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Correlation between Coral Reef Cover Condition and the Abundance of Megabenthos on Setan Island, West Sumatra

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ABSTRACT

In the coral reef ecosystem, there is a food source for small fish, which are prey for various kinds of associated biota; one of the biota that lives in the coral reef ecosystem is megabenthos. Megabenthos is influenced by the quality of the coral reef ecosystem, where if conditions are good, the coral will have a greater chance of high megabenthos diversity. This research was carried out in March 2023 in Setan Island, West Sumatra. This research analyzes the relationship between coral reef conditions and megabenthos abundance. The method used in this research is a survey method. Observations of coral reef cover were carried out using the Underwater Photo Transect (UPT) method, and megabenthos abundance was measured using the Benthos Belt Transect (BBT) method. Observations were carried out at four stations (3 and 6 m deep) with a transect length of 50 m. Based on the average value of the percentage of coral reef cover, it is still categorized as being in poor condition, namely 18.87%. There is a relationship between the percentage of live coral reef cover and the abundance of megabenthos with a percentage of 55.27%, with the types of megabenthos clams (*Tridacna* sp), sea cucumbers (*Holothuria* sp), snails (*Trochus* sp), lobsters (*Panulirus* sp), fur pigs (*Diadema* sp), snails (*Drupella* sp), and starfish (*Acanthasper* sp).

Keywords: Coral reef, Coral cover, Megabenthos

1. INTRODUCTION

Indonesia has a large coral reef area and has enormous potential to be developed in terms of the diversity of biota that lives in it and the aesthetic value of the tourism aspect. In this ecosystem, there is much food for small fish that prey on various associated biota. One of the biota that lives in the coral reef ecosystem is megabenthos (Tuhumena et al., 2013). The substrate's character, type, and zoning influence Megabenthos occupying coral reef areas.

Megabenthos are organisms more significant than 1 cm in size that live sessilely and have varying adaptability to environmental conditions. Megabenthos has an essential role in the food web. Megabenthos is influenced by the quality of the coral reef ecosystem, meaning that the better the condition of the coral reef, the greater the chance of high diversity of megabenthos, and vice versa (COREMAP LIPI, 2014).

Megabenthos is used as an indicator for monitoring coral health conditions. Megabenthos consists of lobsters, sea cucumbers, clams, lola, snails, and starfish. Some megabenthos act as predators of coral polyps, such as the spiny starfish *Drupella* sp, so populations of these animals can cause quite extensive coral damage and the megabenthos groups that have potential as bioindicators are sea urchins and blue starfish (COREMAP LIPI, 2014).

One of the waters containing a coral reef ecosystem and a megabenthos habitat is Setan Island in the Mandeh Bay area. The Mandeh Bay area, or Mandeh Sea National Park, is located in Koto XI Tarusan District, Pesisir Selatan Regency, 56 km from Padang City. The Mandeh area has tourism potential in the form of natural tourism, tourism, artificial tourism, and marine tourism (snorkeling or diving), all of which can be developed into an attractive tourist destination worth visiting (Frananda et al., 2019).

Related research on coral reefs and megabenthos has been carried out, such as Hasugian et al. (2022) regarding the relationship between the condition of coral reef cover and the density of megabenthos in the waters of Talam Island, Tapanuli Tengah Regency, North Sumatra Province (Giyanto et

al., 2017); regarding monitoring the health of coral reefs and related ecosystems in Nias Utara district, (Rahmita et al ., 2022) regarding the relationship between coral cover conditions and megabenthos density on Pandan Island, West Sumatra Province. However, in the location that the author studied, there has yet to be any research regarding the relationship between the condition of coral reef cover and the abundance of megabenthos. Hence, this research needs to be carried out. This research analyzes live coral cover, megabenthos abundance, and the relationship between coral reef conditions and megabenthos abundance in the Setan Island area.

2. RESEARCH METHOD

Time and Place

This research was carried out in March 2023. Sampling was located in the waters of Setan Island, West Sumatra. Setan Island is located at coordinates 01°07'10." BS and 100°22'53." BT. The station point is determined in the field based on the cardinal direction. In this study, there are 4 station points: station I is in the north direction, station II is in the east direction, station III is in the south direction, and station IV is in the west direction (Figure 1).

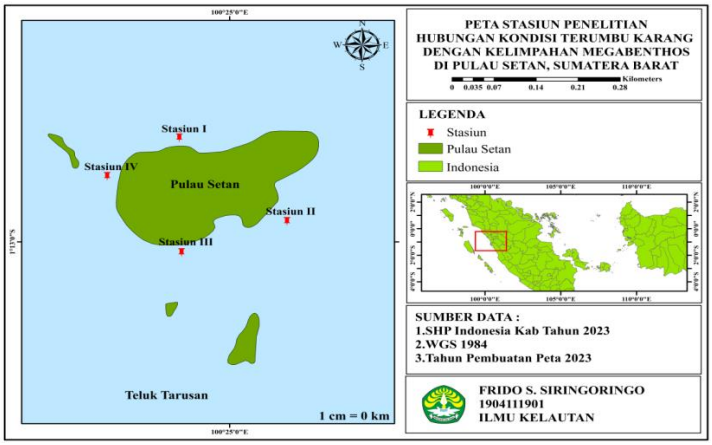

Figure 1. Location station research on Setan Island, West Sumatra

Method

The survey method collects primary data from direct observations in the field and secondary data from literature studies in books, journals, papers, articles, and related parties.

Procedures

Observation of coral cover

Observations of coral reef cover were carried out using the Underwater Photo Transect (UPT) method. Data collection in the field takes the form of underwater photographs by shooting using an underwater digital camera. Data was collected at 3 m and 6 m depths by drawing a transect line parallel to the coastline for 50 m. The photos are managed with the CPCe application. Then, a random point is selected on each photo, which has been determined by the software randomly. Then, the results will be categorized according to (Suparno et al., 2021) with the following categories: very Good: 75-100%; good: 50-74.9%; medium: 25-49.9%; bad: 0-24.9%.

Abundance of megabenthos

Megabenthos data collection was carried out simultaneously. Calculation of megabenthos abundance uses the following formula according to (Hasugian et al., 2022):

$$K = ni/L$$

Note:

K = Abundance of species (ind/ m^2)
ni = Number of individuals of each species
L = The total area of observation area (100 m^2)

Data on the abundance of megabenthos, the target megabenthos in this research, include sea cucumbers, clams, lobsters, lola, spiny starfish, drupella snails, and sea urchins. This makes determining the relationship between megabenthos abundance and coral cover easier.

Measurement of water quality parameters

The water quality parameters observed in this study are oceanographic parameters, including temperature, current speed, salinity, and brightness. The observation time was

carried out at the same time as megabenthos data collection at each station. Water quality measurements were carried out three times.

Data Analysis

Data analysis in this study was conducted using simple regression analysis by calculating the relationship between the percentage of coral cover and the value of megabenthos abundance. The regression equation used is the formula (Tanjung, 2014):

$$Y = a+bX$$

The strength of the relationship can be seen from the correlation coefficient (r), with the following categories: $r < 0.25$ means the relationship is weak; $0.25 < r \leq 0.50$ means a moderate relationship; $0.50 < r \leq 0.75$ indicates a strong relationship; $r > 0.75$ means the relationship significant.

3. RESULT AND DISCUSSION

General Conditions of the Research Location

Geographically, Setan Island is located at coordinates 01°07'10." BS and 100°22'53." B.T. Setan Island is one of the Mandeh Tourist Attraction Area islands, Koto XI Tarusan District, Pesisir Selatan Regency. Setan Island is a hilly island in the western part, with rocky beaches in the southeast and northwest and sandy beaches in the north and east. This island grows several types of plants, such as coconuts, sea waru, ketapang, and mangroves. In the waters of Setan Island, biotas such as clams, spiny starfish, sea cucumbers, sea urchins, morray eels, and groupers, and the algae Padina australis can also be found. On Setan Island, there is a pier in the east as the entrance to the island. This island is a tourist island that is often visited by people from morning to evening. There are water rides like jet skis, banana boats, and donut sliders. Setan Island is managed jointly by the surrounding community to carry out empowerment.

Water Quality

The water quality parameters observed in this study are oceanographic parameters, including temperature, current speed, salinity, and brightness, as in Table 1.

Table 1. Water quality on Setan Island, West Sumatra

St	Coordinate		Parameter			
	LS	BT	Salinity (ppt)	Temperature (^oC)	Current speed (m/sec)	Brightness (m)
I	01°12'50.5"	100°25'00.7"	30	30.9	0.13	6
II	01°13'08.5"	100°25'02.1"	33	27	0.10	6
III	01°13'06.2"	100°24'54.8"	31	30.5	0.16	6
IV	01°12'49.6"	100°24'50.6"	30	31.7	0.10	6

Based on Table 1, the results of measuring water quality parameters at stations 1, 2, 3, and 4 shows that the salinity obtained ranges from 30-33 ppt, temperature ranges from 27-31^{0}C, current speed ranges from 0.10-0.16 m/s, and the brightness of the four stations is 6 m.

According to PP number 22 of 2021, good salinity for coral growth is between 33 - 34 ppt. Although coral reefs can survive salinities outside this range, their growth is less good than average salinity. The salinity at this coral reef research location is around 30 – 33 ppt, which means it can grow, but the growth is less. Temperature is one of the parameters that play an essential role in coral reef growth. According to Patty and Akbar (2018), the ideal temperature for the growth and development of coral reefs is around 25^{0}C, which means that the research location is still suitable for the growth and development of coral reefs because the temperature is about 27^{0}C.

Currents are essential in coral growth by supplying food for coral polyps and cleaning coral from sediment. According to Haruddin in Rizal (2016), a good current for coral reef growth is < 20 cm/sec (0.2 m/s), and the current speed at the research location is 0.10-0.16 m/s. The current speed on Setan Island is relatively low because the surrounding islands protect it. The brightness of the waters also greatly influences coral reef growth. According to PP No. 22 of 2021, good brightness for coral reef growth is < 5 m, so the brightness at the research location is optimal.

Coral Cover Percentage

The results of calculating the percentage

of coral reef cover in this study can be seen in Table 2.

Table 2. Percentage of coral cover in the waters of Setan Island, West Sumatra

Station	Depth (m)	Percentage of live coral cover %	Category
I	3	31.36	currently
	6	30.50	currently
II	3	26.47	currently
	6	18.36	bad
III	3	23.26	bad
	6	17.34	bad
IV	3	3.40	bad
	6	0.33	bad

Source: Suparno et al. (2021)

Based on Table 2, the condition of coral reef cover in the waters of Setan Island is classified as moderate and poor. The percentage of coral reef cover in these waters ranges from 0.33–31.35%. The highest percentage of coral reef cover is at station I at a depth of 3 m, namely 31.35%, while the lowest percentage is at station IV at 6 m, 0.33%. Based on this percentage, the average percentage of live coral cover was 18.87%, where according to the criteria for assessing the condition of coral reefs; the condition of coral reef cover was included in the poor category (Suparno et al., 2021).

The leading cause of damage to coral reefs is due to the high dependence of society on coral reef ecosystems, both as providers of various types of food sources and for building materials. The extraction of natural resources is carried out excessively, even in ways that damage environmental sustainability (Efendi, 1999). Biological factors also influence because Setan Island is located not too far from residential areas and is also one of the tourist islands in the area. It is affected by fresh water from the Mandeh estuary, not too far from that location. This is by Gomes et al. (2023), who state that coral growth is influenced by natural factors (availability of nutrients, predators, physicochemical conditions of the sea) and human factors.

Coral reef ecosystems from the four stations on Setan Island are based on primary substrate coverage conditions consisting of live coral, algae, soft coral, rubble, dead coral, and sand. The percentage of coral reef cover at each station and depth varies. At a depth of 3 m, the percentage of live coral cover for station I is 31.36%, station II is 26.47%, station III is 23.26%, and station IV is 3.40%. Massive coral (CM) is the most dominant living coral at a depth of 3 m, namely at station I at 27.56%, station II at 22.67%, station III at 17%, and station IV at 2.93%. According to Nurma et al. in Hasugian et al. (2022), CM is a hard coral that can live in shallow waters close to the coast. At a depth of 6 m, the percentage of coral reef cover at station I is 30.50%, station II is 18.36%, station III is 17.34%, station IV, with life coral dominating, namely coral massive (CM), namely at station I was 13.98%, station II was 14.96%, station III was 11.40%, station IV was 0.20%.

At the research location, there is algae, which also dominates at each station. Timothy in Rahmita et al. (2022) stated that the presence of coral competitors, one of which is caused by algae, will cause coral animals to die. The presence of algae in coral reef areas can also inhibit coral growth, where the microalgae (Zooxanthellae) contained in coral polyps will be unable to compete with algae that have increased in terms of competing for nutrients in the water.

Abundance of Megabenthos

The types of megabenthos found at each station in the waters of Setan Island and the presence of each type of megabenthos on each transect can be seen in Table 3.

The total abundance of megabenthos obtained was 15,600 ind/ha. The highest abundance was at station I at a depth of 3 m, namely 6600 ind/ha, and the lowest was at station IV at 6 m, 100 ind/ha. Sea urchins are the megabenthos with the highest abundance in terms of numbers. The abundance is 13,300 ind/ha, and the lowest abundance of megabenthos is snails, lobsters, and spiny starfish, with an abundance of 100 ind/ha.

The megabenthos most commonly found at the research location are sea urchins (*Diadema* sp), which can live in groups or alone. The discovery of sea urchins, especially the *Diadema* sp, shows that the coral in the area is unhealthy. Sea urchins indicate coral health, whereas their presence in large numbers indicates unhealthy coral (COREMAP CTI LIPI, 2015).

Table 3. Distribution of megabenthos in the waters of Setan Island, West Sumatra

No	Megabenthos type	The presence of megabenthos							
		SI		S II		S III		S IV	
		K3	K6	K3	K6	K3	K6	K3	K6
1.	Spiny starfish (*Acanthaster* sp)	-	-	+	-	-	-	-	-
2.	Sea urchin (*Diadema* sp)	+	+	+	+	+	+	+	-
3.	Sea cucumber (*Holothuria* sp)	-	-	-	+	+	-	-	-
4.	Kima (*Tridacna* sp)	+	+	+	+	+	+	-	-
5.	Snail (*Drupella* sp)	-	-	-	-	-	+	-	+
6.	Lola Snail (*Trochus* sp)	-	-	-	+	-	-	-	-
7.	Lobster (*Panulirus* sp)	-	-	+	-	-	-	-	-

Note: (+) = Megabenthos found; (-) = No megabenthos found; SI = Station I; SI = Station II; SIII = Station III ; SIV = Station IV; K3 = Depth 3 m; K6 = Depth 6 m.

Table 4. The abundance of megabenthos in the waters of Setan Island, West Sumatra

Station		Abundance of megabenthos (ind/ha)							Amount (ind/ha)
		Snail	Lobster	Sea cucumber	Kima	Snail	Spiny starfish	Sea urchins	
I	K3	0	0	0	400	0	0	6200	6600
	K6	0	0	0	300	0	0	3500	3800
II	K3	0	100	0	300	0	100	1300	1800
	K6	100	0	100	200	0	0	900	1300
III	K3	0	0	100	200	0	0	600	900
	K6	0	0	0	200	100	0	600	900
IV	K3	0	0	0	0	0	0	200	200
	K6	0	0	0	0	100	0	0	100
Amount (ind/ha)		100	100	200	1600	200	100	13300	15600

Note: SI = Station I ; SII = Station II ; SIII = Station III; SIV= Station IV; K3 = Depth 3 m; K6 = Depth 6 m

Sea urchins are not a threat to coral reefs, unlike algae, which are competitors for coral reefs to maintain living space and sunlight. Sea urchins can repel the presence of this alga because megabenthos acts as grazers (algae eaters) in the coral reef ecosystem. The fewest sea urchins were found at station IV because there were not as many algae found as food for sea urchins at this station as at other stations.

Clams (*Tridacna* sp) are found at almost every station. This is because, at these stations, many massive corals are located, where massive corals provide a suitable substrate for the growth of clams. Whether clams are found depends on the suitability or unsuitability of the habitat regarding substrate and water conditions and other factors (COREMAP CTI LIPI, 2015). Except at station IV, clams were not found. Station 4 is dominated by sandy substrate, which is unsuitable for clam habitat.

Megabenthos such as lola snails (*Trochus* sp), lobsters (*Panulirus* sp), and sea cucumbers (*Holothuria* sp) were very rarely found at the research location. This is because fishermen were fishing for megabenthos, such as lobsters, at the research location. Megabentos is also a sustainable catch target for fishermen because it has high economic value, such as at the research location. This is also because megabenthos are nocturnal or active at night and hide in crevices and under coral.

Snails (*Drupella* sp) are only found sometimes at the research location. Snails are

only found at stations III and IV at a depth of 6 m. These snails are a group of megabenthos that habitually eat coral polyps, especially on branching corals; the small number of megabenthos is due to the location research dominated by massive corals.

The thorny sea star (*Acanthaster* sp) was only found at station II at a depth of 3 m at the research location. Even though it is rare to find megabenthos, it is worth being wary of because megabenthos have quite a severe impact because they eat coral polyps. Even though they were only found in small numbers, these sea stars had already severely threatened coral conditions (COREMAP CTI LIPI, 2015). According to Gomes et al. (2023), *Drupella* sp density is negatively correlated with live coral cover, so it is rarely found in live coral tissue and tends to stay away from areas that have not been eaten to avoid the stinging cells (nematocysts) of coral animals.

The diverse conditions of coral reefs and clear water conditions influence the abundance of megabenthos. The presence of megabenthos in a coral reef ecosystem indicates that the coral in that location is still healthy or the coral has experienced damage. The physico-chemical conditions of the waters are sufficient to support the life of the megabenthos species group (Siringoringo et al., 2014).

Coral Cover Relationship with Megabenthos Abundance

The results of the analysis of the relationship between the percentage of live coral and the abundance of megabenthos in this study can be seen in Figure 2.

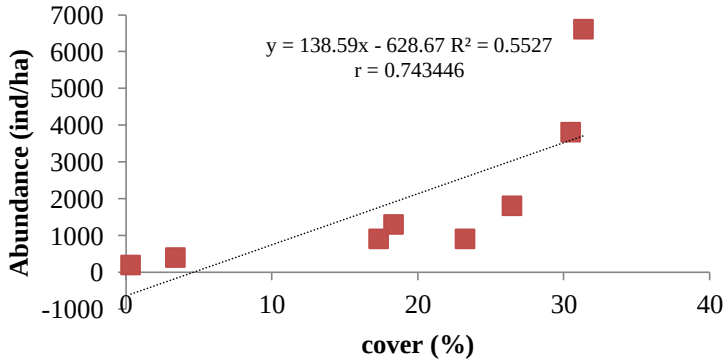

Figure 2. Relationship between coral cover and megabenthos

The results of the regression analysis of data on the percentage of coral cover and megabenthos showed that the correlation coefficient (r) was 0.743446, meaning that the relationship between coral cover and megabenthos was strongly positive. The R2 value was also obtained at 0.5527, meaning that the percentage of live coral reef cover affected megabenthos by 55.27%, while error factors and other factors influenced the rest. Coral reefs and megabenthos have a close relationship because coral reefs are one of the main habitats for various megabenthos species. Coral reefs provide shelter and food for different megabenthic species. The complex structure of coral and its various gaps offer an ideal place to hide from predators.

Several megabenthos have their respective roles, such as acting as parasites on coral reefs, benefiting coral reefs, and having economic value. Megabenthos, such as Drupella sp., are parasitic, and some, such as sea urchins, are beneficial for coral reefs, which play a role in cleaning algae. Sea urchins can play a role in restoring the condition of coral reef ecosystems, which compete with algae growth. There is also a megabenthos with high economic value at the research location, namely the lola snail, which can be eaten apart from its meat. Its shell can be used as raw material for making clothes, buttons, and jewelry. It can also stimulate pearl formation in oyster cultivation (COREMAP CTI LIPI, 2017).

It can be seen that megabenthos have a strong relationship, meaning that the stronger the correlation between megabenthos and live coral reef cover, the greater the influence on coral reef cover. The presence of megabenthos indicates that the waters are classified as good. The higher the live coral cover value, the higher the megabenthos density value.

4. CONCLUSION

Based on research results, the coral reefs

on Setan Island can be categorized as being in bad condition. This can be seen from the average value of the percentage of live coral reef cover on Setan Island, which is 18.87%. In the waters of Setan Island, seven types of megabenthos indicators of coral reef cover were found, namely clams (*Tridacna* sp.), sea cucumbers (*Holothuria* sp), snails (*Trochus* sp), lobsters (*Panulirus* sp), sea urchins (*Diadema* sp), snails (*Drupella* sp), starfish (*Acanthasper* sp), with the abundance of megebenthos obtained being 15,600 ind/ha. Based on the results of the regression analysis that has been carried out, there is a relationship between the percentage of live coral reef cover and the abundance of valuable megabenthos in the waters of Setan Island, West Sumatra. Live coral reefs have a strong relationship with megabenthos, with a correlation coefficient (r) of 0.743446.

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