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STRUCTURE OF CORAL COMMUNITY IN SIDODADI VILLAGE, TELUK PANDAN DISTRICT, PESAWARAN REGENCY

Struktur Komunitas Karang di Desa Sidodadi, Kecamatan Teluk Pandan, Kabupaten Pesawaran

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ABSTRACT

Indonesian waters have abundant natural resources, one of which is coral reefs. The purpose of this study was to analyze the structure of the coral community in Sidodadi Village, Pesawaran Regency. The research was conducted in September 2023. The research location was in the waters of Sidodadi Village, Teluk Pandan District, Pesawaran Regency, Lampung Province. The research method used Underwater Photo Transect (UPT). Data analysis with CPCe software. The percentage of live coral cover in the observation area at station 1 was 44,65%, station 2 was 0,12%, station 3 was 78,03% and station 4 was 44,05%. The category of coral cover percentage was very good, moderate and poor. The physicochemical conditions of the waters were classified as good to support coral growth. The diversity index value at the research location was included in the low category, the uniformity index value was included in the low and high categories and the dominance index value was included in the low and high categories. The physicochemical parameters of the waters that most influenced the amount of coral cover were dissolved oxygen and brightness.

Keywords: Coral, Coral Cover, Ecological Index, Physical-Chemical Waters

ABSTRAK

Perairan Indoensia memiliki sumber daya alam yang melimpah dimana salah satunya adalah terumbu karang. Tujuan penelitian ini untuk menganalisis struktur komunitas karang di Desa Sidodadi, Kabupaten Pesawaran. Waktu penelitian dilakukan pada bulan September 2023. Lokasi penelitian di perairan Desa Sidodadi, Kecamatan Teluk Pandan, Kabupaten Pesawaran, Provinsi Lampung. Metode penelitian menggunakan *Underwater Photo Transect* (UPT). Analisis data dengan perangkat lunak CPCe. Persentase tutupan karang hidup daerah pengamatan pada stasiun 1 sebesar 44,65 %, stasiun 2 sebesar 0,12 %, stasiun 3 sebesar 78,03 % dan stasiun 4 sebesar 44,05 %. Kategori persentase tutupan karang berupa baik sekali, sedang dan buruk. Kondisi fisika-kimia perairan tergolong baik untuk mendukung pertumbuhan karang. Nilai indeks keanekaragaman di lokasi penelitian termasuk dalam kategori rendah, nilai indeks keseragaman termasuk pada kategori rendah dan tinggi dan nilai indeks dominansi tergolong pada kategori rendah dan tinggi. Parameter fisika-kimia perairan yang paling sangat mempengaruhi besarnya tutupan karang adalah oksigen terlarut dan kecerahan.

Kata Kunci: Karang, Tutupan Karang, Indeks Ekologi, Fisika-Kimia Perairan

INTRODUCTION

Indonesian waters have abundant, diverse natural resources and great potential for more effective and efficient development. One of these natural resources is coral reefs. Coral reefs are an ecosystem built and formed by various marine biota that produce lime, especially coral animals along with other marine biota that live in the sea (Kusuma et al., 2022a). Coral reefs have an important role in terms of physical, ecological and economic (Kusuma 2024). Although coral reefs have ecological and economic value, they are very vulnerable to damage, both from natural and anthropogenic factors. Damage caused by natural factors, for example, increases in sea temperature, global climate change, storms, earthquakes, tsunamis, predation, and disease, while damage caused by anthropogenic factors is fishing activities using explosives, toxic chemicals, and environmentally unfriendly fishing gear (Uar et al., 2016). Giyanto et al. (2017) said that the current condition of coral reefs in Indonesia is 6.39% in very good condition, 23.40% in good condition, 35.06% in fair condition and 35.15% in poor condition.

Sidodado Village as one of the villages in Pesawaran Regency is an area dominated by marine areas with very potential marine resources, especially coral reefs. Around the coral reef area, fishing activities have been carried out intensively by local fishermen and foreign fishermen using explosives and toxic materials. In fact, as is known, coral reefs that are already in a severely damaged condition take a long time to recover (Kusuma et al., 2022b). The consequences of the coral reef ecosystem that has been exploited require time to recover naturally in order to maintain and restore the quality and quantity of available resources. One indication of good ecosystem health is the ability of an ecosystem to recover from a damaged condition to a better one. The level of coral reef ecosystem recovery is one of the important indications for managers in carrying out good and proper coral reef ecosystem management. This information is usually needed in assessing the level of coral reef vulnerability to disturbances and estimating the duration of the restoration and rehabilitation process of a coral reef ecosystem. To determine the health of coral reefs, a study is needed by looking at the condition of the coral reef ecosystem. As a first step, information about the condition of the coral reef ecosystem is very much needed. Healthy coral reefs will provide important ecological benefits and also provide economic benefits to the community, especially coastal communities. This study aims to analyze the structure of coral communities in Sidodadi Village, Teluk Pandan District, Pesawaran Regency, Lampung Province.

METHODS

Time and Location

This research was conducted in September 2023. The research location was in Sidodadi Village, Teluk Pandan District, Pesawaran Regency, Lampung Province.

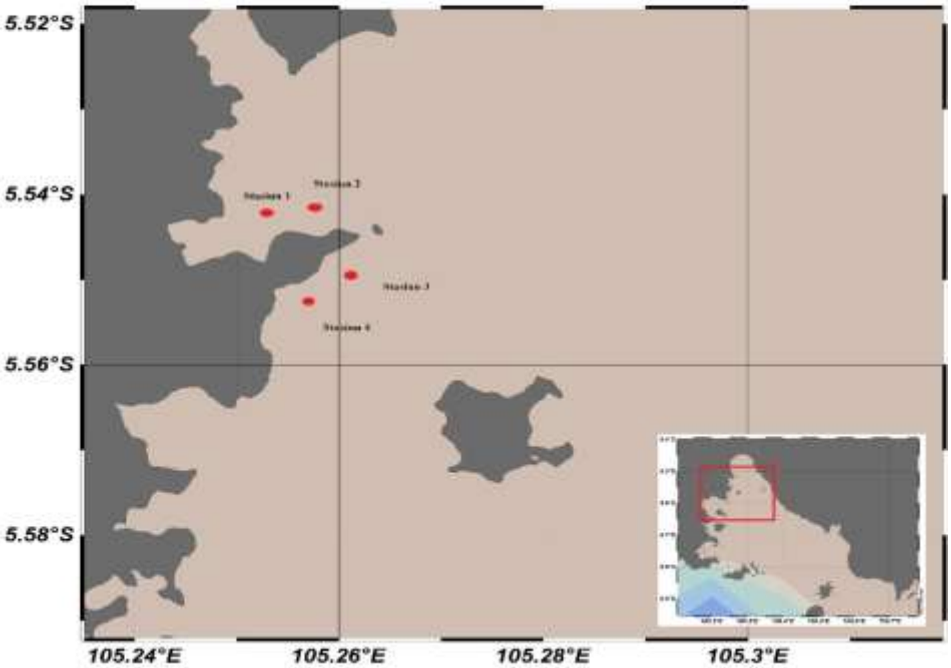

Figure 1. Map of Research Location

Tools and Materials

The tools and materials used in this study include GPS (Global Positioning System) to determine the coordinate position of the location. 1m x 1m square transect to measure the area of the transect. SCUBA equipment and stationery were used for data collection. Coral identification book to identify coral types. Software for data processing, and underwater cameras for documentation and data collection.

Work Procedure

The method in this study uses Underwater Photo Transect (UPT) with CPCe software (Giyanto et al., 2023). This method is a method that utilizes technological developments, both the development of digital camera technology and computer software technology. Data collection in the field in the form of underwater photos.

Data Analysis

Diversity Index

The diversity index is used to obtain a mathematical picture of the organism population in order to easily analyze information on the number of individuals of each type in a community. This index is calculated using the equation:

$$H' = -\sum_{i=1}^{s} pi \ln pi$$

$$pi = \frac{ni}{N}$$

Where:

H' : diversity index
Ni : number of individuals in the i-th species
N : total number of individuals of all species

Uniformity Index

The uniformity index is used to measure the similarity of the number of individuals between types in a community. This index is calculated using the equation:

$$E = \frac{H'}{H\ max} \qquad H\ max = \ln S$$

Where:
E : uniformity index
H' : diversity index
H max : maximum diversity
S : number of individuals

Dominance Index

The dominance index is used to see the extent to which a type dominates a population. This index is calculated using the equation:

$$C = \frac{1}{N^2} = \sum_{i=1}^{s} n_1^2$$

Where:
C : dominance index
Ni : number of individuals of the i-th species
N : total number of individuals of all species

Coral Relationship with Physicochemical Parameters of Waters

PCA is used to see the correlation of habitat characteristics with the types and distribution of soft corals in each research location. The physical-chemical parameters of the waters analyzed include temperature, salinity, acidity (pH), dissolved oxygen (DO), current speed, depth and brightness. This analysis shows the relationship between each parameter that produces habitat grouping (Parenden et al., 2023).

RESULTS

Live Coral Cover

The percentage of live coral cover in the observation area consists of Acropora where Acropora Branching (ACB), Acropora Encrusting (ACE), Acropora Submasive (ACS), Acropora Digitate (ACD), Acropora Tabulate (ACT), Non Acropora where Coral Branching (CB), Coral Massive (CM), Coral Encrusting (CE), Coral Meliopora (CME), and Coral Mushroom (CMR), other biota where Soft coral (SC), Sponge (SP), Zoanthid (ZO), Other (OT), Dead coral where Dead Coral (DC), Dead Coral With Algae (DCA), while the percentage of abiotic component cover in the study area consists of Silt (Si), Sand (S), and Rubble (R). The percentage of coral cover at station 1 where live coral is 44.65%. Live coral is dominated by Coral Massive (CM) of 41.81% and Coral Mushroom (CMR) of 2.84%). Next, dead corals amounted to 17.32%, dead corals with algae 10.41%, coral fragments amounted to 25.23%, abiotic 2.36%, and others amounted to 1.46%. Station 2 where live corals amounted to 0.12%. Live corals in the form of Coral Foliose (CF) amounted to 0.06% and Coral Mushroom (CMR) amounted to 0.06%. Next, dead corals amounted to 0.19%, coral fragments amounted to 9.21%, abiotic amounted to 90.17%, and others amounted to 0.42%. Station 3 where live corals amounted to 78.03%. Live corals are dominated by Coral Branching (CB) of 0.51, Coral Encrusting (CE) of 0.5, Coral Foliose (CF) of 67.75%, Coral Massive (CM) of 0.61%, Coral Mushroom (CMR) of 3.66% and Coral Submassive (CS) of 4.98). Furthermore, dead corals of 14.34%, coral fragments of 4.98%, abiotic of 2.64%, and others of 0.71%. Station 4 where live corals are 44.05%. Live corals in the form of Coral Branching (CB) of 1.04, Coral Encrusting (CE) of 1.80%, Coral Foliose (CF) of 38.73%, Coral Massive (CM) of 0.48% and Coral Mushroom (CMR) of 2.01%). Furthermore, dead coral was 3.04%, dead coral with algae was 33.40%, marine biota was 0.69%, coral fragments were 4.01%, abiotic was 13.83% and others were 4.29%. The percentage of hard coral cover in the waters of Sidodadi Village ranges from 20-70% (Hartoni et al., 2012; Titaheluw, 2017; Barus et al., 2018). The percentage of benthic habitat cover at the research location can be seen in Figure 2.

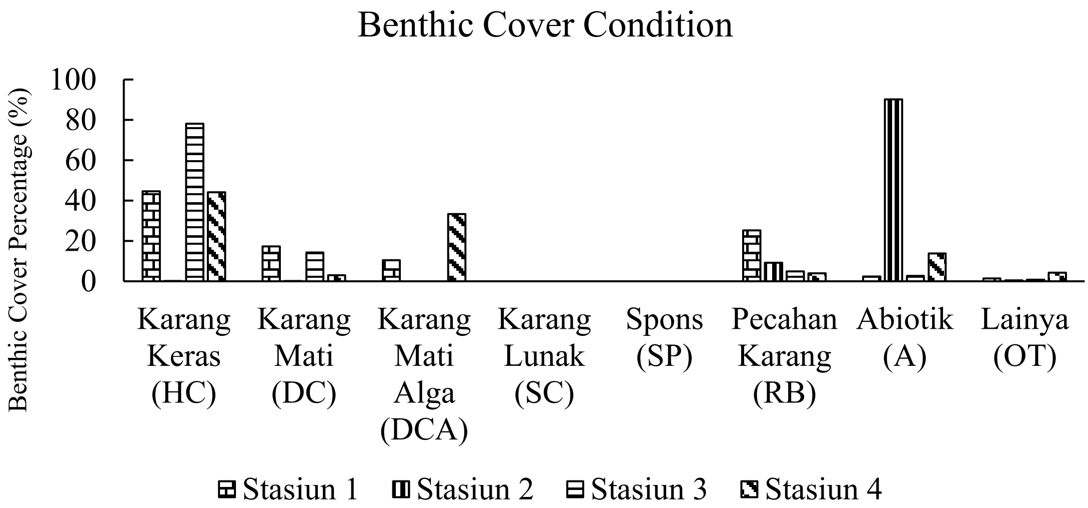

Figure 2. Percentage of Benthic Habitat Cover at the Research Location

Physics-Chemistry of Waters

Physics-chemical parameters of waters are one of the important factors supporting coral growth. Water quality is a biophysical and chemical factor that affects the life of marine organisms in their ecosystem. Water temperature ranges from 31-32°C. The water temperature in Sidodadi Village is 30°C (Hartoni et al., 2012). The optimal temperature for coral reefs is 28-30°C (KLH, 2004). Corals can still tolerate a maximum temperature of 36-40°C and a minimum of 18°C (Brown et al., 2023). Salinity ranges from 28-30 ppt. The salinity of the waters in Sidodadi Village is 30 ppt (Hartoni et al., 2012). The optimal salinity for coral reefs is 33-34 ppt (KLH, 2004). The acidity (pH) of the waters ranges from 7.8-8.1. The optimal pH for coral reefs is 7-8.5 (KLH, 2004). Dissolved oxygen (DO) ranges from 6-8 mg/l. Dissolved oxygen in the waters of Sidodadi Village ranges from 5.29 to 6.19 mg/l (Hartoni et al., 2012). The optimal DO for coral reefs is above 5 mg/l (KLH, 2004). Water clarity ranges from 7 to 10 m. The clarity in the waters of Sidodadi Village ranges from 8 to 10 m (Hartoni et al., 2012). The optimal clarity for coral reefs is around 10 m (KLH, 2004). Current speed ranges from 0.001 to 0.009 m/s and a depth of 10 m. The physical-chemical conditions of the waters at the research location are seen in Table 1.

Table 1. Physical-Chemical Conditions at the Research Location

No	Parameter	Unit	Station 1	Station 2	Station 3	Station 4
1	Temperature	°C	31	32	30	31
2	Salinity	ppt	28	29	28	30
3	Acidity (pH)	-	7.8	8	7.9	8.1
4	Dissolved oxygen	mg/l	7	6	8	7
5	Brightness	m	9	7	10	9
6	Current speed	m/s	0.001	0.009	0.002	0.004
7	Depth	m	10	10	10	10

Ecological Index

The diversity, dominance and evenness indices can provide an overview of the distribution of balance and number of individuals in a species and indicate the richness of the species. The diversity index at station 1 was 1.34, station 2 was 0.35, station 3 was 0.72 and station 4 was 1.35. The diversity index at all stations is in the low category because it is less than 2 (Aunkhongthong et al., 2021). The evenness index at station 1 was 0.20, station 2 was 0.82, station 3 was 0.77 and station 4 was 0.30. The evenness index at stations 1 and 4 is low while stations 2 and 3 are high (Ismail & Khoo, 2019). The dominance index at station 1 was 0.70, station 2 was 0.18, station 3 was 0.37 and station 4 was 0.67. The uniformity index at stations 1 and 4 is classified as high while stations 2 and 3 are classified as low (Parenden et al., 2023).

Table 2. Ecological Index at the Research Location

Station	Diversity Index	Uniformity Index	Dominance Index
1	1.34	0.20	0.70
2	0.35	0.82	0.18
3	0.72	0.77	0.37
4	1.35	0.30	0.67

Relationship of Benthic Habitat Cover with Water Physics-Chemistry

The results of the principal component analysis (F1 and F2) show that the cumulative characteristic root is around 86.31%. This information is explained by the F1 axis of 36.92% and the F2 axis of 49.39%. The Fi factor is obtained from the total principal components (F1 and F2) which are eigenvalues that indicate the characteristics of a matrix with the number of components used (Nurhasanah et al., 2016). The minimum requirement that must be met is that the cumulative variable reaches 60% or 75% (Wahyu & Prasetyo, 2021). The relationship between the percentage of benthic habitat covers and the water physics and chemistry can be seen in Figure 3.

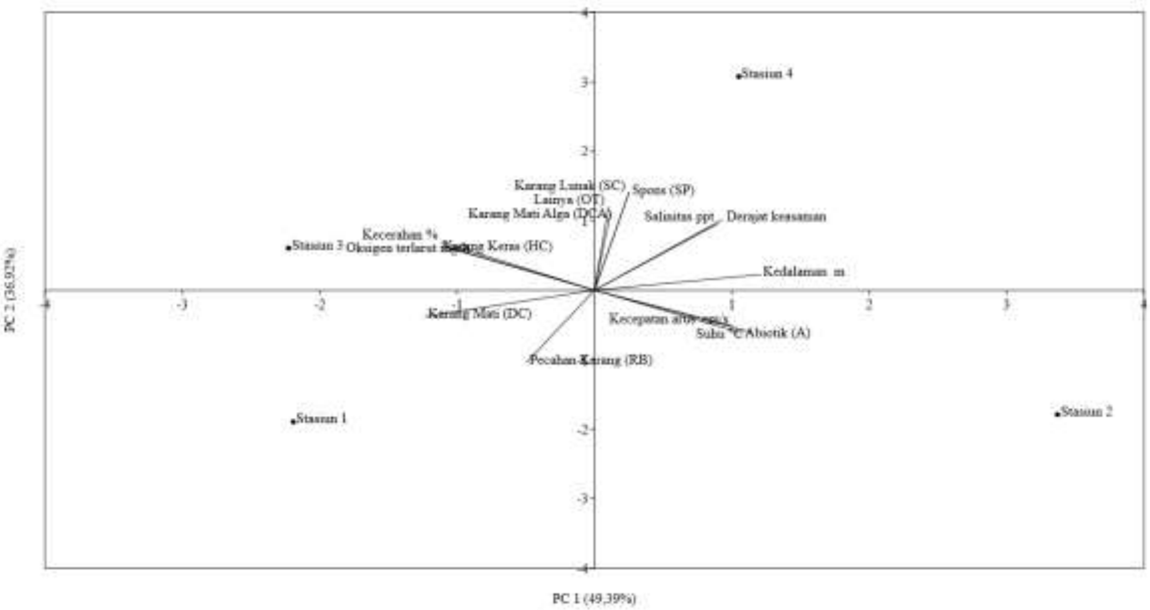

Figure 3. Relationship of Benthic Cover with Water Physics and Chemistry Conditions at the Research Location

DISCUSSION

The highest percentage of live coral cover was at station 3 while the lowest was at station 2. The percentage of live coral cover at station 3 was the highest because it was close to the location of the Floating Net Cages (KJA). This KJA cultivation activity has a positive impact on the supervision of coral reefs from damage (Triwibowo, 2023). With this supervision, coral reefs have the opportunity to recover. However, even though this station is used as a KJA area, it does not mean that the location does not cause problems. Waste from the feed has the potential to cause nutrient enrichment in the waters (Barokah et al., 2016). High nutrients can increase algae growth (blooming) which disrupts coral communities with competition for space and low oxygen conditions which cause marine biota to lack oxygen. The low percentage of live coral and the high percentage of dead coral at station 2 were caused by fishing activities using bombs and toxic chemicals. Fishing using bombs can be one of the causes of coral reef damage (Pontoh, 2011). Furthermore, fishing using chemicals makes coral polyps associated with zooxanthellae unable to recover (Pemana et al., 2021). Based on the Decree of the Minister of Environment Number 4 of 2001 concerning the Standard Criteria for Coral Reef Damage, the condition of coral cover at station 1 is in moderate condition, station 2 is in poor condition, station 3 is in very good condition and station 4 is in moderate condition. A coral reef ecosystem will be in better condition if the percentage of live coral cover in the ecosystem is greater than the percentage of abiotic cover.

Temperature is related to the heat capacity in a body of water. Temperature greatly affects the survival of coral. Water temperatures that are too high can cause coral bleaching if they continue to occur will cause zooxantella to come out of the coral polyps, causing the coral to die (Patthanasiri et al., 2022). The temperature in the waters is greatly influenced by the circulation of seawater masses, the effectiveness of sunlight and the intensity of evaporation. Salinity is related to the amount of dissolved salt contained in one kilogram of seawater where it is assumed that all carbonates have been converted into oxides and the elements Bromide (Br), Iodine (I) are replaced by Chloride (Cl) and all organic materials have been completely oxidized. Salinity affects coral life because it affects the osmotic pressure on coral living tissue. Corals do not like fresh water. Waters with low salinity disrupt the normal electrochemical processes of cells and result in decreased photosynthetic activity, bleaching, loss of zooxantella and ultimately death (Ding et al., 2022). Salinity is influenced by fluctuations in precipitation intensity, evaporation and freshwater input (run off) from land. The degree of acidity (pH) is related to the amount of hydrogen ions (H^+) expressed logarithmically in a body of water. Waters that have a low pH value will interfere with the coral calcification process so that coral growth is inhibited, the skeletal structure becomes weak and fragile and vulnerable to physical environmental influences such as currents and waves (Thomsen et al., 2015). The pH at the research location still supports the survival of coral animals. Dissolved oxygen is the amount of oxygen content dissolved in a body of water. Corals need sufficient oxygen in the water to breathe, maintain the health of zooxanthella and inhibit the growth of pathogenic microorganisms (Nelson & Altieri, 2019). Dissolved oxygen in waters is greatly influenced by physical, chemical and biological processes such as photosynthesis, respiration and organic matter decomposition. Low dissolved oxygen concentrations indicate high levels of organic matter that must be decomposed in a body of water. In addition, waters with low dissolved oxygen indicate a high level of contamination by pathogenic microorganisms that are harmful to coral. The rate of oxygen entry from the air into the water is influenced by the level of water saturation, temperature, salinity, and movement of water masses. Dissolved oxygen at the research location is still included in the good and optimal category to support coral growth. Brightness is related to the description of the transparency of a body of water. Brightness is related to the intensity of sunlight which is very much needed by zooxantella as a source of energy for the photosynthesis process where the results of this photosynthesis will later be used by corals as the main food supply for corals (Kuanui et al., 2022). Waters that have high brightness will help photosynthesis activity to be optimal. Brightness at the research location is still included in the good and optimal category to support coral growth. Current is related to the movement of water masses from one place to another. Corals need sufficient current because it is related to the supply of nutrients as food and cleaning themselves from suspended particles (D'Angelo & Wiedenmann, 2014). In general, the physical-chemical conditions of the waters at the research location still support coral growth.

The diversity index is related to the abundance of a community based on the number of species and the number of individuals of a species in a body of water. The diversity index can be interpreted as a systematic way that describes the structure of a marine biota community and makes it easier to analyze the abundance of species and species richness. The high and low values of the diversity index are caused by the large number of coral species (Nurhaliza et al., 2019). The diversity index from all stations is relatively low. This indicates that the environmental conditions of the research location are under high ecological pressure. This ecological pressure comes from the anthropogenic activities of the local coastal community. The uniformity index is related to the evenness of the distribution of individuals. According to Puspitasari et al. (2016) the value of the organism uniformity index approaches 1, then the waters are in a stable state. The uniformity index at stations 1 and 4 is relatively low, indicating that they are under pressure because there is dominance, while stations 2 and 3 are relatively high, indicating that they are in a stable condition. A low uniformity index value indicates that the distribution of the number of individuals of each type is not the same, so there is a tendency for one type of biota to dominate. This condition can be seen from the dominance index. The uniformity index at stations 1 and 4 is classified as high, indicating high dominance, while stations 2 and 3 are classified as low, with no dominance. A high dominance index value indicates the presence of coral reefs that dominate at the observation station. The dominant coral reefs are non-Acropora hard corals. This is because non-Acropora hard corals have a good level of survival in large environments with anthropogenic pressure. A low dominance index value means that the waters are said to be stable because there are no dominant species of organisms in the waters (Nugraha et al., 2020).

The results of the PCA analysis show that all environmental parameters and coral cover are correlated with each other. It can be seen that station 2 is characterized by temperature and current speed, station 3 is characterized by dissolved oxygen and brightness, and station 4 is characterized by salinity, pH and depth. For coral cover, station 1 is in the form of dead coral and coral fragments, station 2 is abiotic, station 3 is live coral, station 4 is soft coral, sponges and other biota. Hard corals are strongly correlated with dissolved oxygen and brightness. This is the same as stated by (Thovyan et al., 2017) where the percentage of coral cover is positively correlated with dissolved oxygen and brightness parameters. Corals need sufficient oxygen in the waters to breathe, maintain the health of zooxantella and inhibit the growth of pathogenic microorganisms. Brightness related to the intensity of sunlight is very much needed by zooxantella as a source of energy for the photosynthesis process where the results of this photosynthesis will later be used by corals as the main food supply for corals. The more the waters have high brightness and dissolved oxygen, the more optimal the photosynthesis activity becomes.

CONCLUSION

In this study it can be concluded that the live coral cover at the research location for station 1 is moderate, station 2 is poor, station 3 is very good and station 4 is moderate. The diversity index value at the research location is included in the low category, the uniformity index value is included in the low and high categories and the dominance index value is included in the low and high categories. The physical-chemical conditions of the waters are classified as good to support coral growth. Hard corals are strongly correlated with dissolved oxygen and brightness. The more the waters have high brightness and dissolved oxygen, the more optimal the photosynthesis activity becomes.

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