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Condition of coral cover in the waters of the Pieh Island Conservation Area, West Sumatra

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Abstract
Coral reefs are the main components of coastal and marine ecosystems and are important in maintaining coastal and marine functions. West Sumatra is one of the provinces in Indonesia whose territory faces the Indian Ocean and has a wide diversity of coral reef cover. This research aims to determine the condition of coral cover in the waters of the Pieh Island Conservation Area, West Sumatra. The method for collecting coral cover data uses UPT (Underwater Photo Transect) with a transect length of 50 meters and a frame size of 58 x 44 cm^2, photographed every meter at 3 (three) station points. The research results show that the condition of coral cover on Pandan Island is 63.04% in the good category, Toran Island is 77.94% in the very good category, and Air Island is 88.30% in the very good category. The average coral cover condition at the research station was 76.42%. Based on KEPMEN LH No.4 of 2001 concerning Standard Criteria for Coral Reef Damage, it is included in the very good category.

1. INTRODUCTION

According to a report from Reefs at risk revisited, 60% of the world's coral reefs have experienced bleaching caused by local and global impacts. Regional impacts of coral bleaching are caused by excessive fishing, destructive fishing practices such as coastal development, and pollution from both sources: land and sea. Meanwhile, as a global impact, coral bleaching is caused by rising sea temperatures and ocean acidification due to high carbon dioxide levels. This local and global impact will put 90% of the world's coral reefs in danger within 20 years and almost 100% by 2050. Coral reefs in Southeast Asia are currently the most problematic region globally, where 94% of coral reefs have been damaged and threatened by local impacts. Damage caused by regional and global effects can cause coral to deteriorate, reducing the condition of its cover (Jeremy, 2011).

The condition of coral cover can be seen from how many live corals there are in a body of water, where the higher the coral cover, the healthier the coral reef ecosystem, and vice versa. The lower the coral cover, the worse the coral reef ecosystem. Whether coral cover is good or bad, apart from being caused by water quality, it is also influenced by the amount of dead coral and the primary substrate of the coral reef. This research aims to determine the condition of coral cover in the Pieh Island Conservation Area.

2. RESEARCH METHODS

Time and Place

This research was carried out on January 9-21, 2024. The research location was in the Pieh Island Conservation Area, Padang Pariaman Regency, West Sumatra. This location was chosen because it is a protected coral reef ecosystem and a habitat for marine biota. Data analysis was conducted at the Marine Biology Laboratory, Marine Science, Faculty of Fisheries and Marine, Universitas Riau.

Material and Tools

The tools used during the research were Scuba, scroll meter, underwater camera, GPS, CPCe software, 58x44 cm^2 quadrant map, thermometer, hand refractometer, Secchi disk, current drogue, pH meter, and Do meter. The method used in the research was the UPT (underwater photo transect) method, which was then analyzed using CPCe (coral point count with Excel extensions) software. Research supporting parameters in temperature, salinity, pH, DO, brightness and current speed were measured at each research station and carried out directly in the field. Taking photos of coral reefs can be seen in the illustration in Figure 1.

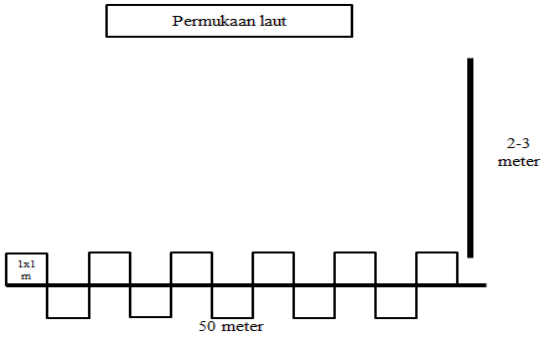

Figure 1. Illustration of data collection

Data Analysis

Coral covers data analysis using CPCe software. The data analysis results show biota and substrate categories at each point. The percentage of coral biota cover has been directly analyzed by the CPCe program. The grouping of coral reef conditions based on the percentage value of live coral cover measured based on KEPMEN LH No. 4 of 2001 can be seen in Table 1.

Table 1. Coral cover criteria

Live Coral Cover (%)	Assessment criteria
75 – 100	Very well
50 – 74, 9	Good
25 – 49, 9	Currently
0 -24, 9	Bad

Source: KEPMEN LH No.4 of 2001

3. RESULTS AND DISCUSSION

General Conditions of Research Locations

The Pieh Island conservation area is a national marine conservation area located in West Sumatra Province, to the west of the administrative area of Padang Pariaman Regency (Decree of the Minister of Forestry and Plantation No: 070/Kpts-II/2000 on 28 March 2000). The Pieh Island conservation area consists of several small islands, namely Bando Island, Pieh Island, Toran Island, Pandan Island and Air Island, with a total area of 39,900 Ha.

Research stations were set on three islands in the Pieh Island conservation area: station I Pandan Island. Station II, Toran Island; and station III, Pulau Air. Pandan Island is the first research

station located at coordinates 100.13861, -0.946722. This island has an area of 16.04 Ha. This island is dominated by sea pandan (*Pandanus tectorius*), coconut (*Cocus mucifera*) and nipah (*Nypa fruticans*) vegetation. With white sandy beaches, there is a turtle hatchery and a house on this island that is used as a place for island guards. The coral reefs on Pandan Island vary, but the non-Acropora form dominates.

The second research station is Toran Island. Toran Island with coordinates 100.168972, -1.035556. This island has an area of around 25.23 ha. Like Pandan Island, Toran Island is also dominated by coconut and nipah. White sand, this island is uninhabited. Non-Acropora growth forms dominate the coral reefs on Toran Island.

Next, the third research station is Air Island, a water island with coordinates 100.204444 and -0.872944. Air Island has an area of 4.75 ha. It is the island closest to the coastline of Sumatra. This island has the same vegetation as other islands: white sand. The water island is also uninhabited. The Acropora growth form dominates the coral reefs on this island.

Water Quality Measurement Results

Several water quality parameters were measured directly in the field to determine the condition of the waters around the research station, namely, pH, salinity, temperature, current speed, brightness and DO. Parameters are calculated at each data collection location using different tools according to the measured parameters. Water quality parameter measurement data can be seen in Table 2.

Table 2. Results of measuring the condition of water quality parameters

Water quality parameters	Pandan Island	Toran Island	Water Island	Quality Standards
pH	6.12	6.48	6.92	7 - 8.5
Salinity (ppt)	29	28	28	33 -34
Temperature (^{0}C)	29.8	31.6	30.2	28-30
Current speed (m/s)	0.5	0.9	0.7	-
Brightness (m)	8	7.5	4	>5
DO (mg/L)	6.46	5.36	5.48	>5

Water quality parameters are measured to determine the general environmental conditions for biota life in these waters. The water parameter measurement results found that each station did not experience significant differences. The results of these measurements are then compared with seawater quality standards following Government Regulation No. 22 of 2021.

Water parameter measurements were carried out two days after collecting coral reef data. The results of measuring water parameters are shown in Table 2. The first day of data collection was carried out on 18 January 2024, located on Pandan Island where the weather was cloudy at the time of departure, and at the time of data collection, it was accompanied by rain and wind. Even though there is rain and wind on the surface, the currents are not too strong below the sea surface. Data was collected on the second day, 19 January. 2024, located on Toran Island and Air Island. The water conditions are murky after it rains. However, when collecting data on coral reefs, the weather was clear. At the time of data collection, the underwater current was quite strong.

Results of Analysis of Coral Cover Conditions

The coral cover percentage and categories were calculated using the Coral Point Count with Excel Extension (CPCe) software program. Analysis was carried out on each frame by selecting 30 random points to estimate the percentage cover of categories and substrates. The photo analysis process for each frame obtained is calculated based on the number of points in the frame (Code Karang Intermediate). Figure 2 shows the calculation results at each research location with different coral cover.

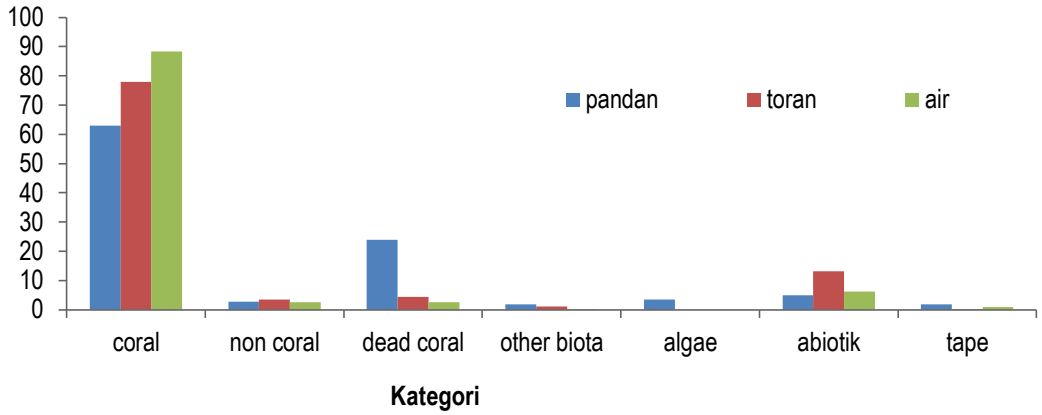

Figure 2. Percentage of coral cover

Based on Figure 2, the condition of coral cover at station I Pandan Island has a value of 63.04%, with this value included in the good category. With the form of coral growth, namely, Acropora branching (ACB) at 0.34%, Acropora digitate (ACD) at 0.07%, Acropora encrusting (ACE) at 11.35%, Coral encrusting (CE) at 20.86%, Coral foliose (CF) was 14.54%, and Coral massive (CM) 15.90%. Then, there is a Non-Coral (NC) of 2.65%, whereas the NC in this study is the transect rope analyzed. Then, the biota in this station consists of anemones at 0.14%, dead coral at 21.94 and coral affected by disease at 1.97%. The algae found at this station were 3.53% macroalgae. The primary substrate at this station is rock at 1.56% and coral fracture at 2.92%, and then there is the identified darkness at 1.87%.

Toran Island Station II has a percentage value of 77.94%, which is included in the very good category. The forms of coral growth at this station are Acropora encrusting (ACE) at 3.01%, Coral encrusting (CE) at 2.47%, and Coral foliose (CF) at 72.46%. Then non, coral (NC) was 3.48%. Then, at this station, 1.07% of anemones were found, 3.01% of dead corals and 1.40% of diseased corals. The primary substrate at this station consists of coral fractures, amounting to 13.10%. Then darkness is 0.27%.

Station III Pulau Air has a percentage of 88.30%, which is included in the very good category. At this station, the most diversity of coral growth forms is found. Coral growth forms at this station are Acropora branching (ACB) at 1.01%, Acropora digitate (ACD) at 3.23%, Acropora encrusting (ACE) at 26.63%, Acropora tabular (ACT) at 6.32%, Coral branching (CB) at 4.44%, Coral encrusting (CE) at 23.74%, Coral foliose (CF) at 14.26%, Coral massive (CM) of 8.47%, and Coral mushroom (CMR) of 0.20%. Then there is Non Coral (NC) at 2.69%. The biota found at this station were anemones at 0.20%, dead coral at 1.88% and diseased coral at 0.67%. The primary substrate at this research station is 1.34% rock and 0.87% coral fracture. Then darkness is 1.34%.

The condition of the coral reefs in the Pieh Island Conservation Area is classified as fringing reef and patch reef. Small islands and a series of coral reefs form an elongated north-south formation parallel to the western coastline of West Sumatra Province. The coral reef ecosystem at each observation location was analyzed based on the percentage of live coral cover with three observation stations.

From the results of data analysis in Figure 2, apart from live coral, there is also a category that is analyzed, namely non-coral, which is included in the non-coral category in the form of transect lines photographed in the frame. Next, dead coral is analyzed as coral killed by algae or diseased coral. Then, there is another biota, namely coral animals such as fish, starfish, and soft coral. Then, the algae analyzed at the research station are in the form of microalgae. Next is the abiotic category; this category is also called the primary substrate of coral, which includes rubble (coral fracture), rock (rock),

sand (sand), and silt (mud). Then the last one is the tape, wand, shadow category, a code that indicates unclear coral, covered with something, and dark.

Pandan Island is station I, included in the good category of coral reefs, with a cover percentage of 63.04%. Good physical-chemical factors support this condition. Research conducted by Ramita (2021) also shows that coral reefs are in the good category on Pandan Island. Non-Acropora dominates the growth form of coral reefs. Dead coral with algae was found at station I, which was high at 23.91%. According to Timotius (2003), one of the natural factors that causes coral animals to die is the presence of coral competitors, one of which is caused by algae. The presence of algae in coral reef areas can also inhibit coral growth, where the zooxanthellae found in coral polyps will be unable to compete with the rapidly growing algae in terms of fighting for nutrients in the water.

Toran Island is station II, which has a percentage of coral cover and is included in the very good category with a rate of 77.94%. This station is a core zone where any fishing activity is not permitted. According to research conducted by Sutono (2018), Toran Island has coral cover in the medium category with a percentage value of 35.00%. In this research, there was an increase in the condition of coral cover on Toran Island, which could occur due to changes in water quality. The conditions of the aquatic environment greatly influence coral growth. Environmental conditions are not always constant but often change due to disturbances originating from nature or human activities (Oktarina et al., 2014). The coral growth on Toran Island is also dominated by the non-Acropora form.

The percentage of coral cover at Pulau Air Station III is included in the very good category (88.30%). The low abiotic components and the small number of dead corals cause this station's high percentage of coral cover. According to Manuputty (2009), the physical condition of coral reef ecosystems is influenced by abiotic components such as dead coral, sand, mud, rocks and coral fractures. This percentage increased compared to the previous year. Previous research obtained a rate of coral reefs in the good category (Indrawadi, 1995). Acropora corals dominate the growth form of coral reefs on Air Island. Apart from measurements in the field, the data obtained is also compared with data already held by the area manager. The condition of coral cover is compared to the 2019-2023 data received from the Pekanbaru LKKPN, while the 2024 data is processed data.

Based on Figure 2, the condition of coral cover can be seen by looking at the value of live coral in the waters. The condition of coral cover on Pandan Island has a value of 63.04%, which is in the good category; Toran Island has a value of 77.94%, which is in the very good category; and Air Island has a value of 88.30%, which is in the very good category. This category is adapted to KEPMEN LH No. 4 of 2001 concerning Standard Criteria for Coral Reef Damage. Various factors can influence the high percentage of coral cover, such as environmental factors and human activities. Based on physical and chemical data, the waters at the research station have good ecological factors (Table 3).

Over the last five years, Pandan Island has seen changes that tend to go up and down, and it is thought that the depth at this station is relatively shallow, allowing coral animals to die due to exposure to direct sunlight. This is based on research conducted by Farid et al. (2018). Tides can cause coral death if there are shallow tides so that coral reefs appear above the water surface, and this occurs during the day (hot sun) or when it rain so that rainwater directly hits coral reefs.

Based on Table 3, Toran Island has experienced an increase, but in 2024, it will experience a decrease due to the large number of coral fractures at the research location. This coral fracture is thought to have occurred due to the current solid speed at the research location (Table 3). So, the coral is unable to support it and ends up breaking. This is by research conducted by Netty et al., 2016. The main factors in coral reef damage are generally due to natural factors and human activities. Damage caused by natural factors such as typhoons, changes in sea water temperature, earthquakes, global climate change, high current speeds, predators, disease, and the eruption of Mount Merapi.

Meanwhile, Air Island experienced an increase. This is due to changes in water quality parameters at the location and the substrate found in these waters. Another factor in high coral cover is low current speed. Research conducted by Ramita (2021) states that the current speed in the Pieh Island Conservation Area has an average value of 0.23 m/s. The low current speed makes it easier for

hard coral planulae to attach to the substrate. Another factor is the absence of development on the island.

Table 3. Condition of coral cover in 2019-2024

Station	Year	Coral Cover	Condition
Pandan Island	2019	58.47	Good
	2020	33.67	Currently
	2021	48.80	Currently
	2022	53.67	Good
	2023	59.67	Good
	2024	63.04	Good
Toran Island	2019	-	-
	2020	62.4	Good
	2021	71.27	Good
	2022	88.8	Very well
	2023	90.27	Very well
	2024	77.94	Very well
Water Island	2019	35.07	Currently
	2020	35.30	Currently
	2021	66.14	Good
	2022	79.20	Very well
	2023	82.73	Very well
	2024	88.30	Very well

Source: Secondary data from LKKPN Pekanbaru (2019-2023)

Coral reef ecosystems do not only consist of coral animals. Several other components comprise the coral reef ecosystem, including algae, other biota and abiotic components. Each component found at the research station has a different percentage. The abiotic percentage at the research station ranges from 4.52 to 13.10%. The abiotic components of coral substrate consist of rock, sand and coral rubble. Rubble is the abiotic component that dominates all research stations. The high percentage of coral fractures is thought to be caused by the strong current at the research location, namely 0.5-0.9 m/s. A large number of coral fractures also occur due to coral damage.

Algae is only found on Pandan Island, namely macroalgae at 3.53%. DCA (dead coral with algae) also dominates the percentage of dead coral. Algal layers can hinder the coral recovery process. Algae quickly take over dead coral skeletons, so the substrate formed is unsuitable for coral growth (Anggara, 2017).

4. CONCLUSIONS

This research concludes that the condition of coral reef cover at the research station has an average value of 76.42%, which is included in the very good criteria.

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