Conditions Of Scleractinian Coral Cover Percentage On The North Coast Of Ambon Island, Maluku Province

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Abstract.

Coral reefs are one of the most ecologically productive and diverse ecosystems. This study aims to determine the condition of scleractinian coral cover in the northern coastal waters of Ambon Island. Data collection in the field is carried out using the systematic sampling method. A quadrant measuring 1x1 m2 becomes the sampling area. Quadrants are placed on transects 20 m long with quadrant intervals on transect lines of 5 m (0, 5, 10, 15, and 20 m). The transects are placed parallel to the shoreline at depths of 3 m and 10 m, with four transects at each depth, and the distance between transects is 1 m. The data obtained were then analyzed to see the percentage of coral cover in each category and component. The results showed that the percentage of the benthic substrate of coral reefs on the North Coast of Ambon Island to a depth of 3 meters was dominated by rubble with a percentage of 26.33% - 54.83%, and for a depth of 10 meters the percentage value of ruble was 11.33% - 48.83% and sand (4% - 54.50%). The category of Acropora corals both at a depth of 3 meters and 10 meters dominated by Acropora branching (ACB), while the non-acropora category is dominated by Coral Branching (CB), Coral Encrusting (CE), and Coral Massive (CM). Overall, the condition of live coral cover on the North Coast of Ambon Island is categorized as in poor condition.

Keywords: *Coral reefs, coral cover, living corals and life form.*

I. INTRODUCTION

Scleractinia is a group of hermatypic corals that compose and dominate the main coral reef ecosystem and have a symbiotic relationship of mutualism with zooxanthellae. Coral recruitment is the emergence of individual young corals produced through sexual and asexual reproduction (fragmentation) or migration of planula larvae (Karmila et al., 2019). The planula larvae then go through their life as planktonic larvae and will attach to a hard substrate at the bottom of the waters (Rafilu et al., 2020). Eghbert et al. (2021) also added that the life cycle of this coral begins with the emergence of planula larvae, then these planula larvae will soon undergo metamorphosis into an individual coral animal that continuously grows into a colony and continues to become a full-fledged coral reef ecosystems. Coral reefs are ecosystems that are very vulnerable and have a low recovery power when environmental pressure occurs (Sangaji, M., 2017).Coral reef damage can occur both naturally and anthropogenically (Kealoha et al., 2020). According to Hadi et al., (2018), the condition status of coral reefs in Indonesia in 2018 was in the category of damaged at 36.18%, good category at 22.98%, and very good category at only 6.56% while the status of coral reef category is quite good at 34.3%. The condition of coral reefs is decreasing every year. Various factors can cause a decrease in the condition of corals, among others, caused by human activities that often use fishing gear that is not environmentally friendly, climate change which can trigger coral bleaching, and pollution from the land which can trigger a decline in coral reef conditions (Erdana et al., 2022).

Ambon Island is a small island that has a water location with water conditions and potential coral reefs scattered in coastal waters. The waters of the North Coast of Ambon Island have a potential and strategic distribution of coral reefs. The location of these waters has the potential of coral reefs which are often used as strategic locations for marine tourism development, aquaculture activities, reef fishing activities, and various other activities. The high socio-economic activities around the waters of coral reef ecosystems will affect the growth and development of coral reefs, especially Scleractinia corals. Scleractinia corals are highly susceptible to environmental stresses caused by anthropogenic activities and aquatic pollution. Meanwhile, studies and research on monitoring the condition of coral reefs, especially Scleractinia

corals on Ambon Island are still very limited. For this reason, data collection and knowledge of the condition of Scleractinia corals in the waters of the North Coast of Ambon Island are very relevant to do. Research on the condition of coral reefs in the northern coastal waters of Ambon Island that are detailed so far still uses data published in 1998 by Edrus and Syam as basic data. According to Edrus and Syam (1998), the condition of coral reefs on the north coast of Ambon Island at several points (Kalauli Village, SPK Universita Pattimura in Hila, and Tanjung Setan Morella) is still relatively good, with the percentage of rocky coral cover ranging from 1.12-95.5% (average 34%). However, the data illustrates the condition of coral reefs in the past, while data from the results of recent studies (above the 2000s) on the current condition of coral reefs on the north coast of Ambon Island are still rare.

II. MATERIAL AND METHODS

Research Time and Location

The research was conducted from September to November 2022 in the northern coastal waters of Ambon Island, Leihitu & Salahutu Districts, Central Maluku Regency, Maluku Province. Field data collection was carried out by determining four research stations. Each station is located in four villages/countries: Negeri Liang, Negeri Morella, Hila Village, and Kaitetu Village (Figure 1).

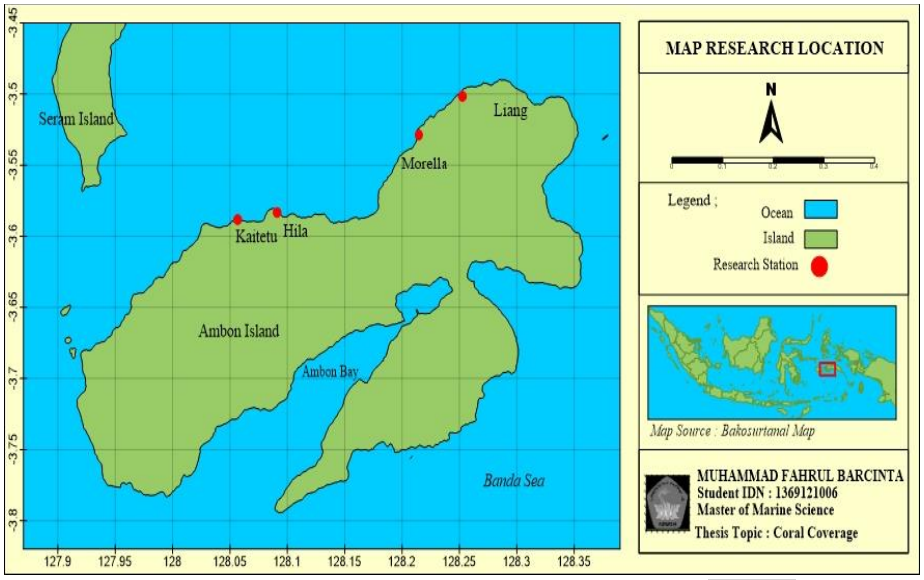

Fig 1. Map of Research Location on the North Coast of Ambon Island

Tools and materials

The tools and materials used were diving equipment (SCUBA), Global Positioning System (GPS), Olympus TG-5 camera, Meter Roll, New top paper, stationery, Quadrant 1x1 m^2, life form identification book (*Manual Lifeform*: Coral Reef Ecosystem (2001), CPCe 4.1 software, computer equipment (PC).

Work Procedures

Data Collection Procedures

Research activities consisted of preparing tools and materials and observing the general condition of hard corals by looking at the percent cover. Analysis of the percentage cover of hard corals in general based on their life form. Data on the percentage of coral cover was taken using the LIT (Line Intercept Transect) method. The LIT is a method developed by the Australian Institute of Marine Science (AIMS) and The Great Barrier Reef Marine Park Authority (GBRMPA) which is often used for coral data collection by using straight-line transects horizontally and then recording the substrate on the transect (Isdianto et al., 2020). this method is often used because it requires little equipment, is very simple to implement, and is an accurate and efficient technique for obtaining quantitative data on the percentage of coral cover (Sarbini et al., 2016).

Field Sampling Method

a) Dive points at each station are carried out in areas that have a bottom topography that is not too steep and has a wide flat coral reef.

b) Field data collection was carried out using a systematic sampling method with the following stages: quadrant measuring 1x1 m^2 to be the sampling area. Quadrants are placed on a 20 m-long transect with quadrant intervals on the transect line of 5 m (0, 5, 10, 15, 20 m) (this is a modification of the method proposed by Obura and Grimsditch, 2009).

c) Transects were placed parallel to the shoreline at a depth of 3 m and 10 m with a total of four transects at each depth and the distance between transects was 1 m.

d) The quadrants were placed and then photographed for use as hard coral cover data.

e) All data captured on each transect were processed using the CPCe (*Coral Point Count With Excel extension*) application.

f) In the CPCe, 30 sampling points were used in each quadrant, which was arranged systematically in the quadrant image.

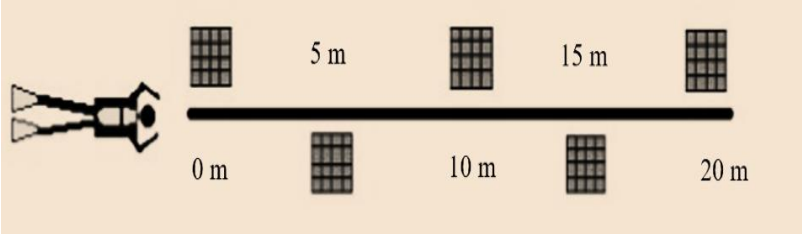

Fig 2. Illustration of how to collect data and place the quadrants on the transect.

Data analysis

According to English et al.,1997, the calculation of the percentage of coral cover (percent of cover) for each category of live coral growth by comparing the total length of each category with the total transect length uses the following equation:

$$the\ percentage\ of\ coral\ cover = \frac{the\ number\ of\ point\ categories}{many\ points} \times 100\%$$

In this study, 20 category Life Forms were used (Table 1) with a total of 30 observation points which were placed systematically in the CPCe 4.1 software.

Table 1. Benthic Cover Category (*Life Form*)

No.	Components	Explanation
Acropora:		
1.	ACB	*Acropora Branching*
2.	ACD	*Acropora Digitate*
3.	ACT	*Acropora Tabulate*
4.	ACE	*Acropora Encrusting*
5.	ACS	*Acropora Submassive*
Non Acropora:		
6.	CB	*Coral Branching*
7.	CM	*Coral Massive*
8.	CE	*Coral Encrusting*
9.	CS	*Coral Submassive*
10.	CMR	*Coral Mushroom*
11.	CF	*Coral Foliose*
Others:		
12.	SC	*Soft Coral*
13.	SP	*Sponge*
14.	OT	*Other Fauna*
15.	TA	*Turf Algae*
Abiotic:		
16.	S	*Sand*
17.	RB	*Rubble*
18.	RCK	*Rock*
19.	DCA	*Dead Coral With Algae*
20.	DC	*Dead Coral*

According to the decree of Kementerian Lingkungan Hidup No.4 Tahun 2001, The percentage value of closure, as an estimate of the condition of coral reefs, can be categorized as shown in Table 2:

Table 2. Criteria for Damage to Coral Reefs (KepMen LH No.4 Tahun 2001).

Parameter	Criteria for Coral Reef Damage	(%)
Percentage of Living Coral Reef Cover Area	Bad	0-24.9
	Moderate	25-49.9
	Well	50-74.9
	Very good	75-100

III. RESULTS AND DISCUSSION

Substrate Composition Category

Data from the calculation of the percentage of substrate constituent categories as a whole at two depths can be seen in Figures 3 and 4.

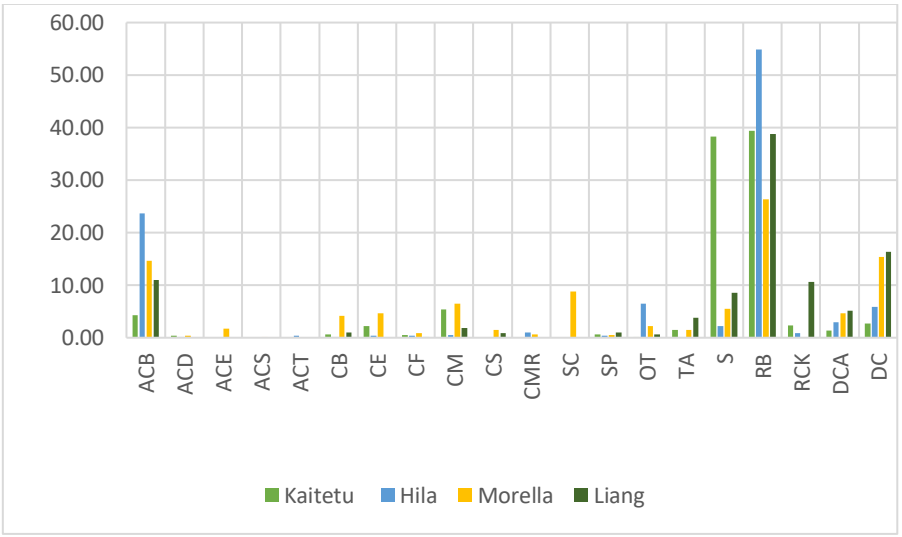

Fig 3. Substrate Composition Categories at 3 m Depth.

The category of benthic substrate constituents at all research stations at a depth of 3 meters was dominated by rubble with a range of 26.33% - 54.83%, while the Acropora category was dominated by Acropora Branching (ACB) with a range of 4.33% - 23 .67%, while non-Acropora were mostly found at Morella and Kaitetu stations, with the dominant categories being Coral Branching (CB), Coral Encrusting (CE), and Coral Massive (CM) when compared to other locations and cover categories.

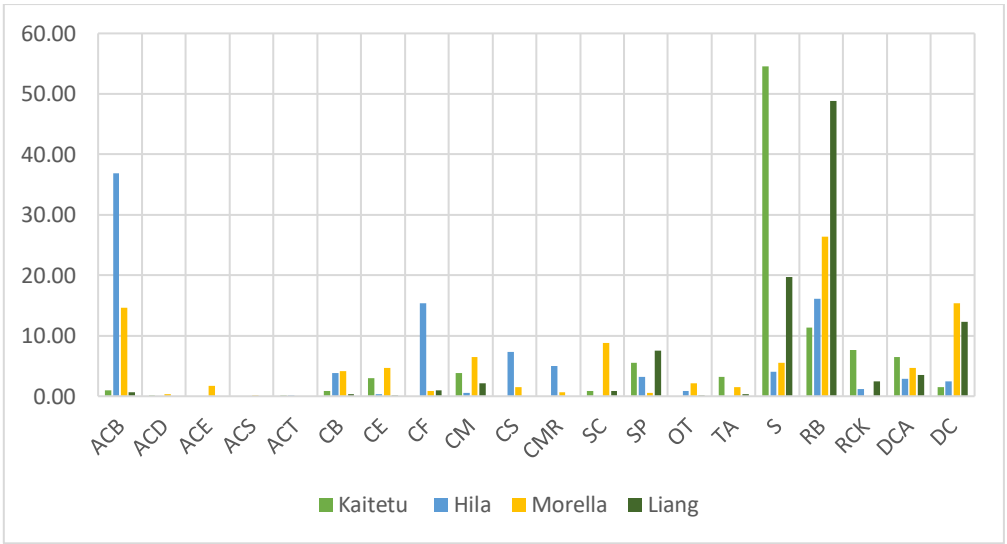

Fig 4. Substrate Composition Category at 10 m Depth.

Meanwhile, at a depth of 10 m, the percentage of benthic cover at all research stations for the Abiotic category was dominated by rubble with a range of 11.33% - 48.83% and sand (4% - 54.50%). Meanwhile, the Acropora category was dominated by Acropora Branching (ACB) with the highest percentage being at Hila station at 36.83%, for the non-Acropora category most of them were found at Hila and Morella stations with the dominant categories being Coral Branching (CB), Coral Encrusting (CE), Coral Foliose (CF), Coral Massive (CM), Coral Submassive (CS) and Coral Mushroom (CMR) when compared to other locations.

Percentage of Hard Coral Live (HCL)

Data from the calculation of the percentage of live coral cover at the 4 study sites (Liang Village, Morella Village, Hila Village, and Kaitetu Village) can be seen in Table 3 and Figure 5.

Table 3. Percentage of Living Coral Reef Coverage in North Coastal Waters of Ambon Island

Site	Depth (m)	Live Coral Cover (%)	Category
Hila	3	26,50	Moderate
	10	69,33	Well
Liang	3	14,00	Bad
	10	4,33	Bad
Morela	3	35,17	Moderate
	10	16,88	Bad
Kaitetu	3	13,67	Bad
	10	9,00	Bad
Average		**23,61**	**Bad**

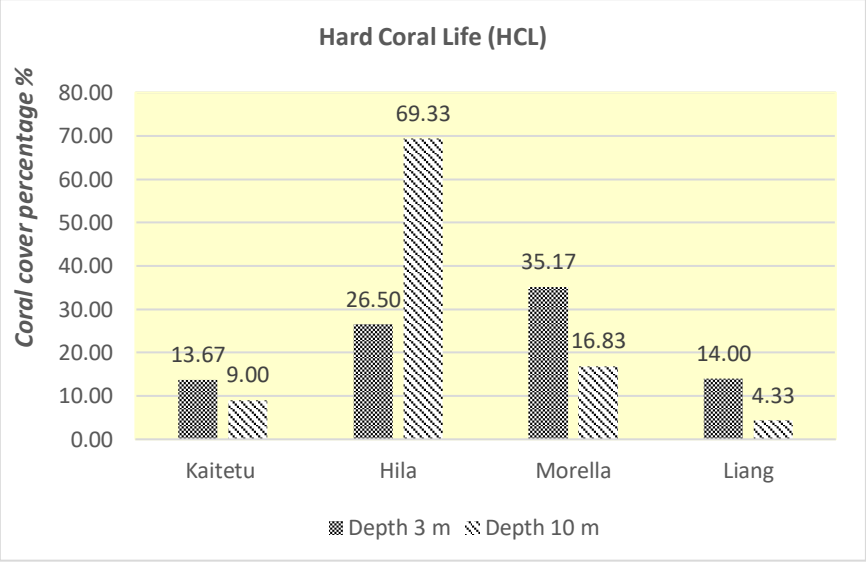

Fig 5. Percentage of Hard Coral Cover (HCL) at the two depths.

Based on the results in Table 3 and Figure 5, it can be seen that the percentage of live coral cover at each location and depth has different results. This can be seen in Negeri Hila Waters, Where at a depth of 3 m, a percentage of coral cover was found at 26.50%, which means it is in the moderate category, while at a depth of 10 m a percentage value of 69.33% is obtained, which means that the condition of coral cover is in a great category. In Liang and Kaitetu State waters at 3 m and 10 m depth and in Morela Country at 10 m depth, the percentage value of coral cover ranges from 4.33% - 14.00%, which means that the condition of coral cover in these waters is in a bad category. Meanwhile, in the waters of Negeri Morela at a depth of 3 m, the percentage value of coral cover was 35.17%, which means that the condition of coral cover was in the moderate category.In general, the average value of live coral cover at the four research sites was 23.61%, which means they were in bad condition. If we specify for each location only the lower reaches of the station, which has a moderate and good percentage of live coral cover at depths of 3 and 10 respectively. As for the other three stations (Kaitetu, Liang, and Morella) based on the results of the data analysis, they are in a bad category.

This is very worrying because it will greatly affect the marine biota that inhabit and forage around coral reef areas (Hukubun, 2020).Coral damage in the bad category obtained in this study, especially in the Liang, Morela, and Kaitetu locations, is suspected to be caused by fishing by fishermen in an unfavorable way, namely by using explosives that can damage the ecosystem. this is to the statement of Sahetapy, 2018a, which states that the damage to the coral reef ecosystem in Maluku is generally caused by destructive use, one of which is by using explosives/bombs. Sudarmaji and Efendy (2021) also state that fishing gear that is not environmentally friendly causes small and large fish to die and has an impact on the damage to coral reefs which function as reef fish habitats.In addition, the declining condition of coral reefs is also caused by reclamation and development in coastal areas, resulting in excessive sedimentation, input from residential waste, both plastic waste, and liquid waste. This situation is very damaging to coral reef ecosystems because it can reduce coral reef populations and even destroy the diversity of marine biota.

Percentage of Non-HCL

In addition to live corals, the percentage of non-HCL cover (Dead Scleractinia, Algae, Other Fauna, and Abiotics) was also calculated at the four study sites, which can be seen in Table 4.

Table 4. Percentage of non-HCL cover on the North Coast of Ambon Island

Basic Components	Percentage of non-HCL cover Per Location							
	Hila		Liang		Morella		Kaitetu	
	3 m	10 m	3 m	10 m	3 m	10 m	3 m	10 m
Dead Scleractinia								
Recent Dead Coral (DC)	5,83	2,5	16,33	12,33	15,33	2,33	2,67	1,5
A l g a e								
Dead Coral with Algae (DCA)	3	2,83	8,5	3,83	6	19,67	2,83	9,17
Other Fauna								
Soft Coral (SC)	0	0	0,83	0,83	8,83	1,5	0	0,83
Sponge (SP)	0,33	3,17	1	7,5	0,5	2	0,67	5,5
Fleshy Seaweed (FS)	0	0	0,5	0	0	0	0	0
Other Biota (OT)	6,5	0,83	0,83	0,17	2,33	1	0,17	0,5
Abiotic								
Rubble (R)	54,83	16,17	38,83	48,83	26,33	32,67	39,33	11,33
Sand (S)	2,17	4	8,5	19,67	5,5	23,67	38,33	54,5
Rock (RK)	0,83	1,17	10,67	2,5	0	0,33	2,33	7,67

From Table 4 it can be seen that overall in the four study locations, the percentage of the non-HCL cover was dominated by Recent Dead Coral (Dc), Dead Coral with Algae (DCA), Sponge (SP), Other Biota (OT), Rubble (R), Sand (S) and Rock (RK). This component is usually used by groups of herbivorous fish to find food. The high percentage of abiotic components such as broken coral, dead coral, and dead coral overgrown with algae is thought to be due to unstable substrate conditions, and cloudy waters due to sedimentation, which does not support coral growth. Buhari et al. (2021), stated that sedimentation that covers coral polyps can cause death to corals because it reduces the brightness of the waters and disrupts the physiological processes of corals, especially the process of photosynthesis, it also causes the corals to spend a lot of energy cleaning up the sediment.

The high percentage of Rubble (R) and Dead Coral (DC) found in this study is probably due to the fishing process using tools/materials that are not environmentally friendly, such as bombs and poison, which causes coral growth to be stunted and ecosystem destruction. This is supported by local community reports through personal interviews, that after the 1998 conflict in Maluku, communities on the coast of Leihitu-Salahutu often used explosives (bombs) to catch fish in the coral reef ecosystem. Zewanto et al. (2017) explained that coral rubble was identified as physical damage to coral, this, if left unchecked, will increase the percentage of coral fragments, which will result in increased damage to coral.Sand is also a threat to coral health because the particles from the component have the potential to close coral polyps, which will have an impact on the coral's foraging process. However, if they are swept away by the current, the sand will reduce the visibility of the waters and prevent the penetration of light into the waters, which will reduce the photosynthesis process of the symbionts of the corals (Nusaputro et al., 2019).

IV. CONCLUSION

The percentage of benthic substrate of coral reefs on the North Coast of Ambon Island to a depth of 3 meters is dominated by rubble with a percentage of 26.33% - 54.83%, and for a depth of 10 meters, the percentage value of ruble is 11.33% - 48.83% and sand (4% - 54.50%). The category of Acropora corals both at a depth of 3 meters and 10 meters dominated by Acropora branching (ACB), while the non-acropora category is dominated by Coral Branching (CB), Coral Encrusting (CE), and Coral Massive (CM) which are generally spread at Hila and Morella stations. The percentage value of HCL (*Hard Coral Live*) on the North Coast of Ambon Island is generally in the bad category, only the location of the waters of Hilla Village and Perarian Morella Village has a presentation value in the medium to good category.

REFERENCES

[1] Buhari, N., Himawan, M. R., Jefri, E., Paryono, P., Rahman, I., & Damayanti, A. A. (2021). Kondisi Terkini Presentase Tutupan Terumbu Pada Masa Pandemi Covid-19 di Gili Air, Taman Wisata Perairan Gili Matra, Nusa Tenggara Barat. ***Jurnal Sains Teknologi & Lingkungan***, 7(2), 238–247.

[2] Edrus.I.N., dan Syam. A. R., 1998, Sebran Ikan Hias Suku Chaetodontidae di Perairan Karang Pulau Ambon dan Peranannya Dalam Penentuan Kondisi Terumbu Karang**. *jurnal Panelitian Perikanan Indonesia***, Vol.1V No. 3.

[3] Eghbert.E.A, Camellia. K. T., Iis. T., Nuryani. W., Putu I., dan Mangku. M., 2021, Spot Rekrutmen Karang Pada Terumbu Buatan Bioreeftek Di Perairan Pesisir Desa Kerobokan, Buleleng, Balai Riset dan Observasi Laut, BRSDMKP, Kementerian Kelautan dan Perikanan.Jl. Baru Perancak, Negara- Jembrana, Bali 82251, Indonesia.

[4] English S, Wilkinson C, Baker V. 1997. Survey Manual for Tropical Marine Resources. 2nd edition. ASEAN-Australia Marine Science Project. AustralianInstitute of Marine Science, pp. 390.

[5] Erdana E, Pratikto I, Suryono CA dan Suryono. 2022. Hubungan Persentase Tutupan Karang Hidup dan Kelimpahan Ikan di Kawasan Konservasi Perairan Pulau Koon, Kabupaten Seram Bagian Timur, Provinsi Maluku. ***Journal of Marine Research***, 11(2):145-155.

[6] Hadi TA, Giyanto P, Hafizt M dan Suharsono AB. 2018. Status Terumbu Karang Indonesia. Puslit Oseanografi-LIPI, Jakarta, 19 hlm.

[7] Hukubun RD. 2020. Kondisi Terumbu Karang Di Perairan Pesisir Desa Amahusu (Batu Capeu) Kota Ambon. ***Jurnal Ilmu Kelautan dan Perikanan Papua***, 3(1):16-19.

[8] Isdianto A, Luthfi M, Irsyad M.J, Haykal M.F, Asyari I.M, Adibah F dan Supriyadi. (2020). Identifikasi Life Form dan Persentase Tutupan Terumbu Karang untuk Mendukung Ketahanan Ekosistem Pantai Tiga Warna. BRILIANT: ***Jurnal Riset dan Konseptual*** Volume 5 Nomor 4.

[9] Karmila,B.Sabarun,&Rahmadani. 2019. Jenis dan kepadatan rekrutmen karang berdasarkan bentuk pertumbuhan karang Scleractinia di perairan Desa Lalanu Kabupaten Konawe Sulawesi Tenggara. Sapa Laut, 4(3): 106-112.

[10] Kealoha AK, Doyle S M, Shamberger KEF, Sylvan JB, Hetland RD dan DiMarco SF. 2020. Localized hypoxia may have caused coral reef mortality at the Flower Garden Banks. *Coral Reefs*, *39*(1), 119–132.

[11] Keputusan Menteri Negara Lingkungan Hidup, No.4. 2001. Tentang Kriteria Baku Kerusakan Terumbu Karang.

[12] Obura, D. and G. Grimsditch. 2009. Resilience assessment of coral reefs: Rapid assessment protocol for coral reefs, focusing on coral bleaching and thermal stress. IUCN. Gland. Switzerland. 70 pp.

[13] Rafilu, A.H., B. Sadarun, & R.D. Palupi. 2020. Rekrutmen karang di Pulau Hari Kabupaten Konawe Selatan Sulawesi Tenggara. Sapa Laut, 5(1): 9-14.

[14] Sahetapy 2018a.Kekayaan Spesies Karang Batu Dan Kondisi Terumbu Karang Perairan Pesisir Dan Pulau-Pulau Kecil Provinsi Maluku.Dalam Buku:Pengelolaan Lingkungan dan Sumberdaya Laut,Pesisir dan Pulau-Pulau Kecil.Fakultas Perikanan dan Ilmu Kelautan Universitas Pattimura,Ambon.ISBN 978-602-53210-0-9:23 – 36.

[15] Sangaji M., 2017. Potensi dan Status Kerentanan Terumbu Krangan di Perairan Pelita Jaya Kabupaten Seram Bagian Barat Provinsi Maluku. ***Jurnal Biosel*** Vol.6 No.1: 26-35.

[16] Sarbini, R., Kuslani, H., & Nugraha, Y. (2016). Teknik pengamatan tutupan terumbu karang dengan menggunakan transek garis (line intercept transect) di Pulau Kumbang Kepulauan Karimun Jawa. Buletin Teknik Litkayasa, 14(1), 33–42.

[17] Sudarmaji,Efendy M.2021 Hubungan Persentase Penutupan Karang Hidup Terhadap Kelimpahan Ikan Karang di Perairan Pulau Noko Selayar Kabupaten Gersik**. *Juvenil: Jurnal Ilmiah Kelautan dan Perikanan***, 2(1): 39-46.

[18] Zewanto I, Nasir M dan Kurnianda V. 2017. Persentase Tutupan Karang di Pantai Ulee Kareung Kecamatan Simpang Mamplam Kabupaten Bireuen. Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah, 2(2):302-309.