Original research article

The Coral Reef Health Disturbance in The Waters of Pongok Island, South Bangka District

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ABSTRACT

This research aims to analyze coral reef cover and analyze coral reef health problems. This research was conducted in October 2023 in the waters of Pongok Island. Coral reef cover data collection using the method of Underwater Photo Transect (UPT) and data collection on the distribution of coral health disorders was taken using the belt transect method (belt transect). The results of the research showed that the percentage of coral reef cover in Pongok Island waters ranged from 28.67% - 63.87% which was categorized as Medium to Good. Coral reef health problems found at the research location in Pongok Island waters are Bleaching (B), Sedimentation damage (SD), Pigmentation response (PR), growth anomalies (GA), and crown of thorns starfish (CoTS). Sedimentation damage is the highest prevalence in the research location with 3.42%, then pigmentation response (PR) with a total of 0.48%, Crown of thorns starfish (CoTS) 0,05%, Bleaching (B) 0,04%, and Growth anomalies (GA) with an amount of 0.01%.

Introduction

The Bangka Belitung Islands Province is one of the provinces that has high marine resource wealth. The Bangka Belitung Islands Province has a water area of 65,301 km^2 (Central Statistics Agency, 2023). One of the water areas that has high coastal ecosystem richness is the waters of Pongok Island, South Bangka Regency. Pongok Island is one of the islands located in South Bangka Regency. One of the potential coastal ecosystems on Pongok Island is coral reefs.

Coral reefs are coastal ecosystems that have important functions. Coral reefs are home to a variety of biota such as mollusks, crustaceans and various coral fish. Apart from that, ecologically, coral reefs are spawning grounds (spawning ground), a place of care (nursey ground), a place to find food (feeding ground), and enlargement area (rearing ground) for various types of biota (Muftiadi, 2021). Coral reefs also have a function in

preventing abrasion and maintaining coastal stability (Rizal *et al*., 2016). Coral reefs are vulnerable to negative impacts from human activities which can cause disruption to coral reefs. There are several health problems in coral characterized by changes in color of the lost coral tissue (Nirwanda *et al*., 2017). Other disturbances on coral reefs can occur due to increases in temperature and salinity which also play a role in the emergence of coral bleaching (Dedi *et al.,* 2016).

The waters of Pongok Island are often used as a source of livelihood for the local community who generally work as fishermen. This activity has the potential to become a threat that can damage coral reefs due to the breaking of parts of the coral reef. Apart from that, the lack of information regarding coral reef health disorders, especially on Pongok Island, is the background for the author to carry out research related to coral reef health disorders on Pongok Island. Based on

this, this research can provide information regarding coral reef health problems considering the importance of coral reef health in the waters of Pongok Island. So, it is necessary to carry out further studies regarding coral reef health data as a first step in sustainable ecosystem management and conservation efforts.

Research methods
Time and place

This research was conducted in October 2023 in Pongok Waters, South Bangka Regency. Data collection was carried out directly in the field and identification of coral reefs was taken by taking photos using a photo camera underwater, then identified in the Aquatic Resources Management laboratory, Bangka Belitung University. The following is a research map which can be seen in Figure 1.
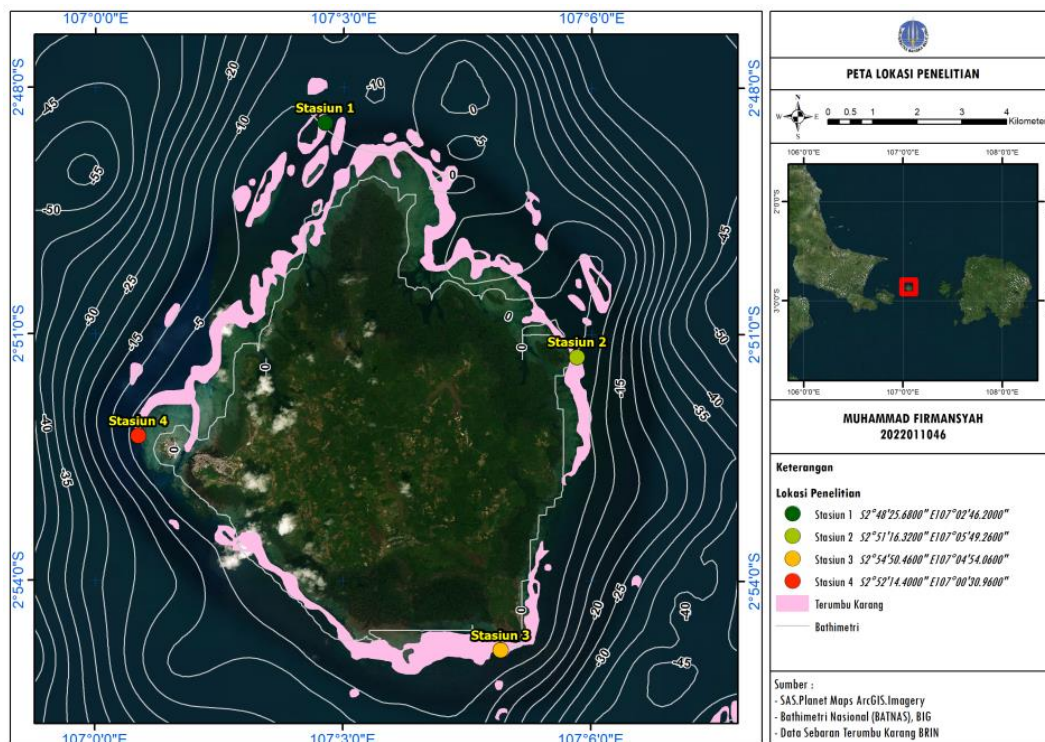

Figure 1. Map of research locations

Tools and Materials

The research tools and materials used can be seen in Table 1.

Table 1. Tools and materials used in collecting coral data

No	Tools and materials	Usage
1.	SCUBA Set	Data retrieval tools
2.	Underwater Stationery	Record the results of underwater research
3.	GPS *(Global Positioning system)*	Determine the point coordinates*sampling*
4.	Photo Camera*Underwater*	Underwater documentation
5.	Roll Meter	Coral reef and fish data collection
6.	*Frame* size 44 x 58 cm	For data retrieval
7.	Identification book	Identifying coral reefs
8.	*Thermometer*	Measuring Water temperature
9.	*Hand Refractometer*	Measuring the salinity of Water
10.	*Dry disks*	Measuring the brightness and depth of waters
11.	pH Meter	Measuring the acidity of waters
12.	Laptop	Analyzing research data
13.	CPCe App	Processing research data

Determining Location Points

Determining the research location using the method of purposive sampling. Determining the location points was carried out through certain considerations by researchers, considering the extent and representation of coral reefs on Pongok Island. The data collection points can be seen in Table 2.

Table 2. Research Coordinate Points.

Location	Station	Latitude	Longitude	Information
Pongok Island	1	S 02° 48'25.6800	E 107°02'46.2000	North side
	2	S 02° 51'16.3200	E 107°05'49.2600	East side
	3	S 02° 54'50.4600	E 107°04'54.0600	South side
	4	S 02°52'14.4000	E 107°00'30.9600	West side

Coral Reef Cover

Data collection uses the methods of Underwater Photo Transect. Data collection was carried out in shallow water with depths ranging from 3-5 meters with 4 data collection points at each station. At each point a 50 meter transect was laid by laying frame square measuring 44 x 58 cm for lifeform at every meter to then take photos (Giyanto*et al.*, 2014). The following illustration of data collection using the UPT method is presented in Figure 2.
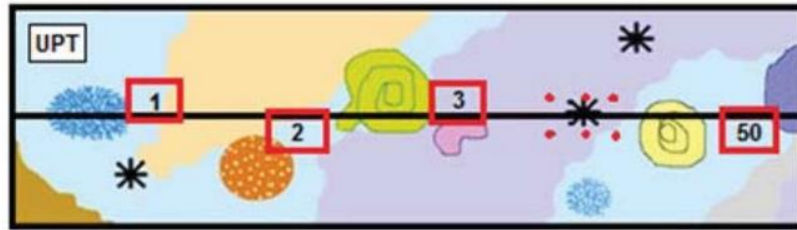
Figure 2. Method illustration of Underwater Photo Transect (UPT)
Source: Giyanto*et al.,*2014

Coral Reef Health Disorders

Data on the distribution of coral health problems was taken using the belt transect method (belt transect) with a transect width of 1 meter left and 1 meter right by following the 50 meters transect line for coral reef data collection. Coral health disorders are taken and identified according to the Coral Diseases/Health Disorders Guidebook according to Raymundo *et al.* (2008).

Retrieval of Physical and Chemical Parameters of Water

The physical and chemical parameters of the waters are taken directly at the location (on site) which includes parameters of temperature, salinity, degree of acidity (pH), current speed, brightness, depth. TSS parameter measurements were carried out in the Aquatic Resources Management laboratory at Bangka Belitung University.

Table 3. Data collection for Physical-Chemical parameters

Environmental Parameters	Unit	Tools used	Sample handling
Temperature	^{O}C	*Thermometer*	*On site*
Salinity	$^{O}/_{and}$	*Refractometer*	*On site*
Degree of acidity (pH)	-	*pH paper*	*On site*
Current speed	m/s	Flow kite	*On site*
Brightness	m	*Dry disks*	*On site*
Depth	m	*Dry disks*	*On site*
Total Suspended Solid (TSS)	mg/L	1.5 liter bottle	Laboratory*/in situ*

Coral Reef Cover

Data analysis to calculate coral reef cover was determined randomly using software CPCe. Photo analysis was performed on each frame randomly with a total of 30 random points. The category cover percentage value for each frame is calculated based on the following formula at the Eq. (1) (Giyanto *et al.*, 2014).

$$Category\ cover\ percentage = \frac{Number\ of\ cover\ category\ points}{Random\ number\ of\ points} x100\% \ldots \ldots (1)$$

Coral reef health assessment is based on the percentage value of live coral cover which refers to Decree of the Minister of the Environment No. 4, 2001, regarding Standard Criteria for Coral Reef Damage.

Table 4. Coral Cover Assessment Criteria

Live Coral Cover (100%)	Research Criteria
75-100	Very good
50-74,9	Good
25-49,9	Currently
0-24,9	Bad

Coral Reef Health Disorders

Coral reef health disorder analysis is an analysis of the proportion of diseased colonies to the total measured population. This analysis can be calculated for individual populations, species or genera, or for coral communities as a whole or for each specific disease/syndrome, group of similar diseases or for all types of disease. The greater the prevalence percentage value, the greater the potential for widespread damage to coral reef health in an ecosystem. The formula used is as the Eq. (2) (Raymundo *et al.*, 2008).

$$Prevalence = \frac{the\ number\ of\ colonies\ affected\ by\ health\ problems}{total\ number\ of\ coral\ colonies} x100\% \ldots\ldots\ldots\ldots.(2)$$

Coral health disorders are differentiated by type of coral reef disorder. The density of each type of coral disturbance is calculated using a formula of the Eq. (3) (Brower *et al*,. 1998).

$$To = \frac{In}{A} \ldots\ldots\ldots\ldots\ldots\ldots.(3)$$

Information:
To : Coral disturbance density (colonies/m^2)
In : Number of colonies attacked
A : Area of transect for health problems (m^2)

Results

Coral Reef Coverage Percentage

The percentage of coral reef cover at 4 stations in Pongok Island waters was analyzed using CPCE software (Coral Point Count with Excel Extensions). The percentage of coral reef cover in Pongok Island waters showed that the percentage of coral reef cover ranged between 28.67%-63.87% which was categorized as moderate to good, which refers to Decree of the Minister of the Environment No. 4 of 2001 concerning Standard Criteria for Coral Reef Damage. Below is a presentation of the percentage of Coral Reef cover which can be seen in Table 5.

Table 5. Percentage of Coral Reef Cover

Station	Coral reefs (%)	Category
1	50,20	Good
2	63,87	Good
3	28,67	Currently
4	49,67	Currently

Coral Reef Health Disorders

a) Lifeform Colony Affected by Health Problems

Based on the results of the analysis that has been carried out, 9 were obtained lifeform coral reefs at the research location with 7 lifeform coral reefs that are experiencing disturbances, namely Acropora Branching (ACB) with a total of 7 colonies, Acropora Tabulate (ACT) as many as 7 colonies, then followed Coral Branching (CB) 2 koloni, Coral Folliose (CF) 28 colonies, Coral Massive (CM) 86 colony, Coral Mushroom (CMR) 4 colonies, and Coral Submassive (CS) 5 colony.

b) Prevalence of Coral Reef Health Disorders

Based on the research results, it was found that coral reef health problems were bleaching (B), sedimentation damage (SD), pigmentation response (PR), growth anomalies (GA), crown of thorns starfish (CoTS). Coral reef health disorders were most often found at stations 1, 2, and 3, namely 4 types of disturbances, and at least 3 types were found at station 2. The prevalence of the most common types of coral reef health disorders is sedimentation damage (SD) with a prevalence of 2.73%, and the least disturbance to coral reef health growth anomalies (GA) with a prevalence of 0.04%. Then followed pigmentation response (PR) has a prevalence of 0.85%, bleaching (B) 0,24% and crown of thorns starfish (CoTS) 0.14%. The prevalence of coral reef health disorders is presented in Table 6.
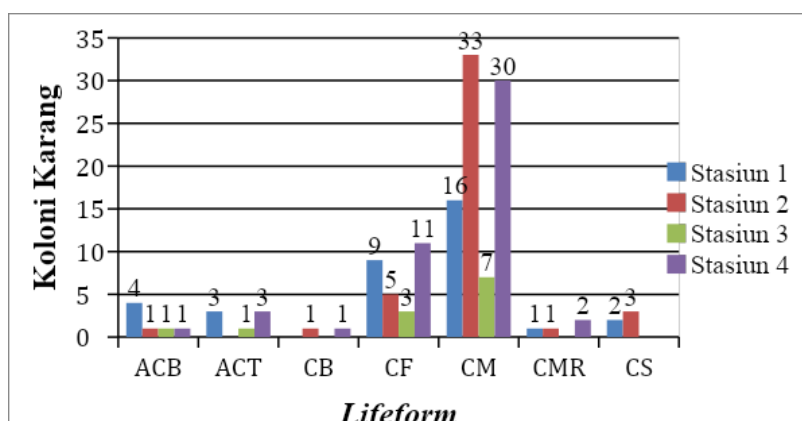

Figure 3. Percentage Graph of lifeform coral reefs

Table 6. Prevalence of Coral Reef Health Disorders

Health problems	Station				Amount
	1	2	3	4	
Bleaching (B)	0.06%	0.00%	0.17%	0.02%	0.24%
Sedimentation damage (SD)	0.83%	0.52%	0.67%	0.71%	2.73%
Pigmentation response (PR)	0.06%	0.45%	0.08%	0.25%	0.85%
Growth anomalies (GA)	0.00%	0.02%	0.00%	0.02%	0.04%
Crown of Thorns Starfish (CoTS)	0.06%	0.00%	0.08%	0.00%	0.14%

c) Density of Types of Health Disorders

Based on the analysis that has been carried out, the species density obtained ranges from 0.01 – 0.24 colonies/m^2. The density of each coral health disorder, namely Bleaching (0.01 colony/m^2), Sedimentation Damage (0.24 colonies/m^2), Pigmentation response (0.09 colony/m^2), Growth anomalies (0.01 colony/m^2), Crown of Thorns Starfish (0.01 colony/m^2). The results of the density of types of coral reef health problems can be seen in Table 7.

Table 7. Density of Coral Reef Health Disorders

Health problems	Station 1	2	3	4	Number of Colonies	Density (Colony/m^2)
Bleaching (B)	2	0	2	1	5	0,01
Sedimentation Damage (SD)	29	23	8	34	94	0,24
Pigmentation response (PR)	2	20	1	12	35	0,09
Growth anomalies (GA)	0	1	0	1	2	0,01
Crown of Thorns Starfish (CoTS)	2	0	1	0	3	0,01
Transect Observation Area	100	100	100	100	400	

Note: Total area of observation transect = 400 m^2

Physical and Chemical Parameters of Water

Based on the results of data collection at the research location, the results obtained were temperature 28°C-30°C, salinity 30 ppt – 31 ppt, current speed ranging between 0.02 m/s to 0.11 m/s, brightness at stations 1,2,3 is 100% and at station 4 is 47.5%, depth 4 m- 8.9 m, pH 7.70 – 8 , and finally TSS, namely 3.00 mg/L - 7.00 mg/L. The following results of the physicochemical parameters at the research location are presented in Table 8.

Table 8 Physical and Chemical Parameters of Water

No	Parameter	Station1	Station 2	Station 3	Station 4	Information
1	Temperature	30°C	28°C	30°C	30°C	Normal(PPRI no 22, 2021) (28°C-30°C)
2	Salinity	30 ppt	30 ppt	30 ppt	31 ppt	< dari (PPRI no 22, 2021) (33ppt-34ppt)
3	Current speed	0,06 m/s	0,11 m/s	0,02 m/s	0,05 m/s	Normal (Suharsono, 1991) in (Nurcahyanto and Nurrahman, 2021)
4	brightness	100%	100%	100%	47,5 %	-
5	depth	7,5 m	8,9 m	4 m	6,2 m	-
6	pH	7,70	7,79	8	7,73	Normal(PPRI no 22, 2021) (7 - 8.5)
7	TSS	3,00 mg/L	7,00 mg/L	5,00 mg/L	7,00 mg/L	< dari (PPRI no 22, 2021) (20 mg/L)

Discussion

Coral Reef Coverage Percentage

The percentage of coral reef cover obtained on Pongok Island has an average of 48.10% which is categorized as medium based on the Decree of the Minister of the Environment number 04 of 2001 concerning Quality Standards for Coral Reef Damage. Based on the analysis that has been carried out, there are 2 stations in the good category, namely station 1 with a percentage of live coral reef cover of 50.20% and station 2 with coral reef cover of 63.87%. Stations 3 and 4 are categorized as medium with a percentage of live coral reef cover of 28.67% and 49.67%. The health of coral reefs on Pongok Island is categorized as good to moderate, this is thought to be influenced by various factors that influence the percentage of coral reef cover, such as environmental factors and the effects of human activities which can cause damage to the coral reef ecosystem. Anthropogenic activities that are suspected of damaging coral reefs are the use of fishing gear that is not environmentally friendly such as fish bombs and potassium. According to information from the local community, fishing has been carried out using explosives at the research location.

Environmental factors are one of the factors supporting the survival of coral reefs with good physical and chemical parameter values. According to (Zurba, 2019) temperature greatly influences the reproduction and change in the outer shape of coral. The salinity obtained at the research location ranged from 30-31 ppt, which is based on Republic of Indonesia Government Regulation Number 22 of 2021. The salinity at the research location does not meet water quality standards. This is thought to be due to influencing factors. According to Kaligis (2008) in (Riska*et al.,* 2013) the salinity in the waters of Pongok Island is still suitable to support coral reef life with a salinity range of 30 ppt-40 ppt.

The current speed at the research location obtained results ranging between0.02 m/s- 0.11 m/s with an average of 0.06 m/s which is still optimal for coral reefs Suharsono, (1991) in Nurcahyanto & Nurrahman, (2021). The brightness of the waters obtained during data collection ranged from 47.5% - 100% with depth at each station ranging from 4 m - 8.9 m. Mark*total suspended solid* (TSS) obtained ranges between 3,00 mg/L- 7,00 mg/L. pHat the research locationranges from 7.70-8 which still meets water quality standards for coral reefs.

According to Suharsono (2008) coral reefs are one of the tropical aquatic ecosystems which are very important for the organisms that build the ecosystem and other ecosystems around it. Based on research results, the condition of coral reefs in the waters of Pongok Island is categorized as good to moderate and cannot be separated from the threat of human activity. Human activity around the research location which is thought to be a threat to the coral reef ecosystem is fishing using environmentally unfriendly tools such as potash and explosives. Fishing using potassium is not recommended because potassium can cause bleaching and death of coral reefs if this is done repeatedly on coral reefs. The recommendation to maintain the sustainability of the coral reef ecosystem at the research location is to use

environmentally friendly fishing tools and methods.

Coral Reef Health Disorders

a)   Lifeform Coral Reefs Affected by Health Problems

The results of analysis from four stations at the research location showed that there were seven lifeform Coral reefs are affected by health problems. The most frequently attacked coral colonies are:*Coral Massive* (CM) with 86 colonies and the colony that was least attacked was *Coral Branching* (CB) as many as 2, apart from that the colonies were attacked by health problems, namely Acropora Branching (ACB) with a total of 7 colonies, *Acropora Tabulate* (ACT) 7 colonies, *Coral Submassive* (CS) as many as 5 colonies, *Coral Folliose* (CF) 28 colonies, and *Coral Mushroom* (CMR) as many as 4 colonies. Based on previous research related to coral reef health disorders, it was found that the coral genus that is often affected by disturbances is the genus*massive* (Mahatir*et al*. 2022). This is in accordance with the results obtained at the research location, namely Pongok Island, with the genus most affected by disturbances being Massive. According to Siringoringo & Hadi (2013) The genus of coral reefs that are often found in Bangka Island waters is the genus*Massive* so the possibility of exposure to coral reef health problems is high. Lifeform *Massive* is thought to have a high tolerance for environmental changes because lifeform this was found at all observation stations.

b)   Prevalence of Coral Reef Health Disorders

Based on the results obtained, the health problems of coral reefs in the research location are classified as diverse. The highest health problems at the research location were sedimentation damage (SD) with prevalence 2,73% then followed by other disorders such as pigmentation response (PR) as big as 0,85%, Bleaching 0,24%, Crown of Thorns Starfish 0,14%, and the lowest is growth anomalies 0,04%.

Prevalence   Sedimentation damage is classified as the highest in the research location due to the influence of anthropogenic activities and the presence of river flows, where Pongok Island is an inhabited island, thereby increasing the sedimentation of the waters. According to the Central Bureau of Statistics (2023), the population on the Pongok Islands is 4,761 people with some Most of the population works as fishermen, one of the anthropogenic activities on the island, such as fishing using bombs. Sedimentation damage caused by anthropogenic activities that can affect the growth of coral reefs. Sediment can occur due to direct activities in coral reef areas such as excavation, bombing at sea and activities on land which can cause high levels of sedimentation (Aldyza & Afkar, 2015). Based on the results of research at the location, fishing activities were carried out using bombs. High sediment will cause coral death because coral polyps will be covered by sediment particles which will block sunlight so that coral biota will find it difficult to carry out photosynthesis (Riska*et al.*, 2019). Locations close to rivers cause sediment to be carried to coral reefs, resulting in a buildup of sediment on coral reefs. According to Barus*et al.*, (2018) rivers

are the source that brings sediment to the sea.

Generally, sediment buildup occurs in water areas where the current is not too strong so that sediment particles cannot be cleaned from coral reefs. Sediment that covers corallites for long periods of time can cause coral death. Coral reefs that adapt to sediment will secrete mucus which causes a decrease in the coral reef's immune system due to producing too much mucus (Peter, 1997). Lifeform coral reefs affected by sedimentation damage are *Acropora Branching* (ACB)*, Acropora Tabulate* (ACT)*, Coral Branching* (CB)*, Coral Foliosie (CF), Coral Massive* (CM), *Coral Mushroom,* (CMR), *Coral Submassive* (CS).

Other health problems found at the research location are bleaching, this interference was encountered at stations 1 and 3. This is caused by loss zooxanthellae in coral colony tissue so that the coral becomes white and loses its color pigment. Bleaching also caused by an increase in sea water temperature (Yee *et.al.*, 2011) and high solar radiation (Tissier & Brown, 1996). Increases and decreases in sea surface temperatures and high levels of solar radiation can cause coral bleaching in coral colonies (Douglas, 2003). Coral bleaching is a response to environmental changes that cause the release of coral polyps when corals experience stress (Hayes & Goreau 1992). The temperature at all stations has a high value, namely 28 ℃ - 30 ℃, according to Wijaya *et al.*, (2017) the ideal temperature for coral reef growth is around 27 ℃ - 29 ℃.

Pigmentation response is a health disorder of coral reefs caused by responses from various factors stressor

such as rising temperatures and competition (Haapkylä *et al.*, 2009). Based on research results, this type of disturbance is often found in corals massive, this is supported by Riska *et al.*, (2019). Disturbed corals are characterized by changes in tissue color (pigmentation) in response to their environment. The part of the coral that is pigmented will appear pink and have a diffusion pattern. Pigmentation response found at every station with the highest number of colonies at station 2 with 20 colonies.

Crown of thorns starfish is one type of coral animal predation that preys on coral, resulting in damage to coral tissue. *Acanthaster placi* usually use coral tissue as food at research locations. *Acanthaster placi* found at the research location due to the influence of certain types of coral. *Acanthaster placi* has the ability to damage and control certain species of dominant coral species (Nybakken, 1988). *Acanthaster placi* prefers to stick to rock corals of the type of Acropora and Pocillopora compared to other types according to Nishishira and Yamazato (1972) in (Alustco*et al*,. 2011).

Growth anomalies usually found on massive corals with coral morphology. Growth anomalies will look different from healthy tissue. This type of disorder is also called a tumor, the pigment of tissue that experiences growth disorders is generally paler or lighter than healthy tissue because it is caused by a reduction *zooxanthella* or none at all. Around the tumor there is a pink band (line) which is a response to coral pigmentation due to injury. The part of the colony that is attacked, growth anomalies, there will be a decrease in the number of polyps and fecundity so that tentacles on the part of the coral infected with tumors will not

appear (Johan, 2010). Growth anomalies usually found in Acropora and Porites corals (Aeby *et al.*, 2011).

c) Density of Coral Reef Health Problems

Based on the results of the analysis of the waters of Pongok Island, the density of health problems obtained is the highest value. Sedimentation damage with an average value of 0.24 colony/m^2, affected coral reefs. Over time, they can die because sediment covers the coral polyps, blocking sunlight so that coral biota find it difficult to carry out photosynthesis. The lowest density at the research location is bleaching with an average value of 0.01 colonies/m^2 which then followed growth anomalies 0.01 colony/m^2, crown of thorns starfish 0.01 colony/m^2 and pigmentation response with an average value of 0.09 colonies/m^2. Factors that influence health problems are water conditions, where water conditions are determined by the physicochemical parameters of the water such as temperature, salinity, pH, current speed, brightness, depth and TSS.

Conclusion

Based on the research results, the following conclusions were obtained:

1. The percentage of live coral reef cover found in the research location, namely Pongok Island Waters, is classified in the moderate to good category with values ranging from 28.67% to 63.87%. The highest coral reef cover is at Station 2 with live coral cover of 63.87%, then followed by Station 1 with cover of 50.2%, Station 4 is 49.67%, and the lowest is Station 3 at 28.67%.

2. Coral reef health problems found at the research location in Pongok Island waters contained 5 types of health problems, namely Bleaching (B), Sedimentation damage (SD), Pigmentation response (PR), Growth anomalies (GA), and Crown of thorns starfish (CoTS). Sedimentation demage is the highest prevalence in the research location with a total of 2.73%, then Pigmentation response (PR) with the amount of 0.85%, Bleaching (B) 0,24%, Crown of thorns starfish (CoTS) 0,14%, and Growth anomalies (GA) with a total of 0.04%.

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