3 meters, which is 17.08% coral cover, and at station 3, the Biawak Island is 7 meters deep coral cover 21.96%. The condition of the Biawak Island coral reef included in the medium criteria is found in all other observation stations, namely at station 1 at a depth of 3 and 7 meters, each of which has a percentage of coral cover of 32.82% and 39.32%, then at station 2 at a depth of 7 meters with a percentage of 33.51, and at station 3 at a depth of 3 meters with a percentage of 44.93% and at this location is the location with the highest percentage of coral cover.

The percentage of coral cover at station 1 at a depth of 3 meters and 7 meters has a medium criterion. This condition is estimated because the location of station 1 in the eastern region of Biawak Island generally has a strong current. Current movements are needed for the availability of food and oxygen supply flows or for the avoidance of corals from sediment deposition deposits [22] so that coral reef conditions are still better compared to other stations.

Table 4: Percentage of Biawak Island Coral Cover 2011

Depth (m)	East	North	South
3	32.82%	17.08%	44.93%
7	39.32%	33.51%	21.96%

The results of this study also illustrate that the percentage of coral cover from each station has different criteria, at station 1 and 2 the percentage of coral cover is higher at a depth of 7 meters, while at station 3 the percentage of coral cover is higher in a depth of 3 meters. The lower percentage of coral cover at 3 meters depth at stations 1 and 2 occurs because at this depth the condition of coral reefs is more susceptible to stress due to human activities.

Most of the coral reefs in the shallow area are now severely damaged. The pressure on the existence of coral reef conditions is mostly caused by human activities such as fishing using bombs (Potassium Cyanida), trawl nets, or due to disposal of ship anchors, so prevention is necessary [23].

3.4 Coral Reefs Condition in 2016

Observation of the condition of coral reefs in 2016 was carried out at two points, the South and North Island. This selection is based on data from the previous year which shows that there are large differences in coral cover conditions in the north and south. The southern part which has island entrance access in the form of a pier has a high coral cover compared to the northern part which has the lowest percentage of coral cover.

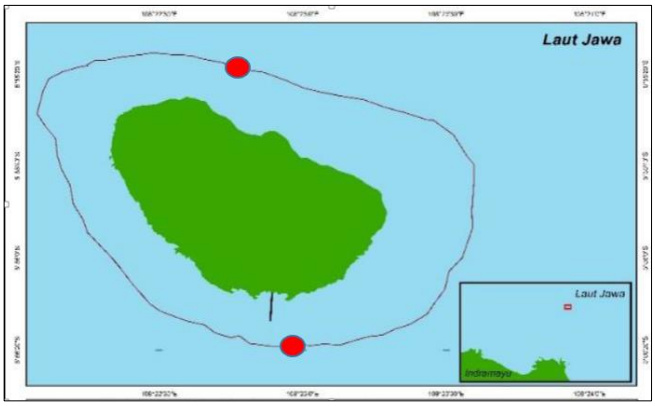

Fig 4: Observation Station Point 2016 [24]

The condition of coral cover in 2016 at two observation stations experienced an increase in the amount of coral cover compared to previous observations (2011). This increase in coral cover indicates that in the previous year of observation until 2016, natural events or atropogenic activities that disrupt coral reefs tend to be minimal. Coral reefs can carry out succession well which can be seen from the amount of

increase in the percentage of coral cover at both observation stations.

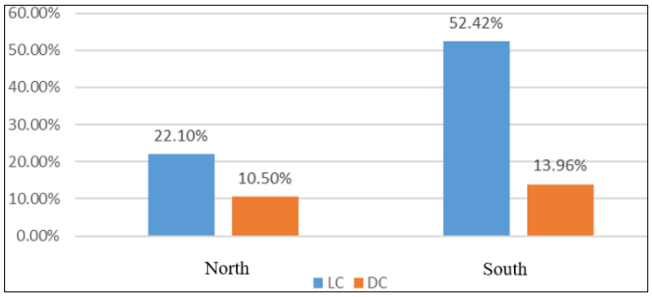

Fig 5: Condition of Biawak Island Coral Reef 2016

The percentage comparison of live corals with dead corals at Station 1 (North) has a value of 22.1% - 10.5%, where the status of coral reefs is still in the bad category. However, overall there is an increase in the percentage of coral cover and coral fracture values that tend to be small (5.68%) can be an indication that the coral in this area can survive and grow. The percentage comparison of live corals with dead corals at Station 2 (South) has a value of 52.42% - 13.96%, where the status of coral reefs falls into the good category. The coral reef observation location is close to the ship and pier traffic lanes. Increasing the value of cover is indicated by the lack of fishing activities for fishing in the area near the dock, where fishermen prefer to enter into the shallower waters to rest.

Table 5: Percentage of Cover of Biawak Island Coral 2016

	North	South
Life Coral	22.10%	52.42%
Dead Coral	10.50%	13.96%

3.5 Condition of Coral Reefs in 2017

Observations were made at three stations to fulfill the requirements for representing coral reef cover in the waters of Biawak Island. The selection of observation locations is in the South, West and North of Biawak Island.

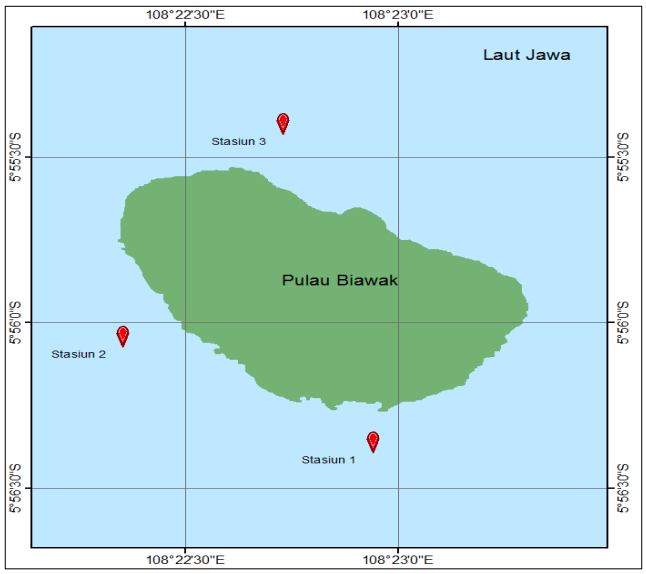

Fig 6: Observation Station Points 2017 [25]

Station 1 is on the south of Biawak Island, which is close to the pier where the ship pulls over. The depth of the dive is at 4-7 meters. The percentage of coral reef cover (Hard Coral + Soft Coral) at this station is at 51%. The percentage of coral cover is included in the good category [10] with the composition of the type of coral substrate as follows.

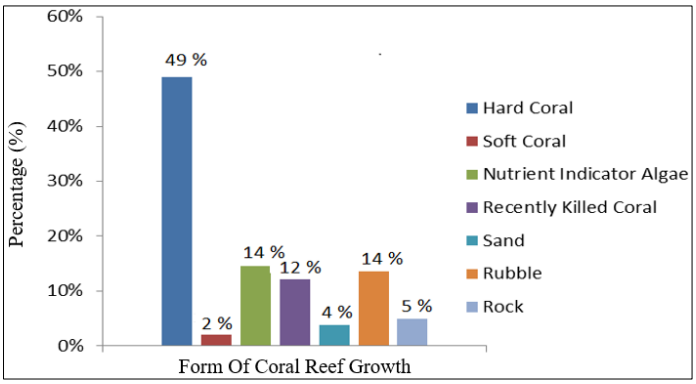

Fig 7: Percentage of Biawak Island Coral Cover 2017 Station 1

Based on the graph above, the percentage of substrate is dominated by hard coral and the lowest is soft coral. In addition, 14% and 12% of rubble (broken coral) and recently killed coral need to be considered because they are likely to become algae cover later.

Station 2 is in the west of Biawak Island with coordinates of 5 ° 55 '50,106 "S; 108 ° 22' 14,957" E. The percentage of coral reef cover (Hard Coral + Soft Coral) at this station is 41% which is the percentage category of cover medium coral reefs [10]. The composition of the type of coral substrate is as follows.

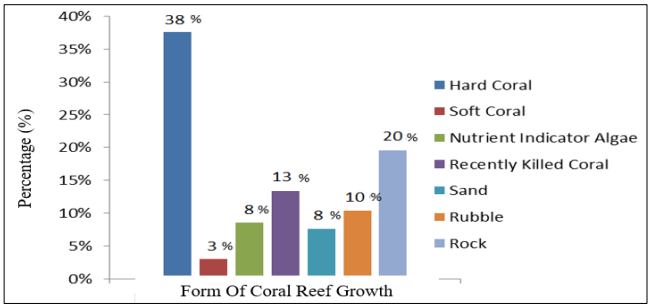

Fig 8: Percentage of Biawak Island Coral Cover 2017 Station 2

Similar to station 1, station 2 is dominated by Hard Coral and the lowest value cover is in the soft coral. Station 2 has more rock percentages than Station 1.The last station or Station 3 is located on the north of Biawak Island with coordinates 5 ° 55 '32,507 "S; 108 ° 22' 55,101" E. The criteria for coral reef cover (Hard Coral + Soft Coral) are included in a poor percentage of 20% [10]. The composition of the type of coral substrate is as follows.

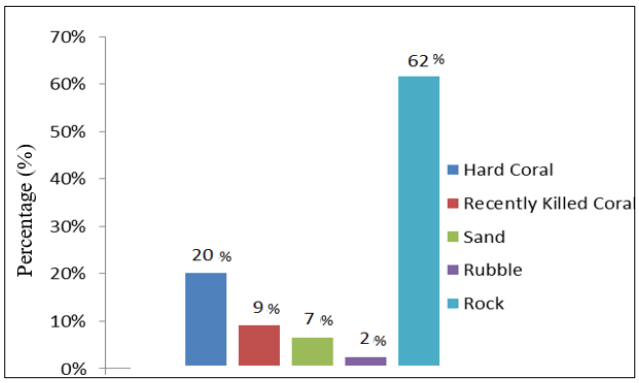

Fig 9: Percentage of Biawak Island Coral Cover 2017 Station 3

Station 3 has a significant difference with the other 2 stations. This is seen in the highest percentage of Rock compared to other types of substrate. Coral cover did not dominate from the station. Based on observations from the 3 stations above, it was found that the average percentage of coral reef cover in the waters of Biawak Island was 37.3% and included in the criteria for moderate coral reef cover [10]. At Station 3, there is no soft coral and nutrient indicator algae, because the current tends to be tight, which is around 0.45 m/s.

Table 6: Percentage of Biawak Island Reef Cover 2017

Depth (m)	West (2)	North (3)	South (1)
7	38%	20%	49%

3.6 Condition of Coral Reefs in 2018

Observation of the condition of coral reefs in 2018 was carried out at 3 observation stations, North, West and South. The conditions of each observation station showed a positive trend or an increase in the percentage of hard coral cover at several observation stations.

The percentage of coral cover of Biawak Island in 2018 shows different values. Station 1 is 23.27%, station 2 is 33.75%, and station 3 is 51.25%. Based on the criteria for the percentage of coral reefs, the condition of the coral reef at station 1 is categorized as damaged / damaged. While station 2 is categorized as medium, and station 3 is categorized as good. Different conditions of coral reefs at each station are caused by other factors such as flow, sedimentation, and fishing activities.

Too strong currents will break coral fragments. Excessive sedimentation / siltation of land is a major threat to coral life. Fine mud in the form of dissolved sediments that settles will cover the pores of coral animals and cause death. In addition, the lifting of sediments and deposits on the substrate causes the waters to become cloudy, and reduces the intensity of sunlight needed for photosynthesis, which will cause death on coral reefs [26].

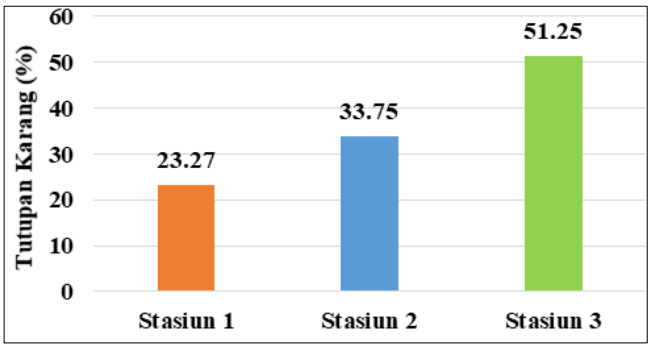

Fig 10: Condition of Biawak Island Coral Reef 2018

At station 1, coral reefs are categorized as damaged due to fishing activities centered on the area. The destruction of coral reefs in the northern part of Biawak Island was caused by fishing activities that generally used bombs, cyanide and trawl nets [2]. This tool is one of the fishing tools that is not environmentally friendly, so that it becomes one of the causes of damage to coral reefs. This can be proven by the many found rubble in the region. In addition, the damage to coral reefs is also caused by the dumping of anchored fishing vessel waste, such as engine oil disposal, so that if the remainder of the disposal is not carried away then it will settle on the coral reef so that it inhibits the process of photosynthesis [27].

At Station 2, namely in the eastern part of Biawak Island, the condition of coral reefs is in the moderate category. This is influenced by the strong currents in the east, thus accelerating the process of sedimentation and can break the coral. Because data collection is carried out during the transition season, the dynamics of physical and chemical factors in the aquatic environment are increasingly high, while coral reefs are organisms that are susceptible to environmental changes.

Coral reefs at station 3 are included in good condition. Station 3 or to the east of the island Biawak is an area that is not exposed to human activities. The area does not include tourist or fishing areas. The movement of currents in this region is sufficient for the availability of food supply and oxygen flow or for the avoidance of corals from sediment deposits. At this station, there is not much rubble or algae or Nutrient Indicator Algae.

3.7 Compilation of Biawak Island Coral Reef Cover for 2004 – 2018

Observation of the condition of coral reefs from 2004-2018 in several locations of the observation stations experienced trend changes that varied in each location. In the initial year of observation (2004) which can be said as the initial condition of Biawak Island coral reefs there was a percentage of coral cover in two locations where the two locations showed a significant difference from the percentage. The northern part has a fairly low percentage of coral cover, while the southern part has a good percentage of coral cover.

Then the next observation was carried out in 2010, where there was a change in the percentage of coral cover at the 2004 observation site. However, in observations of the following years, namely 2011, 2016, 2017 and 2018, there was a positive trend of increasing cover of Biawak Island reefs throughout observation location.

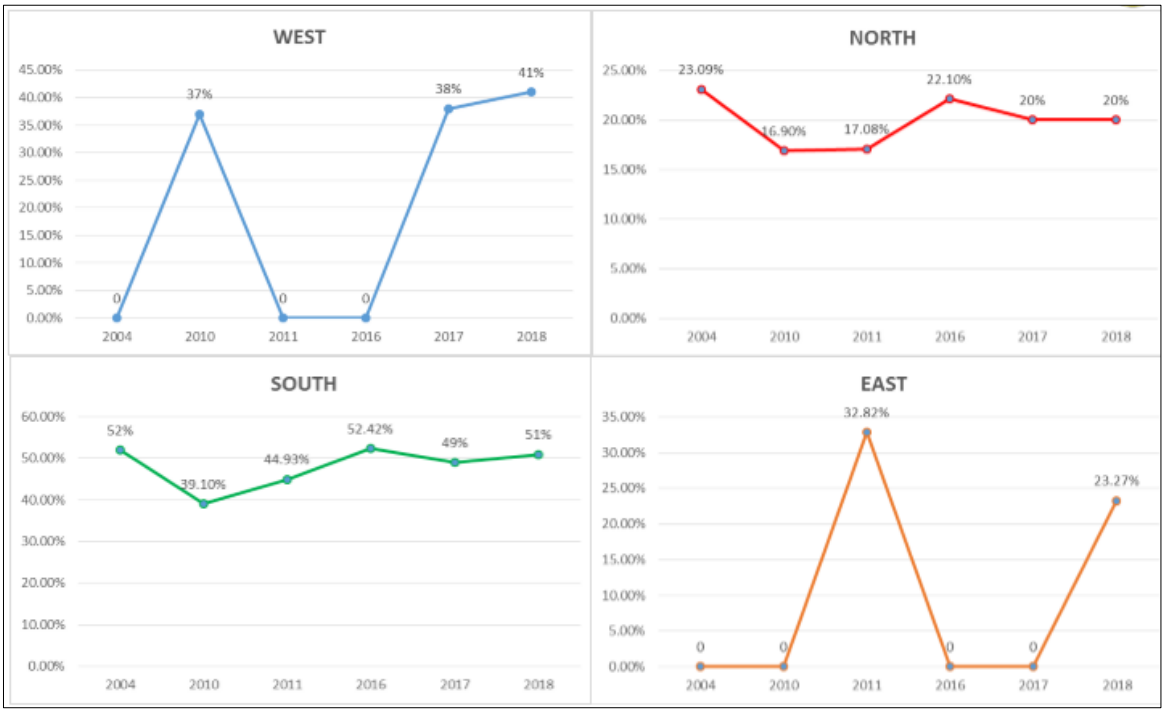

Fig 11: Graph of Changes in Percentage of Coral Cover of Biawak Island 2014-2018

Table 7: Percentage of Change in Coral Reefs of Biawak Island for 2004-2018

Location	2004	2010	2011	2016	2017	2018
West	-	37%	-	-	38%	41%
North	23.09%	16.90%	17.08%	22.10%	20%	20%
South	52%	39.10%	44.93%	52.42%	49%	51%
East	-	-	32.82%	-	-	23.27%

4. Conclusion

Based on the above discussion, the following are some conclusions related to the condition of the coral reefs on Biawak Island MPA including.

1. Coral reefs in the waters of Biawak Island are generally spread in the north, west, south and east. The condition of the coral reefs in the west and south is generally relatively better compared to the north and east.
2. Based on the time series data from 2004 to 2018 it is known that the condition of the coral reefs in the waters of Biawak Island tends to fluctuate. In the western and southern waters the condition of coral reefs tends to be better than the north and east. This condition is caused by natural factors caused by human factors around it.

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6. References

1. Law of Republic Indonesia No. 23 concerning Goverment, 2014.
2. Dinas Perikanan dan Kelautan, Provinsi Jawa Barat. Laporan Akhir Penyusunan Naskah Akademik Pengelolaan KKLD Pulau Biawak Kabupaten Indramayu, 2005.
3. Gumilar I. Partisipasi Masyarakat Pesisir Dalam Pelestarian Ekosistem Hutan Mangrove (Studi Kasus Di Kabupaten Indramayu Jawa Barat). Jurnal Sosiohumaniora, 2018,20(2).
4. West Java Provincial Regulation Number 05 of 2019 concerning Zoning Plans for Coastal Areas and Small Islands of West Java Province.
5. Dahuri *et al*. Pengelolaan Sumber Daya Wilayah Pesisir dan Lautan Secara Terpadu. Pradnya Paramita. Bogor, 2001.
6. Pet Soede L. The Effects Of Coral Bleaching On Fisheries In The Indian Ocean. Pp. 145-178. *In* Socioeconomic Assessment Of The Impacts Of The 1998 Coral Reef Bleaching In The Indian Ocean (S Westmacott, H Cesar, And L Pet-Soede, Eds.). Resources Analysis And Institute For Environtmental Science (Ivm).Report To The World Bank, African Environtmental Division For The Cordio Programme, 2000.
7. Chair Rani, 1986. *Perikanan Dan Terumbu Karang Yang Rusak: Bagaimana Mengelolanya*? Jurusan Ilmu Kelautan, Fakultas Ilmu Kelautan dan Perikanan Universitas Hasanuddin, Makassar.
8. Singarimbun Masri dan Sofian Effendi. Metode Penelitian Survei, LP3ES, Pustaka Jakarta, 2006.
9. Wilson J. Metode Pemantauan Biologi Untuk Menilai Kesehatan Terumbu Karang dan Efektivitas Pengelolaan Kawasan Konservasi Laut di Indonesia Versi 1.0. Australia. The Nature Conservancy, 2009**.**
10. The Minister of Environment Decree No.4 of 2001concerning Standard Criteria for Quality of Damage to Coral Reefs.
11. Sugiyono. Metode Penelitian Kuantitatif, Kualitatif dan

R&D, Alfabeta, Bandung.
12. Santoso dan Kardono. Teknologi Konservasi Dan Rehabilitasi Terumbu Karang. Jurnal Teknologi Lingkungan. Jakarta. 2008; 9(3):121-226. ISSN 1441-318X.
13. Odum. Dasar-Dasar Ekologi. Gadjah Mada University Press, Yogyakarta, 1993.
14. Government Regulation of the Republic of Indonesia Number 19 of 1999 concerning Marine Pollution.
15. Division for Ocean Affairs and the Law of the Sea Office of Legal Affairs, Law of the Sea. Bulletin No. 88 United Nations, New York, 2007..
16. Mukhtasor. Pencemaran Pesisir dan Laut. Penerbit PT. Pradnya, 2007.
17. Sumadhiharga, K. *Zat-Zat yang Menyebabkan* Pencemaran di Laut. Jurnal Pusat Studi Lingkungan Perguruan Tinggi Seluruh Indonesia: Lingkungan dan Pembangunan. 1995; 15(4):376- 387.
18. Dunbar MJ. Ecological Development of Polar Regions, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1968, 119.
19. Netty Murti, dan Hadisusanto. Kerusakan Lingkungan Akibat Aktivitas Manusia pada Ekosistem Terumbu Karang. Majalah Geografi Indonesia, Maret, Fakultas Geografi UGM, Yogyakarta. 2016; 30(1):88-95.
20. Estradivari M. Syahrir, N. Susilo, S. Yusri, S. Timotius. Terumbu Karang Jakarta : Pengamatan Jangka Panjang Terumbu Karang Kepulauan Seribu (2003-2007). Yayasan Terumbu Karang Indonesia (TERANGI). Jakarta, 2009.
21. Kristiadhi F. Distribusi dan Kondisi Terumbu Karang di Pulau Biawak, Indramayu. Universitas Padjadjaran, Bandung, 2011.
22. Sukarno *et al*. Terumbu Karang di Indonesia, Sumberdaya, Permasalahan dan Pengelolaannya. LON-LIPI. Jakarta, 1983.
23. Ferianita. Metode Sampling Bioekologi, Bumi Aksara, Jakarta, 2007.
24. Purnama E. Harahap, Sriati SA, Syamsuddin ML. The Study of Bottom Substrate Mapping Accuracy with 2D and 3D in Biawak Island Seas of Indramayu District West Java. 2nd International Forum on Sustainable Future in Asia Proceeding, 2017, 37-42.
25. Priandina AG. Bioakumulasi Mikroplastik Pada Ikan Karang Target Di Perairan Pulau Biawak, Kabupaten Indramayu. Universitas Padjadjaran: Bandung, 2018.
26. Suharsono. Jenis-Jenis Karang di Indonesia. Jakarta: Pusat Penelitian Oseanografi. LIPI, 2008.
27. Law of the Republic of Indonesia No. 45 of 2009 Concerning Fisheries.