RELATIONSHIP OF CORAL REEF COVER WITH REEF FISH ABUNDANCE IN THE WATERS OF MIANG ISLAND, SANGKULIRANG, KUTAI EAST, EAST KALIMANTAN

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ABSTRACT

Miang Island is located at coordinates 118° 0' 20" E - 0° 44' 0" N, which is administratively in Sangkulirang District, East Kutai Regency, East Kalimantan. Coral reefs on Miang Besar Island have an area of ± 218.8 ha, with the best coral cover in the waters of Sangkulirang District and one of the best in East Kutai Regency. Reef fish have an active role in coral reef ecosystems because they can be indicators of the health of coral reef ecosystems and can measure the level of suitability of their habitats. If the condition of the coral is damaged, the number of reef fish that inhabit it will decrease because the habitat does not meet the availability of food ingredients and the loss of breeding grounds. Coral reef data retrieval using the UPT method and reef fish using the UVC method. The percentage of coral cover on Miang Island is in the moderate to a bad category where the average percentage of cover is 21% which is in poor condition (<25%). The total abundance of fish at station 1 was 0.45 ind./m^3, station 2 was 0.10 ind./m^3, station 3 was 0.06 ind./m^3, and station 4 was 0.09 ind./m^3. The genus Acropora is the dominant coral genus at all stations, and the Pomacentridae family is the dominant family of reef fish at all stations. The relationship between the percentage of coral cover and the abundance of reef fish is very strong, with an R^2 value of 72.13%.

Keywords: *Miang Island, Coral Cover, Reef Fish Abundance, UPT, UVC*

1. INTRODUCTION

Indonesia is an archipelagic country that is high species richness and endemicity on coral and reef fish (Asaad et al., 2018). One of them is the coral reef ecosystem which has a large area which reaches approximately 60,000 km^2. The coral reef ecosystem is a habitat for 1,511 species in 451 genera and 111 families (Gerald R Allen & Erdmann, 2009). One of the active biomes in coral reef ecosystems is reef fish. Reef fish make coral reef ecosystems a place to live, find food, and breed.

Reef fish have an active role in coral reef ecosystems by acting as bioindicators of coral reef ecosystem health. The presence of certain types of reef fish in a coral reef ecosystem is an accurate indication of the health condition of the ecosystem, for example, fish species from the target group of fish and butterflyfish where the presence of these two types of fish indicates a coral reef ecosystem in a healthy condition (Obura & Grimsditch, 2009). In addition, reef fish also play a role in the formation of new sediments, which are important nutrients for various invertebrates by bioeroding the structure of the coral skeleton (Glynn & Manzello, 2015). Reef fish also control the number of algae in substrate because it allows coral to grow fast to expand their colonies (McClanahan & Arthur, 2001).

The condition of coral reefs will affect the diversity of reef fish. Pratchett & Berumen, (2008) stated that coral reef ecosystems will affect the diversity of reef fish in it, because coral reefs function as shelters and foraging locations. The abundance of reef fish is highly dependent on the condition of coral reefs and the complexity of the habitats that exist in the ecosystem (Bell & Galzin, 1984; McClure et al., 2021). Allen & Adrim, (2003) stated that the presence of fish in coral reef areas is strongly influenced by physical variables

(coral reef conditions and the environment). If the condition of the coral has been damaged, the species of reef fish that inhabit it will be fewer because their habitat does not meet the availability of food and breeding grounds (Hempson et al., 2017).

Miang Island (118° 0' 20" E - 0° 44' 0" N) which is administratively in Sangkulirang District, East Kutai Regency, East Kalimantan. The area of Miang Island is about 7.39 km^2 with a coastline length of approximately 11.73 km (Irawansyah et al., 2019). Coral reefs on Miang Island have an area of ± 218.8 ha, with the best status of coral reef condition or hard coral cover in the waters of Sangkulirang District and one of the best in East Kutai Regency. In addition, in the northwest part of Miang Island, there are several small clusters of coral reefs with a patch reef formation type with conditions similar to those found on Miang Besar Island (Yasser, 2013). There are not many studies on the topic of coral reefs on this island, so there is no information on the distribution of corals and reef fish. This study aims to determine the relationship between reef fish distribution and live coral cover on Miang Island, to provide initial information on the condition of coral reefs as a whole and comprehensively.

2. METHODS

2.1 Research Time and Place

This research was carried out on Miang Besar Island, East Kalimantan on 28 April – 3 May 2018. This location was chosen because this island has the best coral reef cover in Sangkulirang District and one of the best in East Kutai Regency (Yasser, 2013), but still not much research has been done on this island. The location of the study was carried out at 4 points, namely in the North (St.1), West (St.2), East (St.3), South (St.4) of Miang Island which is considered to have represented the entire island. Station 1 is at coordinates (N 00°58,816', E 117°58,538'), station 2 is at coordinates (N 00°43,839', E 117°59,551'), station 3 is at coordinates (N 00°43,901', E 118°01.385'), station 4 is at coordinates (N 00°43.044', E 118°01.172'). The sampling point can be seen in Figure 1.

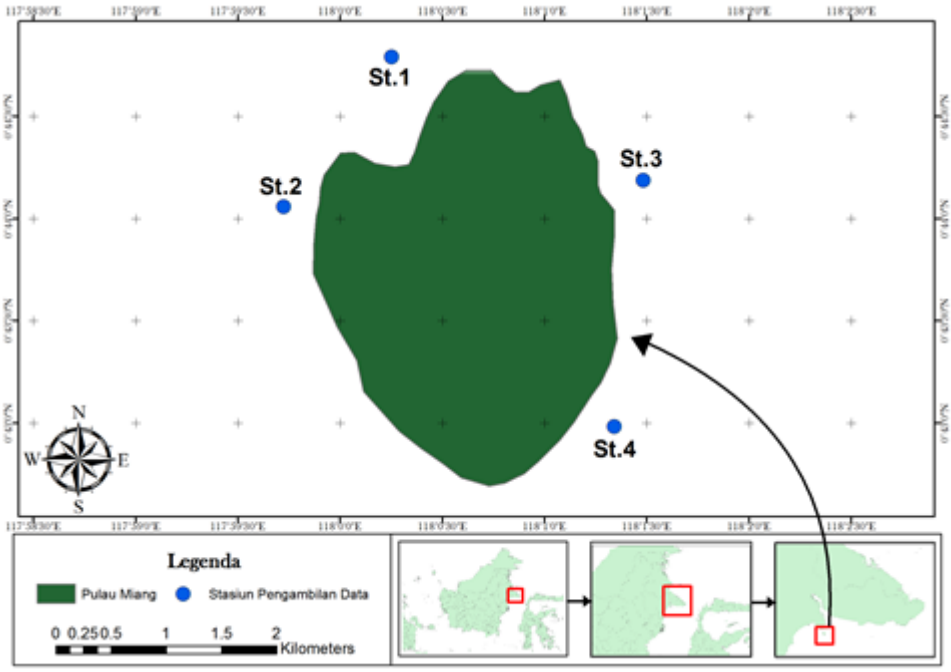

Figure 1. Sampling Point Location

2.2 Data retrieval

The data ??? in this study used two methods, Underwater Photo Transect (UPT) for coral data collection, then Underwater Visual Census (UVC) for reef fish data collection.

The UPT method has been carried out by photographing coral reefs under a quadrant transect (1x1 m) along 100 m parallel to the shoreline. In the transect, the 1x1m quadrants has been divided into four parts with a size of 50x50cm. The photos from the shooting were then analyzed using computer software to obtain quantitative data (Image J and CPCe). (Malinda et al., 2020; Sauri et al., 2019).

Underwater Visual Census is a method that combines fish counting and monitoring techniques. This method has two techniques; the first is to detect differences in organisms using the abundance method. The second technique, counting individuals to perform visuals, where this technique requires a minimum of two divers. Each diver counts the number, size and species of fish in front and above. In this study, each diver brought an underwater camera to record fish during the study. Using this method, the abundance, diversity, and biomass of reef fish on a coral reef will be obtained (Komyakova et al., 2018). Fish that have been identified are recorded directly on the slate while some fish species that have not been identified will be identified referring to the manual after data collection is complete. Identification of reef fish refers to books (Allen & Erdmann, 2012; Kuiter & Tonozuka, 2001).

2.3 Data analysis

The percentage of live coral cover was calculated based on the equation proposed (Giyanto et al., 2014), with the formula:

$$PTK = \frac{JAKT}{LAFF} \times 100\% \quad \text{.....(1)}$$

Where:

PTK = Category Coverage Percentage
JAKT = Number of Areas of the Category
LAFF = Photo Frame Area

According to (Halford & Thompson, 1994), that the abundance of fish found per unit transect and calculated using the formula:

$$Xi = ni/A \quad \text{.....(2)}$$

Where:

Xi = The abundance of the i-th type of fish (individu/m^3)
ni = Number of fish type i
A = Observation transect area

The relationship between the percentage of coral reef cover and the abundance of reef fish was analyzed by simple linear regression, where the percentage of live coral cover was the independent variable (X) and the abundance of reef fish was the dependent variable (Y), with the formula :

$$Y = a \pm bX \quad \text{.....(3)}$$

Where:

Y = Variables are not free
X = Free variable
a = Constant
b = Tilt

According to (Irianto, 2016), that the relationship between the two variables can be seen based on the coefficient value (r). If the coefficient value is close to +1, the relationship between the two variables is positive, on the other hand, if the coefficient value is -1, the relationship between the two variables is very weak or may not exist at all.

3. RESULT AND DISCUSSION

3.1.1. Water qualities

Several oceanographic physicochemical parameters were quantified in situ, they are salinity, pH, temperature, current, and DO (Dissolved Oxygen) using a salinometer equipped with a temperature meter (thermometer), pH meter, current meter, and DO meter respectively. The results of the measurement of the physical and chemical parameters of the waters can be seen in Table 1.

Table 1. Physical and Chemical Parameters

St.	Salinity (ppt)	Temperature (°C)	pH	DO (ppm)	Current (m/s)
1	33,0	31,0	8,9	6,64	0,1
2	32,8	31,2	8,8	8,94	0,2
3	31,1	30,0	8,5	6,02	0,2
4	33,0	30,2	8,6	5,62	0,1

Parameter measurement results have shown that the highest water salinity is found at stations 1 and 4 of 33 ppt and the lowest is at station 3 of 31.1 ppt with an average salinity of 32.5 ppt from all stations. Meanwhile, the highest water temperature was found at station 2 at 31.2°C and the lowest at station 3 at 30°C with an average temperature of 30.6°C from all stations. The highest pH was found at station 1 of 8.9 and the lowest was at station 3 of 8.5 with an average pH of all stations of 8.7. The highest DO was found at station 2 of 8.94 ppm and the lowest was at station 4 of 5.62 ppm with an average DO of all stations of 6.81 ppm. The highest current velocity was found at stations 2 and 3 of 0.2 m/s and the lowest was at stations 1 and 4 of 0.1 m/s with an average current velocity of 0.15 m/s from all stations.

Based on Table 3, it can be seen that the average salinity value is 32.5 ppt, temperature is 30.6°C, pH is 8.7, DO is 6.81 ppm, and current is 0.15 m/s. This salinity value still shows normal limits for coral growth. Corals and other reef organisms can live with salinity limits of 25-40 PSU (Coles & Jokiel, 2018; Jokiel, 2004). Water temperature is very important for the survival of the metabolism of coral and reef fish. Corals have symbionts called zooxanthellae, where if the water temperature is above one degree average of the warmest temperature in a year, the symbionts will die and cause coral bleaching (Baird et al., 2018; Coles & Jokiel, 2018; Jokiel, 2004). Optimal coral growth occurs at a pH value of 6-8 but the fastest growth occurs at a pH value of 7 (McCulloch et al., 2012). The DO value in a waters has a relationship with other parameters, where when there is an increase in temperature there will be a decrease in DO levels, and when there is an increase in salinity, DO will also increase (Rixen et al., 2012). Ocean currents that affect the characteristics of waters in Indonesia are ocean currents generated by wind and tides and the presence of currents is very important for marine biota because it can function as nutrient transport and larvae or juveniles (Pratchett et al., 2017).

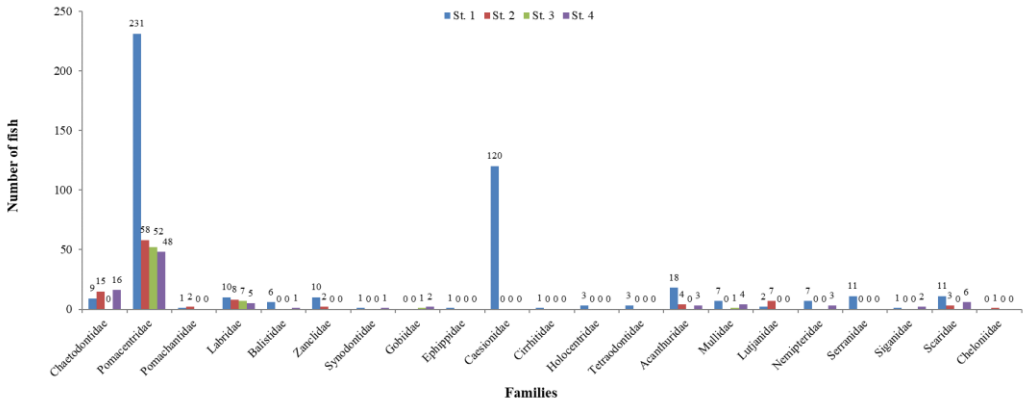

Figure 2. Distribution of Reef Fish at Stations 1, 2, 3, and 4.

3.1.2. Abundance of Reef Fish

The results showed that the total surveyed reef fish were 705 fish which were divided into 21 families. The total number of reef fish that have been obtained from station 1 is 453 fish, station 2 is 100 fish, station 3 is 61 fish, and station 4 is 91 fish. The total abundance of fish at station 1 was 0.45 individuals/m^3, station 2 was 0.10 individuals/m^3, station 3 was 0.06 individuals/m^3, and station 4 was 0.09 individuals/m^3. The most common reef fish species were from the Pomacentridae family with a total of 231 fish at station 1, 58 fish at station 2, 52 fish at station 3, and 48 fish at station 4. The families with the least number of fish were the Ephippidae and Cirrhitidae families with 1 fish at station 1 for families Ephippidae and Cirrhitidae and not found at stations 2, 3, and 4. The graph of reef fish distribution by station can be seen in Figure 2.

The percentage of live coral cover on Miang Island at each station was very different from one another, the highest live coral cover at station 1 (45%) and the lowest at station 3 at 8%. There are 31 genera of corals that have been surveyed from a depth of 5 and 10 m from all stations. While the total coral colonies that have been monitored at station 1 are 1,319 colonies, station 2 are 491 colonies, station 3 are 279 colonies, and station 4 are 804 colonies. The genus Acropora dominates corals with a percentage of 60% at station 1.55% at station 2, 86% at station 3, and 81% at station 4, while the lowest percentage of coral reefs is the genus Anacropora with a percentage of 0.01% at station 4 and not found at stations 1, 2, and 3. The results of the percentage of coral cover can be seen in Figure 3.

The abundance of reef fish found on Miang Island consisted of 88 species from 21 different families with a total of 705 individuals. The abundance of reef fish was dominated by the families Pomacentridae and Caesionidae. According to (Sale, 2013), the Pomacentridae and Labridae families are the most dominant fish in coral reef ecosystems, especially in the tropics because these two families are temperate fish species. The cause of the high abundance of fish from the Pomacentridae family is the condition of the coral reefs which are still classified as very good for the Pomacentridae family, especially for *C. viridis* species where this fish species likes to interact with branching corals, especially the Acropora genus (Allen & Erdmann, 2012). The cause of the high abundance of fish from the Caesionidae family is thought to be due to the habit of this family, these fish have a habit of swimming in groups (schooling) so that when data collection is carried out they come in large groups. The Caesionidae family is a zooplankton feeder in the water column which is commonly found in coral reef ecosystems. The schooling habit of this group of fish sometimes becomes the object of photography for divers because sometimes they crowd around divers in such large numbers that they almost cover the surrounding seascape (Allen & Erdmann, 2009).

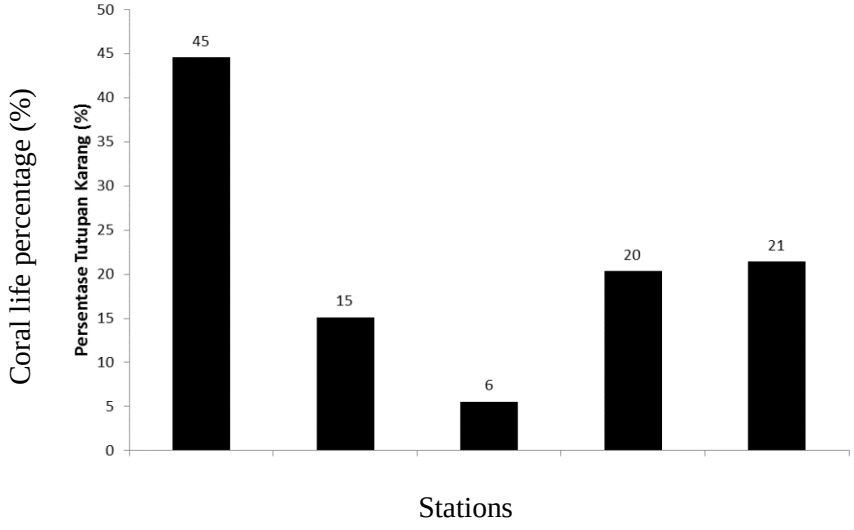

Figure 3. Percentage of Coral Cover

3.1.3. Coral Reef Coverage Relationship with Reef Fish Abundance

The results of the Simple Linear Regression Test have been used to determine the effect of the percentage of coral reef cover on the abundance of reef fish with the results of R^2 = 0.7213. These results indicate a strong influence between live coral cover and reef fish abundance of 72.13%. In this study, coral cover was dominated by the genus Acropora and the abundance of reef fish was dominated by the family Pomacentridae, as said by Allen & Erdmann, (2012), that the family Pomacentridae has a very close relationship with branching corals, especially from the genus Acropora. The linear regression plot of the relationship between the percentage of live coral cover and the abundance of reef fish is presented in Figure 4.

Coral reef cover in the waters of Miang Island has decreased, this is based on previous research conducted by (Yasser, 2013) Miang Island waters have coral cover of 47.5% which is in the medium category. This change could be due to several things, such as the location of the stations being not the same or perhaps due to environmental factors that did not provide support for coral growth. Environmental factors that cause the decline in live coral cover are, such as: high competing biota such as macro algae, sponges and soft corals, low recruitment of corals, unstable aquatic substrates, high sedimentation, and rising global CO_2 concentrations (Irawansyah et al., 2019). The high macroalgae cover and the low number of algae-eating fish (herbivores) hinder the attachment of coral planula to the substrate and make the recruitment value low (Hoey et al., 2011). Damage to coral reefs can also be caused by natural factors such as climate change which can cause corals to experience bleaching, which has an impact on the future of coral reefs (Hoegh-Guldberg et al., 2017).

The abundance of coral reefs is dominated by the genera Acropora and Porites. According to (Yasser, 2013), the dominant coral species on Miang Island are Acropora and Montipora (Acroporidae family) and Porites (Poritidae family). Indonesia, which is located in the Coral Triangle area, has 91 species of Acropora diversity (Wallace & Muir, 2005). The abundance of Acropora in a waters is also influenced by the sexual reproduction pattern of the coral, where several species release eggs and sperm at the same time, so it is possible

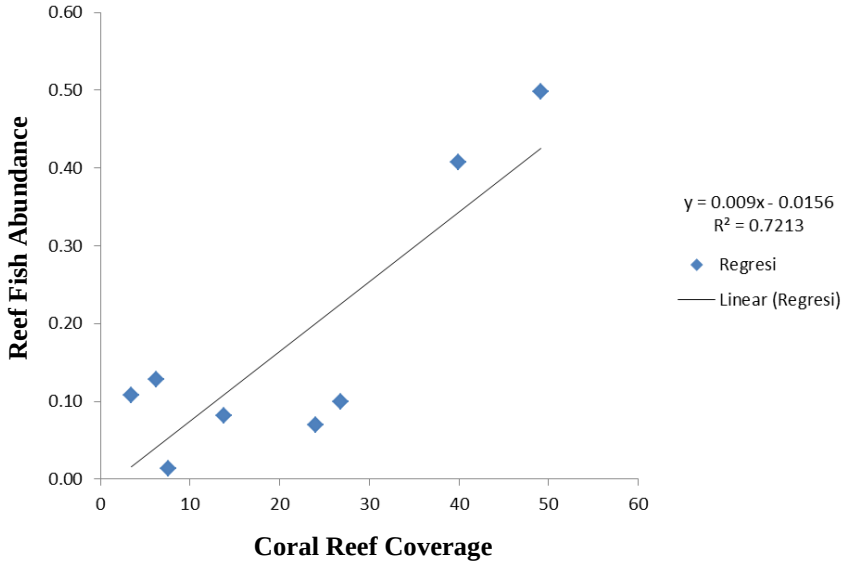

Figure 4. Linear Regression Statistical Test

that the dominance of this species is obtained from the number of corals in small or juvenile forms (Fukami et al., 2000).

The results obtained from the Simple Linear Regression Statistics test show the value of $R^2 = 0.7213$, this relationship can be assumed the greater the percentage of coral cover the better the abundance of reef fish. According to Sale, (1991), that the biota that live in coral reef areas is a community that comes from a collection of various organisms with close dependence on each other. In addition, the factor of food availability, safe shelter and the lack of predators in the coral reef area is thought to play a role in the high distribution of reef fish with high live coral cover.

4. CONCLUSION

The results showed that the hard coral cover on Miang Island greatly affected the abundance of fish in that location. Coral reef ecosystems consist of many elements: biotic and abiotic. This dependence of one element on another is what is then called the dynamics of the ecosystem. The abundance of reef fish in coral reef ecosystems, apart from being influenced by the presence of live coral, is certainly influenced by other factors not examined in this study, could be a source of food such as plankton, algae and possibly looking for a mate. Many reviews on these factors have been written by other researchers. So that the author's suggestion is that this research is perfect, it is necessary to conduct a wider study that focuses on more specific factors and longer research so that the data obtained is more accurate.

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