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Dieting Pattern Of Refused Fish Type Of Non-Acropora Coral In Sempu Island Of Natural Reserves, Malang District

Guntur[1*], Defrian Marza Arisandi[2]

[1]Vice Dean of Student Affairs, Faculty of Fisheries and Marine Science, Brawijaya University

[1]Assoc Professor, Department of Marine Science, Faculty of Fisheries and Marine Science, Brawijaya University

[2]Department of Aquaculture Technique, Polytechnic of Marine and Fisheries Sorong

ORCID ID: 0000-0002-7039-4362

Abstract

Sempu Island Nature Reserve is a unique resource, because it is formed from the Atoll. The percentage of live coral coverin the Sempu Island Nature Reserve has increased over a period of two years. Based on the form of growth (lifeform) rock corals (scleractinian) are divided into two categories, namely Acropora and Non-Acropora corals. Acropora and Non-Acropora coral shave a difference in the structure of their skeleton. Reef fish are groups of fish that live in association with corals. One of the natural factors causing damage to coral reefs is bioeroders. One example of a bioeroder is corallivorous fish. The data taken in this study, namely oceanographic data, data on the condition of non-Acropora coral cover, and data on reef fish. Oceanographic data taken, namely, temperature, salinity, DO, pH, and brightness. Data on the condition of non-Acropora coral cover were taken using the Line Intercept Transect (LIT) method. Data on reef fish were taken using the Underwater Visual Census (UVC) method. Taking reef fish data is assisted by an underwater camera. Data processing is done using Ms. software. Excel 2016 and Minitab18. The condition of non-Acropora coral cover in Sempu Island Nature Reserve, Malang Regency is included in the damaged category with a percentage of 20.01%, because the water conditions are still not supportive for coral growth. The composition of reef fish found in Non-Acropora corals based on their diet in Sempu Island Nature Reserve, Malang Regency, is 79.51% herbivores, 9.29% carnivores, 10.16% corallivores, and 1.37% omnivores. The relationship between the percentage of non-Acropora coral cover and the amount of fish fed on the reef is very strong with a value of R2 = 0.9793, so that the percentage of non-Acropora coral cover and the amount of fish fed is directly proportional.

Keyword : Coral reef, Acropora, Conservation area

INTRODUCTION

Sempu Island is geographically located between 1120 40 '40 "- 1120 42' 45" east longitude and 80 27 "24" - 80 24 "25" south latitude. Sempu Island is administratively located in SendangBiru Hamlet, Tambakrejo Village, SumbermanjingWetan District, Malang Regency, East Java Province. Sempu Island is an area designated as a Nature Reserve site based on decree No. 46 Stbld which was signed when Indonesia was still under Dutch East Indies colonial rule (Sukistyanawati et al., 2016). Sempu Island Nature Reserve is a unique resource, due to its formation from Atoll (Sulistiyowati, 2009). Sempu Island Nature Reserve is a conservation area that has both a coast and a sea, so its existence needs to be protected. Sempu Island Nature Reserve has high natural resource potential, including mangrove forests, fish and coral reefs (Rahajeng et al., 2014).

Coral reefs are one of the ecosystems that have an ecological function as a habitat for marine life, including reef fish. The abundance of reef fish is directly proportional to the condition of the surrounding reefs. Good coral conditions will make reef fish abundant, if coral conditions are damaged, there will be fewer reef fish. Coral reefs can increase the abundance of reef fish by two mechanisms, namely providing shelter and providing food for reef fish that live around them. The existence of corals can also increase the biomass of reef fish that live around it (Manembu et al., 2012). The factors that cause damage to coral reefs are divided into two causes, namely by humans and nature (Guntur et al., 2018).

The potential of coral reefs can be assessed through two aspects, namely ecological aspects and economic aspects. Ecologically, coral reefs are a place to find food, a place to live, and a place for other biota to breed. In addition, the ecological aspect of coral reefs is to protect the coast from waves and abrasion. Meanwhile, economically, the coral ecosystem has aesthetic value so that it can be used as marine tourism. Marine tourism objects in an area that has a coral ecosystem can increase income for the surrounding community and increase state income. The high and low percentage of live coral cover greatly affects the living things around it (Guntur, 2011).

Based on the form of growth (lifeform) rock corals (scleractinian) are divided into two categories, namely Acropora and Non-Acropora corals. Acropora and Non-Acropora corals have a difference in the structure of their skeleton. Acropora corals have axial and radial corals. Non-Acropora corals only have radial coralite. Lifeforms that are included in the Acropora category, namely Acropora Branching, Acropora Tabular, Acropora Encrusting, Acropora Submassive, and Acropora Digitate.

Lifeforms are included in the Non-Acropora category, namely Branching, Massive, Encrusting, Foliose, Mushroom, Submassive, Meliopora, and Heliopora (English et al., 1997). The southern waters of Java are dominated by massive coral lifeforms, because they are directly adjacent to the Indian Ocean so that the currents are quite strong (Luthfi and Siagian, 2017). Each coral lifeform contains various types of associated reef fish.

One of the natural factors causing damage to coral reefs is bioeroders. Bioeroder is a marine biota whose activities can penetrate, erode, and weaken the framework forming the reefs (Tioho and Roeroe, 2002). One example of a bioeroder is corallivorous fish. Corallivorous fish (Chaetodontidae) can prey on more than 50% of coral polyps in a colony. A specific example of the corallivorus fish is Bolbometoponmuricatum. Bolbometoponmuricatum is a fish from the Scaridae family, Bolbometoponmuricatum is able to eat coral tissue as much as 15 kg per m2 in a year (Luthfi and Siagian, 2017).

METHODS

The research location is in Sempu Strait waters, Malang Regency, East Java. Data collection was carried out at three stations, namely station 1 is in KondangBuntung (front) which represents the western part of the strait, station 2 is in TelukSemut which represents the center of the strait, and station 3 is at WatuMeja which represents the eastern part of the strait. The research location and data collection station can be seen more clearly in Figure 1.

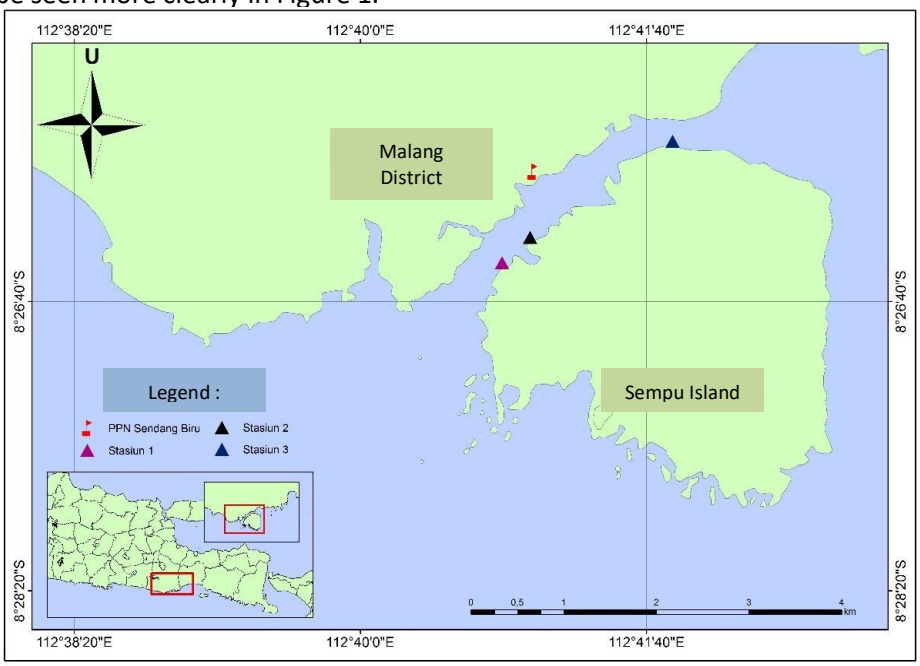

Figure 1. Research Location Map

The flow of research carried out in this study is divided into four stages. The first stage is data collection. The data taken were coral cover and reef fish species. The second stage is the preparation of data processing. The third stage is data processing. Data processing is done using Ms. software. Excel 2016 and Minitab18, which was continued in the fourth stage, was the creation of charts and reports. Retrieval of brightness data is done by using the secchi disk by dipping the secchi disk into the water until it is not visible for the first time and marking the sechi disk strap with D1, then pulling the sechi disk until it is visible first and marking the sechi disk strap with D2, after that calculate the brightness with the formula:

$$D=\frac{(D1+D2)}{2} \quad \text{.....} \quad (1)$$

Information:

D = Brightness(m)

D1 = The firsttimeisnowheretobeseen(m)

D2 = The firsttimeitseemed(m)

The data processing for the condition of non-Acropora coral cover was carried out using Ms. software. Excel 2016. On Ms. software In Excel 2016, data input on the types of corals obtained and coral length calculations were carried out. Coral length is calculated by subtracting the end point from the starting point. After the length of the corals is known, then the calculation of the percentage of Non-Acropora coral cover is carried out using Ms. Excel 2016 with the following formula (English et al., 1997):

$$ni = \frac{li}{L} \text{ x } 100\ \% \text{.....} \quad (2)$$

Information:

ni = Percentageofcoralcover (%)

li = The total lengthof a lifeform (cm)

L = Line transectlength (100 m)

Coral conditions are grouped into four categories, based on their live coral cover. The category of coral cover condition, namely damaged with a percentage of coral cover of 0-25%, moderate with a percentage of coral cover of 26 - 50%, both with a percentage of coral cover of 51 - 75%, and very good with a percentage of coral cover of 76 - 100 % (Gomez and Yap, 1988; Giyanto et al., 2017). The coral

Figure 2. Category Determination of Coral Conditions (Giyanto etal., 2017)

The statistical test method was carried out with the help of Ms. software. Excel 2016 and Minitab18. The statistical test methods used in this study are regression, correlation, and correlation determination.The variables used for statistical tests in this study were coral cover and amount of fish food. Thestatistical test method is carried out after carrying out the normality test to determine the normality of the data distribution used. Regression aims to determine the relationship or influence on variables. Correlation aims to me asure the closeness of the variables used. The determination of the correlation value aims to show the magnitude of the correlation value obtained. Riduwan (2003) Argues that the interpretation of the correlation coefficient is divided into five levels of the relationship based on the coefficient interval which can be seen in Table 1.

Table1. Interpretation of Correlation Coefficients (Riduwan, 2003)

RelationshipLevel	CoefficientInterval
VeryStrong	0,8 – 1
Strong	0,6 – 0,8
Enough	0,4 – 0,6
Low	0,2 – 0,4

VeryLow	0,4 – 0,1

RESULT

Condition of Coral Cover in the Sempu Strait

The condition of coral cover in the Sempu Strait is known through Landsat-8 satellite imagery by knowing the area of coral cover. The area of coral cover in the Sempu Strait obtained from the results of Landsat-8 satellite imagery, is 59.61 hectares. The area of coral cover at Station 1 was found to be 0.87 hectares in the medium condition category. The area of coral cover at Station 2 was found to be 0.35 Ha and the area of coral cover at Station 3 was obtained as wide as 0.16 Ha. Station 2 and Station 3 are in damaged condition. A clearer picture of the extent of coral cover can be seen in Figure 3.

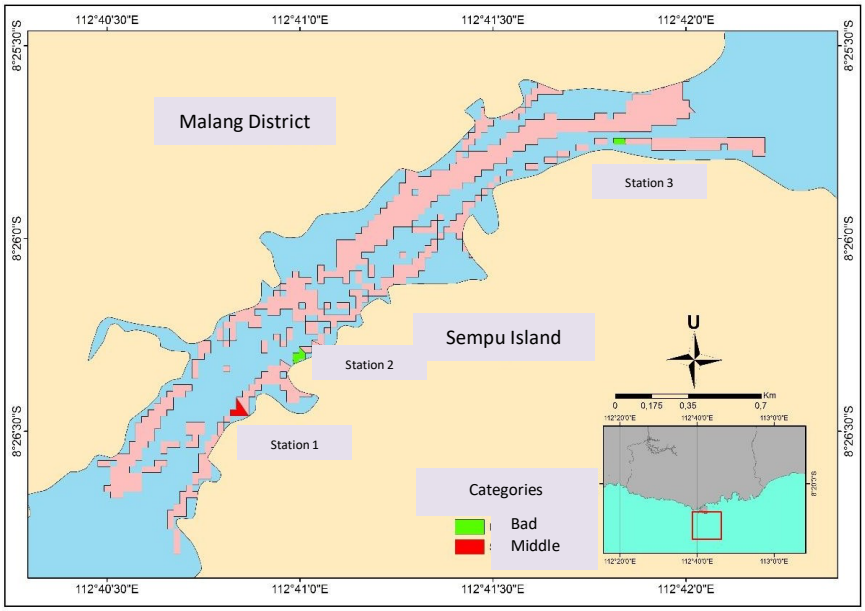

Figure 3. Coral Cover Area Map

Determination of the condition of coral cover is divided into four categories, namely damaged with a percentage of 0 - 25%, moderate with a percentage of 26 - 50%, both with a percentage of 51 - 75%, and very good with a percentage of 76 - 100% (Gomez and Yap, 1988; Giyanto et al., 2017). Water conditions are good for coral growth, namely water temperature 27-29 0C, salinity 30-36 ppt, DO ranges in the range of 6.7 ppm, and pH 7.5 - 8.4 (Giyanto et al., 2017; Wibawa dan Luthfi, 2017). The percentage of non-Acropora coral cover at station 1 was included in the moderate condition category with the

percentage of Non-Acropora coral cover at 31.54% with a coral cover area of 0.87 Ha. The percentage of coral cover at stations 2 and 3 is in damaged condition with the percentage of non-Acropora coral cover of 16.16% with a coral cover area of 0.35 Ha and 12.32% with a coral cover area of 0.16 Ha. The average percentage of non-Acropora coral cover included in the damaged condition with a percentage of 20.01% with a coral cover area of 1.38 Ha.

Condition of Non-Acropora Coral Cover Based on Observation Results

The condition of Non-Acropora corals was seen through the percentage of Non-Acropora coral cover. The calculation of the percentage of substrate cover is divided into three categories, namely Acropora, Non-Acropora, and Non-Living. The percentage of non-Acropora coral cover at each station has different results. Station 1 has a percentage of Acropora coral cover of 8.74%, Non-Acropora corals of 31.54%, and Non-Living of 59.72. Station 2 has a percentage of Acropora coral cover of 4.6%, Non-Acropora corals of 16.16%, and Non-Living of 79.24%. Station 3 has a percentage of Acropora coral cover of 2.12%, Non-Acropora corals of 12.32%, and Non-Living of 85.56%. The average coral cover of Acropora, Non-Acropora, and Non-Living at the three stations was 5.15%, 20.01%, and 74.84%. More clearly, the condition of Non-Acropora coral cover can be seen in Figure 6.

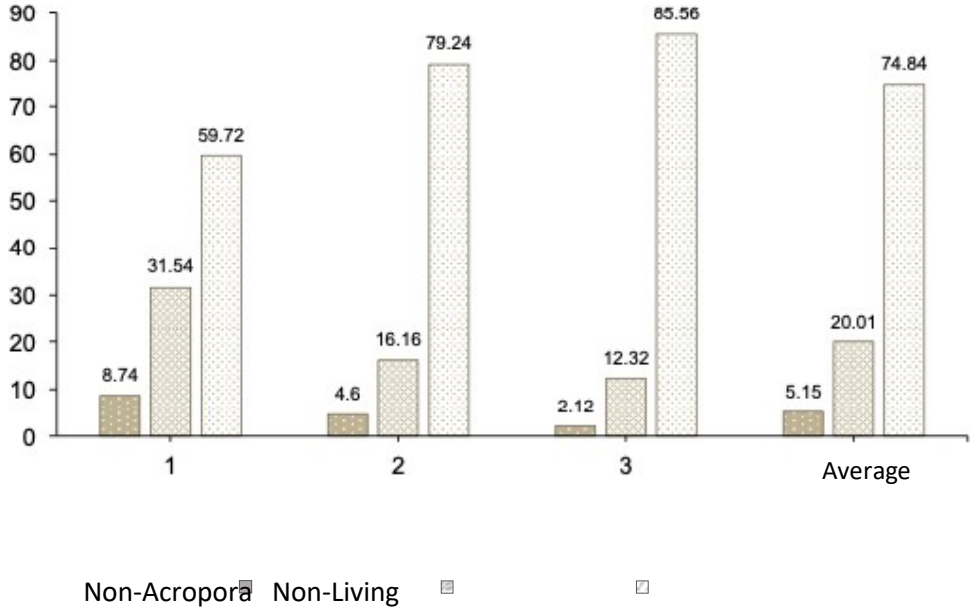

Figure 4. Composition of Reef Based on Their Diet

Composition of reef fish based on their diet

The composition of reef fish based on their diet is the number of reef fish classified based on their diet. The percentage of herbivorous fish has a range between 70% - 90%. Herbivorous fish with the highest percentage was at station 2 with a percentage of 89.55%, while the lowest was at station 3 with a percentage of 72.73%. Carnivorous and corallivorous fish have a percentage range between 4% - 14%. The highest percentage of carnivorous and corallivorous fish was found at station 3 with a percentage of 13.64%. Omnivorous fish are only found at station 1, the percentage of omnivorous fish at station 1 is 4.12%. The composition of reef fish based on their diet can be seen more clearly in Figure 5.

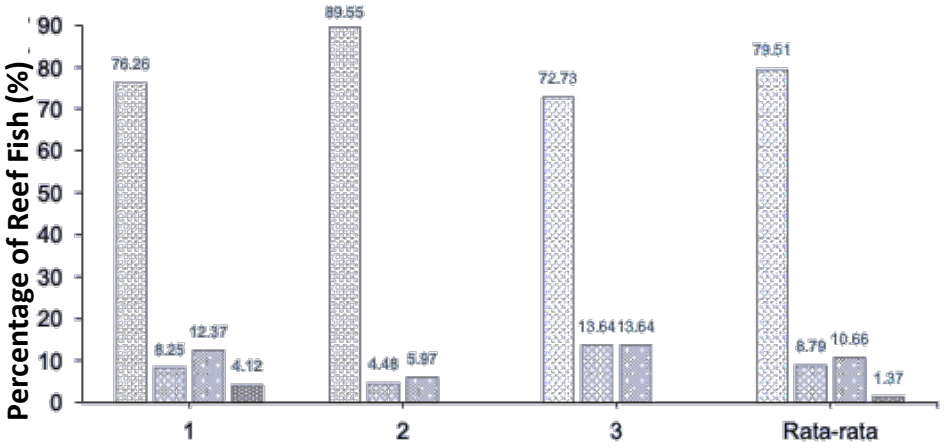

Figure 5. Composition of reef fish based on their diet

The composition of herbivorous fish at station 1 contained 6 species, namely Amblyglyphidodon curacao, Chromismargarifiter, Ctenochaetusbinotatus, Ctenochaetusstriatus, Pomacentrus chrysurus, and Zebrasoma scopas. The most species of herbivorous fish at station 1 were C. striatus with as many as 60 fish. There are four species of carnivorous fish at station 1, namely Aulostomus chinensis, Halichoereshortulanus, Halichoeresmarginatus, and Pomacanthussexfasciatus. Most species of carnivorous fish at station 1 were H. marginatus, with five fish. There are three species of corallivorous fish at station 1, namely Chaetodon lunulatus, Chaetodon unimaculatus, and Heniochusvarius. Most species of corallivorous fish at station 1 were C. lunulatus, with as many as six fish. The omnivorous fish found at station 1 is only Plectroglyphidodondickii with four fish.

The composition of herbivorous fish at station 2 contained 7 species, namely Acreichthystomentosus, A. curacao, Chantigastervalentini, C. binotatus, C. striatus, P. chrysurus, and Scarusghobban. The highest number of herbivorous fish at station 2 was C. striatus with 38 fish. There are two species of carnivorous fish at station 2, namely Epinephelusmera and Synodusdermatogenys. The largest species of carnivorous fish at station 2 were S. dermatogenys with two fish. The composition of corallivorous fish at station 2 contained three Chaetodontidae fish, namely C. citrinellus, C. guentheri, and C. vagabundus. Most species of corallivorous fish at station 2 were C. vagabundus with two fish. The composition of herbivorous fish at station 3 contained 6 species, namely A. curacao, C. valentini, Chlorurusbleekeri, C. binotatus, C. striatus, and P. chrysurus. The highest number of herbivorous fish at station 3 was C. striatus, with as many as six fish. There are three species of carnivorous fish at station 3, namely H. hortulanus, H. trimaculatus, and Plectorhinchusvittatus, with one species each. The composition of corallivorous fish at station 3 contained two Chaetodontidae fish, namely C. citrinellus and C. vagabundus. The most species of corallivorous fish at station 3 were C. citrinellus as many as two fish.

The composition of reef fish based on their diet is divided into four categories, namely herbivores, carnivores, corallivores, and omnivores (Rembet et al., 2011; Noble et al., 2014). The most composition of reef fish is found at station 1, because it has the largest percentage of coral cover. The species of reef fish that dominate at all stations are herbivorous fish. The most herbivorous fish at each station were the famliy Acanthuridae (C. striatus). The abundance of herbivorous fish is inversely proportional to the algae cover, if the herbivorous fish has a high abundance, the algae cover is low. Fish of the Acanthuridae family are herbivorous fish whose existence is influenced by the presence of algae (Ghiffar et al., 2017). According to the statement by Rudi and Fadli (2005), algae is the main food for herbivorous fish.

Prportion of Reef Fish in Each Colony

The proportion of consumption of reef fish at station 1 is divided into two forms of coral colonies, namely three colonies of Coral Foliose (CM) species Montipora sp. and two colonies of Coral Massive (CM) Porites sp .. Location of reef fish bite in the Colony of Montipora sp. and Porites sp. dominant being on the edge of the colony. The shape of the coral colonies and the feeding location of the reef fish can be seen more clearly in Figure 7. The proportion of eating the most reef fish was in colony 5 (Coral massive) with a total dietary amount of 263 bites. The proportion of eating reef fish in colony 5 was dominated by herbivorous fish as many as 261 bites. The least eating proportion of fish was found in

colony 2 (Coral Foiliose) with a total number of meals of 67 bites. The least eating proportion of reef fish in colony 2 is carnivorous fish with a total meal of 1 bite. More clearly, the proportion of consumption of reef fish at station 1 can be seen in Figure 6.

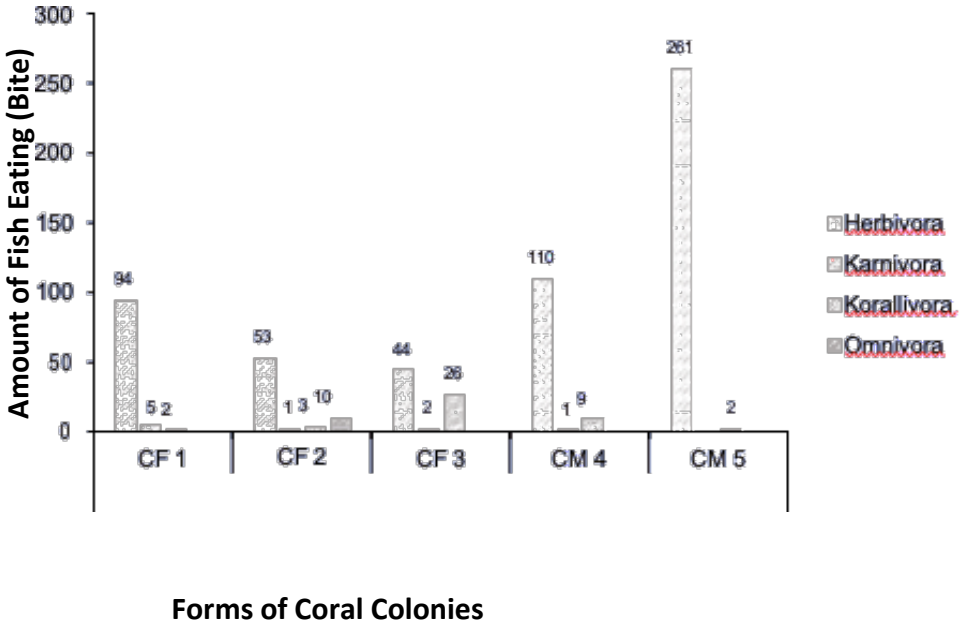

Figure 6. Proportion of Consumption of Reef Fish at Station

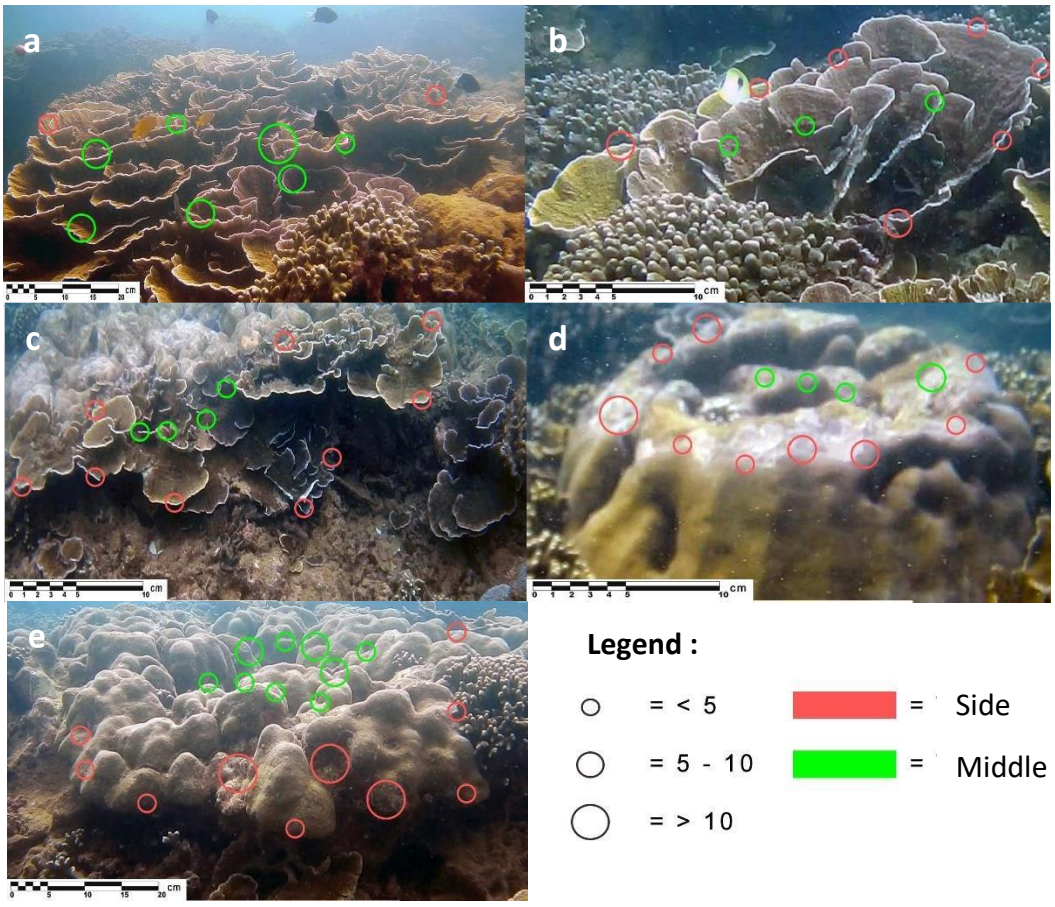

Figure 7. Form of Coral Colony and Location of Fish Bite at Station 1: 1) Coral Foliose (CF); 2) Coral Foliose (CF); 3) Coral Foliose (CF); 4) Coral Massive (CM); and 5) Coral Massive (CM).

The proportion of consumption of reef fish at station 2 has only one form of coral colony, namely Coral Massive (CM) with the type of Porites sp .. Location of reef fish bites in all colonies of Porites sp. at station 2 is on the edge of the colony. The shape of the coral colonies and the feeding location of the reef fish can be seen in Figure 11. The proportion of eating the most reef fish was in colony 4 with a total diet of 175 bites. The proportion of eating reef fish in colony 4 was dominated by herbivorous fish with 172 bites. The smallest proportion of fish food was found in colony 5 with a total number of meals of 44 bites. The eating proportion of reef fish in colony 5 was entirely by herbivorous fish. Furthermore, the proportion of consumption of reef fish at station 3 has only one form of coral colony, namely Coral Massive (CM) type Goniastrea sp. as many as two colonies and Porites sp. as many as three colonies. Location of reef fish bite in the colony of Goniastrea sp. and Porites sp. was on the edge of the colony.

The shape of the coral colonies and the feeding location of the reef fish can be seen more clearly in Figure 13. The proportion of eating the most reef fish was in colony 2 with a total diet of 16 bites. The eating proportion of reef fish in colony 2 was entirely by herbivorous fish. The proportion of eating the least fish was found in colony 4 with a total number of meals as much as 4 bites. The largest proportion of eating reef fish in colony 4 was by carnivorous fish with a total of 2 bites.

Correlation between Coral Cover and Amount of Fish Eating

The percentage of non-Acropora coral cover was calculated at three different stations and got different results. Station 1 has a percentage of Non-Acropora coral cover of 31.54%. Station 2 has a Non-Acropora coral cover of 16.16%. Station 3 has Non-Acropora coral cover of 12.32%. The amount of fish eating the reef fish also varies at each station. The number of eating coral fish at station 1 was 623. The number of eating coral fish at station 2 was 409. The number of eating coral fish at station 3 was 51. The relationship between Non-Acropora coral cover and the amount of eating reef fish can be seen more clearly in Figure 8.

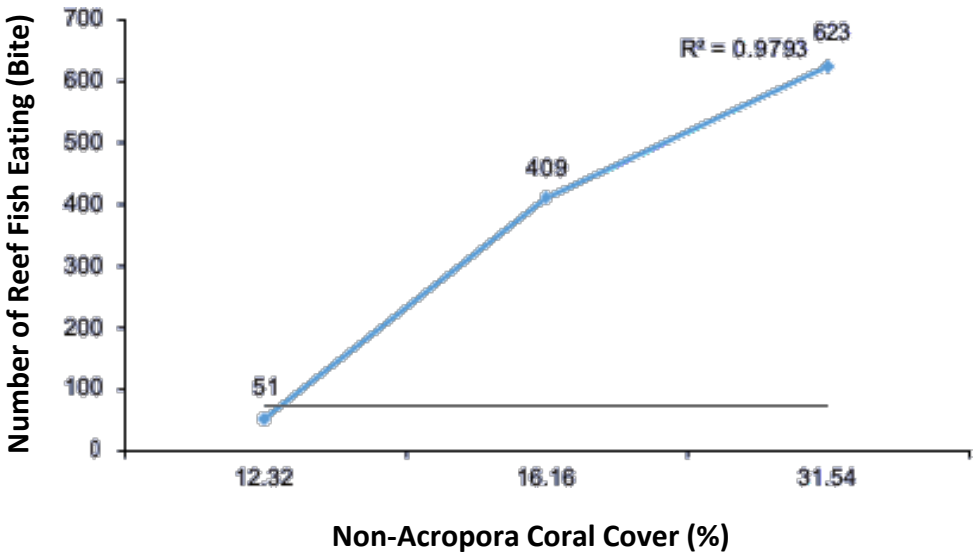

Figure 8. Correlation between Coral Cover and Amount of Fish Eating

The results of this study indicate the amount of feeding of different reef fish at each station. Each research station has a different percentage of Non-Acropora coral cover. Stations with a high percentage of Non-Acropora coral cover have large amounts of reef fish feeding. The results of the

regression test that have been carried out show that the value of R = 1. The R value obtained is greater than α = 0.05, thus indicating that there is a relationship between the percentage of Non-Acropora coral cover and the amount of fish eating on the reef. Correlation statistical test was conducted to measure the closeness of the relationship between the percentage of non-Acropora coral cover and the amount of fish fed on the reef. The results of the correlation test that have been carried out obtained r = 0.888. The r value obtained is in the interval 0.8 - 1, so it can be seen that the relationship between the percentage of Non-Acropora coral cover and the amount of fish feeding on the reef is very strong. The results of the correlation test of determination obtained R2 = 0.9793, if the R2 value is closer to number 1, the relationship between the two variables is getting stronger. The relationship between Non-Acropora coral cover and the amount of fish fed on the reef can be concluded very strongly through the results of statistical tests that have been carried out. The largest number of fish that eat reef fish is herbivorous fish. The high cover of Non-Acropora corals can be influenced by several factors, one of which is low algae cover. High algae cover affects the diet of herbivorous fish, so the abundance of herbivorous fish affects the percentage of non-Acroporous coral cover. Herbivorous fish abundance has a negative correlation with algal cover, but has a positive correlation with coral cover (Mumby et al., 2006). According to the statement of Keith et al. (2018), the percentage of coral cover and the amount of fish feeding on the reef is directly proportional.

Statistical Test Results

The statistical test in this study was carried out by three methods, namely regression, correlation, and correlation determination. The regression test was conducted to determine the relationship or influence on the variable and obtained an R value of 1. Correlation test was carried out to measure the closeness between variables and obtained an r value of 0.888. The correlation determination test was carried out to display the magnitude of the correlation value and the R2 value was 0.9793. The results of statistical tests in this study can be seen more clearly in table 2.

Table 2. Statistical Test Results

Statistic Test	Result
P-Value	0,304
Regresi (R)	1
Korelasi (r)	0,888
Determinasi korelasi (R^2)	0,9793

Source : Results of Researchers' Process

CONCLUSION

The conclusion that can be drawn from research on the dietary pattern of reef fish species found in non-acropora corals in Sempu Island Nature Reserve, Malang Regency, is that the condition of non-Acropora coral cover in Sempu Island Nature Reserve, Malang Regency is categorized as damaged, due to water conditions still less support for coral growth. Furthermore, the composition of reef fish found in Non-Acropora corals based on their diet in Sempu Island Nature Reserve, Malang Regency, namely 79.51% herbivores, 9.29% carnivores, 10.16% corallivores, and 1.37% omnivores. The last one is the relationship between the percentage of non-Acropora coral cover and the amount of fish feeding on the reefs is directly proportional, so that the higher the percentage of coral cover, the more the amount of coral fish feeds.

REFERENCE

English, S.A., Wilkinson, C., Baker, V., 1997. Survey Manual for Tropical Marine Resources. Townsville: AIMS.

Ghiffar, M.A., Irham, A., Harahap, S.A., Kurniawaty, N., Astuty, S., 2017. HubunganKondisiTerumbuKarangdenganKelimpahanIkanKarangTarget Di Perairan Pulau Tinabo Besar, Taman Nasional Taka Bonerate, Sulawesi Selatan. JurnalSpermonde. Vol. 2 No. 3: 17-24.

Giyanto,Abrar,M.,Hadi,T.A.,Hafizt,M.,Salatalohy,A.,Iswari,M.Y.,2017.Status Terumbu Karang Indonesia. Jakarta: PuslitOseanografi -LIPI.

Gomez, E.D., Yap, H.T., 1988. Monitoring Reef Condition. In Kenchington R A and Hudson B E T (ed). Coral Reef Management Hand Book. Jakarta: UNESCO Regional Office for Science and Technology for South East Asia.

Guntur. 2011. Ekologi Karang pada Terumbu Buatan. Bogor: Ghalia Indonesia.

Guntur, Sambah, A.B., Jaziri, A.A., 2018. RehabilitasiTerumbuKarang. Malang: UB Press.

Keith, S.A., Baird, A.H., Hobbs, J.-P.A., Woolsey, E.S., Hoey, A.S., Fadli, N., Sanders, N.J., 2018. Synchronous Behavioural Shifts in Reef Fishes Linked to Mass Coral Bleaching. Nature Climate Change. Vol. 8 Hal: 986 - 991.

Luthfi,O.M.,Siagian,J.A.,2017.MonitoringofCorallivorousFish'sBitesonPorites lobata at South Java Sea, Indonesia. International Journal of Applied Enviromental Sciences. Vol. 12 No. 1: 145 -154.

Manembu, I., Adrianto, L., Bengen, D.G., Yulianda, F., 2012. Distribution of Coral Reefs and Fish in Buyat Bay Area Reef Ball Southeast Minahasa Regency. JurnalPerikanan dan KelautanTropis. Vol. 8 No.1: 28 - 32.

Mumby, P.J., Dahlgren, C.P., Harborne, A.R., Kappel, C.V., Micheli, F., Brumbaugh, D.R., Holmes, K.E., Mendes, J.M., Broad, K., Sanchirico, J.N., Buch,K.,Box,S.,Stoffle,R.W.,Gill,A.B., 2006.Fishing,TrophicCascades, and the Process of Grazing on Coral Reefs. Science. Vol. 311 No. 5757:98–101.

Noble, M.M., Pratchett, M.S., Coker, D.J., Cvitanovic, C., Fulton, C.J., 2014. Foraging in Corallivorous Butterflyfish Varies with Wave Exposure. Coral Reefs. Vol. 33 No. 2: 351 -361.

Rahajeng, M.A., Hendrarto, B., Purwanti, F., 2014. Pengetahuan, Persepsi dan Partisipasi Masyarakat dalam Konservasi di Kawasan Cagar Alam PulauSempu Kabupaten Malang. Diponegoro Journal of Maquares. Vol. 3 No. 4: 109 - 118.

Rembet, U.N., Boer, M., Bengen, D.G., Fahrudin, A., 2011. Struktur Komunitas Ikan Target di TerumbuKarangPulauHogow dan Putus-Putus Sulawesi Utara. Jurnal Perikanan dan Kelautan Tropis. Vol. 7 No. 2: 60 - 65.

Riduwan, 2003. Dasar-Dasar Statistika. Bandung: Alfabeta.

Rudi, E. dan Fadli, N., 2005. Kondisi Terumbu Karang di Perairan Sabang Nanggroe Aceh Darussalam setelah Tsunami. Jurnal Ilmu Kelautan. Vol. 10 No. 1: 50 - 60.

Sukistyanawati, A., Sepiastini, W., Makmun, S., Andriyono, S., 2016. Analisis Vegetasi Hutan Pantai, Hutan Tropis Daratan Rendah dan Ekosistem Mangrove di Cagar Alam Pulau Sempu. Journalof Marine andCoastalSciences. Vol. 5 No. 1: 22 - 35.

Sulistiyowati, H., 2009. Biodiversitas Mangrove di Cagar Alam Pulau Sempu.Jurnal Saintek. Vol. 8 No. 1: 59 - 61.

Tioho, H., Roeroe, K.A., 2002. Kerusakan Terumbu Karang Akibat Proses Biologis.Jurnal Ekoton. Vol. 2 No. 1: 55 – 59.