Volume 11, No. 1, 2018

ISSN: 1907-9931 (print), 2476-9991 (online)

DIFFERENCES OF CORAL REEF AND CORAL COMMUNITY FISH ABUNDANCE CONDITION BASED ON ZONING OF BENGKOANG ISLAND, KARIMUNJAWA

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Submitted: 06 Maret 2018 / Revised: 02 November 2018 / Accepted: 02 November 2018

http://doi.org/10.21107/jk.v11i1.3709

ABSTRACT

Bengkoang Island is an unpopulated island in the northern region of the archipelago. The island is divided into 2 zones, Marine Protection Zone and Marine Tourism Utilization Zone, based on the zoning and management plan of the Karimunjawa National Park, Central Java. This research is aimed to observe the condition of the coral reef and coral community fish abundance in Bengkoang Island based on the zoning. There were 2 stations to represent each of the zones at depths of 5 and 10 meters. Line Intercept Transect (LIT) method was used along 100 meters to data the reef substrate and Visual Census method with Belt Transect was used to data the coral community fish. The result showed that the coral cover was the highest in Station 1 at 5 m which was located in the Marine Protection Zone with 80,31%, while the lowest was found in Station 2 at 10 m which was located in the Marine Tourism Utilization Zone with 18,81%. Meanwhile, the coral community fish abudance was the highest in Station 1 at 10 m with 15.600 individual/ha and lowest in Station 2 at 10 m with 4.280 individual/ha. Based on the result, it can be said that the condition of the coral reef ecosystem in Bengkoang Island varies with a high margin between the data stations. The result indicated that the coral reef ecosystem in the Marine Protection Zone was in a better condition than in the Marine Toursim Utilization Zone.

Key Words: *Karimunjawa, Bengkoang Island, Zoning, Coral Reef, Coral Fish*

INTRODUCTION

Indonesia is an archipelagic state that has a high marine biodiversity. Indonesia is known to have an abundant diversity of coral reef and fish, including pelagic and coral community fish. Coral reef is spreaded across Indonesian waters, where it is mostly found in the central and eastern region (Veron, 2000).

Karimunjawa is one of the established marine protected areas (MPA) in Indonesia. It has the highest biodiversity of marine ecosystem anywhere across the Northern Java Sea (Sulisyati *et al.*, 2014). The coral reef ecosystem in Karimunjawa has a great economical potential. Coral community is one of the top sources of income for the locals and the coral reef itself is a tourism appeal. Bengkoang Island is located in the northern region of Karimunjawa. The island is divided into 2 zones: Marine Protection Zone, designated as a protected area for species, habitats, or ecosystems that support the function of the Main Zone, and Marine Tourism Utilization Zone, designated as an environment-based tourism area that can support the development of tourism and natural recreation (Men. LH No.28/2012).

With the constantly developing marine tourism sector and the increasing number of tourists in Karimunjawa, the activities in the coral reef ecosystem is affected. One of which is in Bengkoang Island that has the Marine Tourism Utilization Zone. The study of coral reef and reef fish structure was conducted to determine the condition of coral reef ecosystem based on the percentage of coral cover, abundance of coral community fish, and its ecological index to review the level of efectiveness of the zonation in Bengkoang Island. The result of this research can help the governemnt to determine policies as an effort for coral reef conservation.

MATERIAL AND METHOD

The research was conducted in November 2017 in Bengkoang Island, Karimunjawa Archipelago, Jepara Regency. Data was taken in 2 stations representing 2 different zones: Marine Protection Zone and Marine Tourism Utilization Zone (Figure 1).

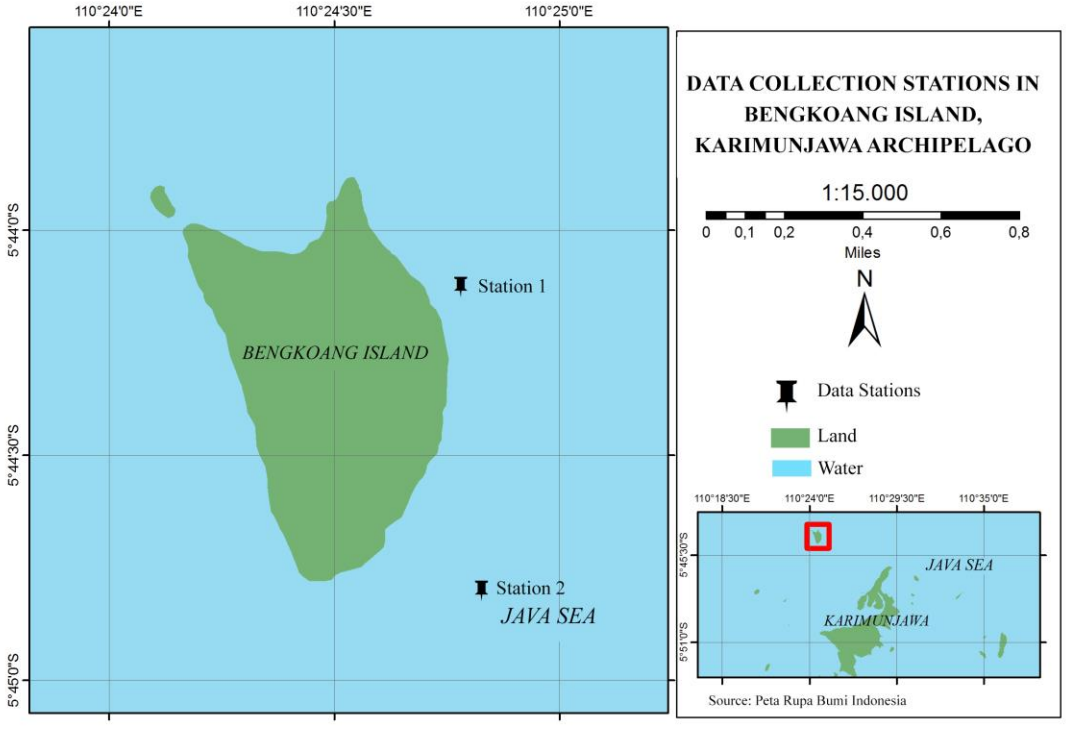

Figure 1. Data Stations in Bengkoang Island

The community structure was assessed based on English *et al.* (1994) with the Line Intercept Transect (LIT) method along 100 meters of the reef in 5 and 10 meters depth. It is assumed corals can live well in both depths as they are still able to gain sufficient sunlight (Nybakken, 1992). The data of the living coral cover to the level of genus, dead coral, substrate, algae, and existence of other organisms is used to describe the coral community structure (Suhasono, 1994). Meanwhile coral community fish abundance was technically determined using the Visual Sensus method with Belt Transect. The data of coral community fish in the radius of 2.5 meters from the transect was recorded to the level of genus (English *et al.,* 1997).

Data Analysis

The coral community structure was analyzed based on the method used in English *et al.* (1994) The percentage of cover (% cover) was calculated using the formula:

$$n_i = \frac{li}{L} \times 100\%$$

ni : Percent substrate cover
li : Total length of each substrate
L : Total transect length

Coral reef condition criteria is based on the percent cover of living coral referred to the Republic Indonesia Minister for Environment No. 04/2001 about the coral reef damage standard

Table 1. Coral Reef Damage Criteria

Living Coral Coverage (%)	Criteria
0 – 24,9	Poor
25 –49,9	Fair
50 – 74,9	Good
75 – 100	Excellent

Coral community fish data was analyzed by calculating abundance based on Odum (1971) using the formula:

$$X = \frac{\Sigma Xi}{n}$$

X : Fish abundance
Xi : Number of fish recorded at station-i

N : Total transect area

RESULT AND DISCUSSION

Substrate Coverage

Substrate coverage in Bengkoang Island consists of biotic and abiotic substrate. Living coral, dead coral, other organisms, algae are classified as biotic substrate meanwhile abiotic substrates are rock, rubble, and sand substrate. The coral reef condition of both data stations can be seen based on the observation on living coral coverage.

Table 2. Percent Substrate Coverage

Station	Depth	Living Coral	Algae	DC	RB	OT	RC	SD
1 (Marine Protection Zone)	5 meters	80,31%	-	14,88%	3,81%	1%	-	-
	10 meters	73,56%	0,75%	-	21,75%	-	3,94%	-
2 (Marine Tourism Utilization Zone)	5 meters	29,18%	-	8,70%	30,15%	-	31,98%	-
	10 meters	18,81%	2,46%	44,70%	26,20%	0,08%	-	8,11%

Notes: DC (*Dead coral*), RB (*Rubble*), OT (*Other*), RC (*Rock*), SD (*Sand*)

The highest living coral percent cover can be found in Station 1 at 5 meters depth with 80,31% categorized as excellent as it is between 75-100% (Men.LH No.4/2001). The growth of corals in Station 1 is supported by its position on the east of the island. The condition of open water allows better water circulation (Sutono, 2016). The lowest living coral percent cover can be found in Station 2 at 10 meters depth with 18,81% categorized as poor (Men. LH No.4/2001). Domination of abiotic substrate indicates that there has been environmental stress in coral reefs. This stress can possibly be caused in the combination of natural and human factors (Ghiffar *et al.,* 2017).

Based on a previous research by Yusuf (2013) on the condition of the coral reef in Karimunjawa, resulting that the coral reef is in poor to fair condition (22% - 49,9%). Meanwhile Malik (2016) did a similar research in Nyamuk Island, Karimunjawa at 3 – 10 meters depth, resulting that the condition of the coral reef in Nyamuk Island varies in the poor to good category (20,15% - 66,59%). Sulisyati *et al.* (2014) did an observation on the condition of the coral reef focusing in the Marine Tourism Utilization Zone in Karimunjawa resulting that it is in fine to good condition.

There is a corellation between the utilization of a certain area with the coral reef cover, that is the higher utilization, the coral reef cover tends to be lower (Juhasz *et al*., 2010). One of the main factors that affect the coral reef is human activity (Hasibuan *et al.,* 2011). Stress on the ecosystem that will result in damage can be caused by recreation activities such as tourism (Soebarjo and Hidayat, 2007) or explorative activies such as fishing using bombs, toxic, or mining. Extractive activities, such as the use of boat achors, can also add stress on the ecosystem (Haruddin *et al.,* 2011). The damage is resulted as the breaking of braching corals that will add as a rubble substrate. The stress can be showed by the abiotic substrate that previously was living corals (Ghiffar *et al.*, 2017). Fractured corals are generally from the branching corals that are damaged by human decomptive activities and nature, such as by strong currents. The high percentage of rubble is influenced by the coral species living there, branching corals will result as fractured corals if under goes damage process. Station 2 at 5 meters depth had a relatively high RB percentage (30,15%), supported by the domination of branching corals such as *Acropora, Montipora,* and *Porites*. Meanwhile, dead corals (DC) are generally corals with massive or submassive growth forms, as they have more solid structure than branching corals. Station 2 at 10 meters depth had a relatively high percentage of DC (44,70%)

supported by the domination of corals such as Diploastrea that has the mentioned growth form

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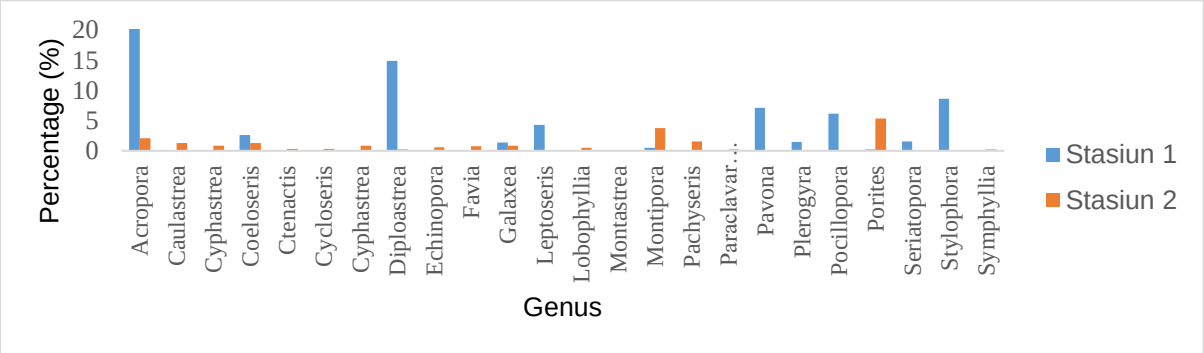

Figure 2. Coral Cover Percentage at 5 meters Depth

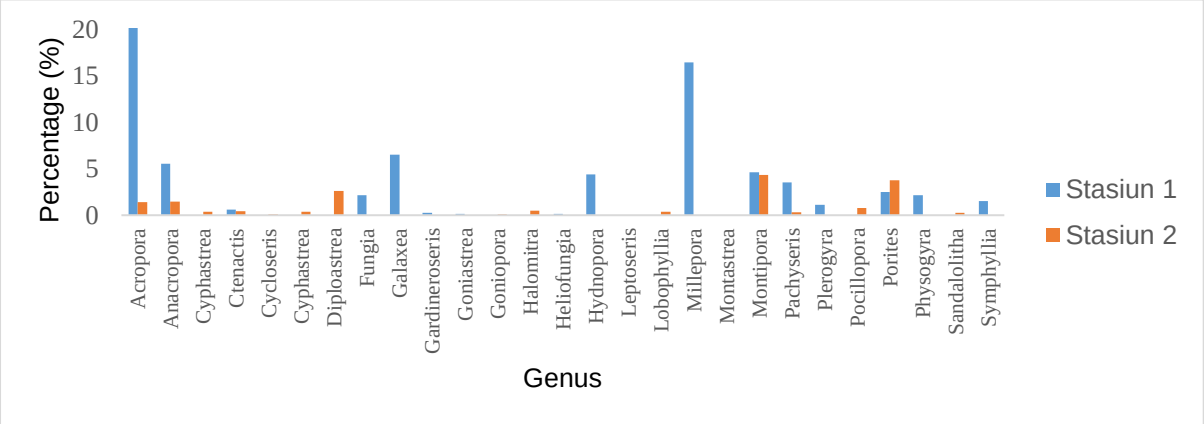

Figure 3. Coral Cover Percentage at 10 meters Depth

The growth of corals are highly influenced by environmental conditions. The result of the measurement of oceanographic factors are presented in Table 3. Among these factors, temperature is the most influential factor on coral growth (Levinto, 1982). Based on Supriharyono (2000), a good temperature for coral growth is 25-29ºC. The temperature obtained from both stations of Bengkoang Island is 28.3-29ºC, stable and suitable for coral growth. Salinity is another influencing factor as corals are true marine organisms. Corals cannot survive in salinity that deviates from normal sea water salinity of 32-35$^0/_{00}$ (Nybakken, 1992). Water visibility is an important factor as well for coral growth, as it affects the amount of sunlight entering the waters. The better visibility, the better the light can enter the waters. Light is used by the symbiotic algae Zooxanthelae for photosynthesis. The result of photosynthesis will be a food supply for the corals (Nybakken, 1992). The water visibility obtained is under the Republic Indonesia Minister for Environment No. 51/2004. That can be caused by the cloudy weather during the observation. Septyadi (2013) states that the growth of corals is better with the presence of currents. From the result obtained, the current in both stations are still in a safe measure.

Table 3. Oceanographic Parameters Condition

No	Parameters	Sea Quality Standard for Marine Organisms*	Station	
			1	2
1	Current (m/s)	<0,2	0,12	0,09
2	Direction	-	210º	101º
3	Salinity ($^0/_{00}$)	25-30	34,1	32
4	Visibility (m)	>6m	4,23	5,18

5	Temperature (°C)	28-30	29	28,3
6	pH	7 – 8,5	7,6	7,9

*Standard based on the Republic Indonesia Minister for Environment No. 51/2004

The living coral cover is higher in Station 1, in the Marine Protection Zone, categorized in good to excellent condition. Meanwhile in Station 2, in the Marine Tourism Utilization Zone, is categorized in poor to fair condition. The high living coral cover in Station 1 is supported by the regulation that any taking of marine resources is prohibited except with a permit.

Coral Community Fish Abundance

There were 39 genus from 17 families recorded in 2 stations. Both stations were dominated by the Famili Pomacentridae such as *Amblyglyphidodon, Abudefduf*, and *Crysiptera*. Pomacentridaes are mayor fish. It is common to be found because it is the main coral community fish in the coral reef at 3 – 10 meters depth (Burges, 1978). Fish from the Famili Caesionidae such as *Caesio* or yellow-tail fish were found as well. They are one of the coral community fish that has a high economical value (Nggajo, Wardiatno, & Zamani, 2009).

The abudance in Station 1 at 10 meters depth was the highest with the number 15.600 individual/ha. Meanwhile the lowest was found in Station 2 at 10 meters depth with the number 4.280 individual/ha. Bell & Galzin (1984) stated that the living coral cover percentage and different habitat zone were the factors that affect the community structure and abundance of fish. The high percentage of living coral cover should be directly in line with high fish abundance. However, the results showed otherwise. The fish abudance was higher in the reef that is in a poor condition, and the abudance was lower in the reef in an excelent condition.

There are other factors that affect the abundance of fish such as food accessibility and human activity (Ghiffar *et al.,* 2017). The shift of fish community structure is also affected by other factors such as hydro-oceanography that causes water instability (Mujiyanto, 2012). Fish abundance is not only affected by coral coverage, but also with the substrate complexity that is related to the fish protection space and the physiology of the sea bed (Sulisyati *et al.,* 2016).

Table 4. Coral Community Fish Abudance

Station	Depth	Abundance
1 (Marine Protection Zone)	5 meters	6.240 individual/ha
	10 meters	15.600 individual/ha
2 (Marine Tourism Utilization Zone)	5 meters	12.400 individual/ha
	10 meters	4.280 individual/ha

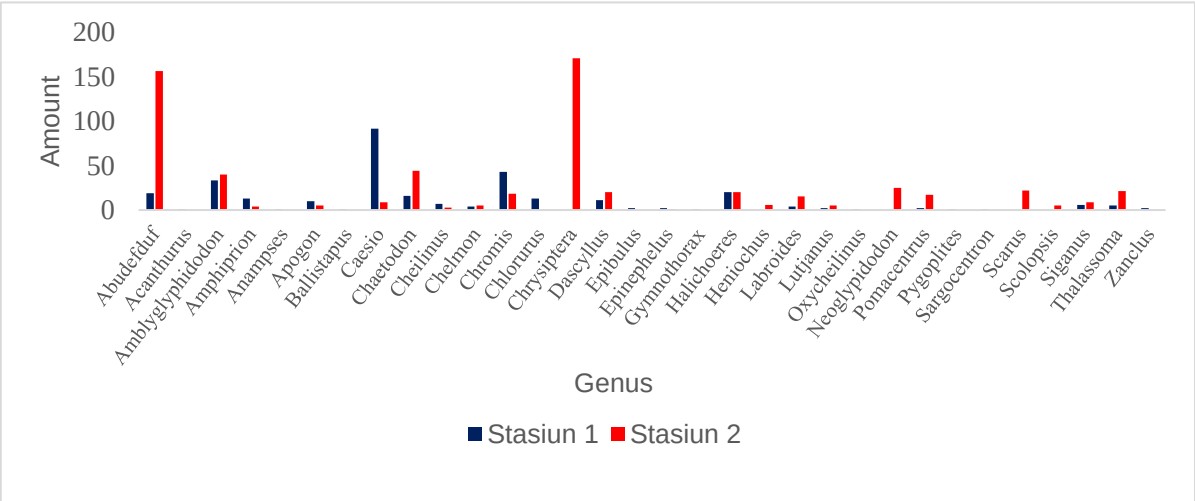

Figure 4. Fish Abudance at 5 meters Depth

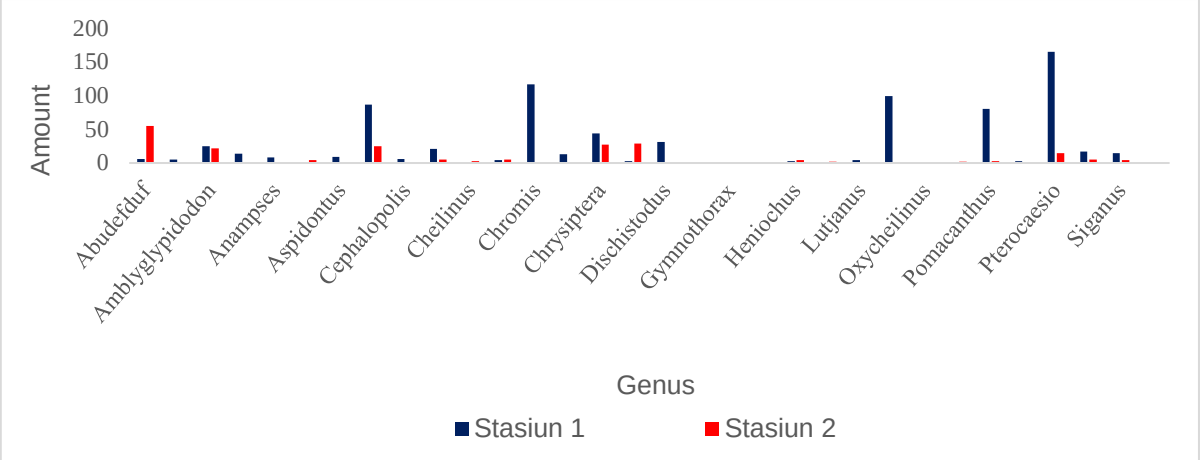

Figure 5. Fish Abudance at 10 meters Depth

The condition of the coral reef will influence the fish abundance and will directly affect the Karimunjawa locals' income, as most of them are fishermen. Furthermore, the damage to the coral reef will influence the tourism sector as well. Because the beauty of the coral reef is one of the selling points of Karimunjawa's tourism. Less strict regulations of zoning management can be one of the factors that affect the condition of the coral reef ecosystem. The zones as well as the regulations applied should be clarified and known by the public, especially to fishermen and tourist agencies as the parties that conduct activities there.

CONCLUSION

The condition of coral reef in the Marine Protection Zone of Bengkoang Island at 5 and 10 meters depth has respectfuly 80,31% and 73,56% living coral coverage. Meanwhile the Marine Tourism Utiliation Zone of Bengkoang Island at 5 and 10 meters depth has respectfuly 29,18% and 19,18% living coral coverage. There were 39 genus from 17 families of coral community fish found in both stations, dominated by the Family Pomacentridae. The highest fish abundance is found in Station 1 at 10 meters depth (Marine Protection Zone) with the amount of 15.600 individual/ha.

ACKNOWLEDGEMENTS

Thank you to Marine Diving Club (MDC) Marine Science, Diponegoro University that has executed the Corallium Expedition XIX as a part of this research. We would like to say thank you as well to Balai Taman Nasional Karimunjawa that has supported this research.

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