

Coral Covers and the Abundance of Reef Fish in Community Base Management Marine Protected Area (CBM-MPA) Bahoi Village North Sulawesi, Indonesia

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Abstract

In the last few decades, the coral reef ecosystem has been under significant pressure due to anthropogenic impacts and naturally driven factors. The coral reef ecosystem is unique because it has very high biodiversity and many organisms depend on its existence. Every organism in a coral reef ecosystem uniquely contributes to how coral reef communities survive and function. However, coral reef ecosystems are also vulnerable to pressures that cause degradation, interfering with the ecosystem balance. This study aims to monitor the ecological condition of coral reefs and the abundance of reef fish to see how the MPA program in Bahoi village helps the coral reef ecosystem from degradation. The data was collected using the Line Intercept Transect (LIT) method, which was drawn 70 meters transect line horizontally at a depth of 3-5 meters. The same transect line was also used to collect data about reef fish by using a Visual Census. The observation distance length is 2.5 meters to the left and right of the transect line. Results of the study showed that the coral cover of MPA Bahoi Village is in the Fair category and the abundance of reef fish in the MPA area is in the Moderate category.

Keywords: Coral Cover; Coral Reef; Marine Protected Area (MPA); Monitoring; Reef Fish

INTRODUCTION

The Coral reef ecosystem has been under significant pressure due to anthropogenic impacts and naturally driven factors for the last few decades. The pressure comes from natural impacts such as climate change and human activities to exploit ecological, social, and cultural values (Spalding et al., 2017; Hughes et al., 2017).

The expansion of Marine Protected Areas (MPAs) has been advanced as a potential solution to this problem. A good implementation of an MPA will reduce the pressure on coral reef ecosystems and maintain its sustainable ecological, sociocultural, and economic roles (Wilkinson et al., 2003). In addition, MPA will provide benefits to fisheries around the area for about 3-5 years and offer changes in fish density and coral reefs only one year after implementation (Wiryawan and Dermawan, 2006). In North Minahasa Regency, North Sulawesi Province, a community base management marine protected area (CBM-MPA) located in Bahoi Village has been running for several years. A previous study by Walukow et al.

(2016) reported that the coral cover inside of the MPA was 33.04 %. According to standards issued by The Minister of Environment of Republic Indonesia No. 4 of 2001 and Gomez & Yap (1988), coral cover inside of the MPA was in "fair enough" category (25 % - 49.9 %).

The MPA of Bahoi Village is located right on the coast and close to community settlements. The people of Bahoi village mostly work as fishermen and farmers, so the community dependence on marine resources is very high. This condition impacts the development of coral growth in MPA locations correlated to fishery activities around the MPA. Fishing activities using non-environmentally friendly tools such as fish bombs, poison, and fishing violations in the MPA prohibited zone are only a tiny part of exploitation that may affect the development of coral reefs. Therefore, this study aimed to monitor the ecological condition of coral reefs and the abundant reef fish to see the progress of MPA management in Bahoi village. It is hoped that this research can provide some insight into what extent the Bahoi Village MPA has achieved the goal of establishing the MPA from an ecological perspective.

MATERIAL AND METHODS

Research Sites and Time

The research was conducted in Bahoi Village MPA in December 2021 at two stations (Figure 1). The coral cover and fish data were carried out in the core zone and outside the MPA area. The core zone area is a no-take zone representing the conservation area. Meanwhile, the second site was outside the MPA, representing the closest fishing ground to the MPA.

Research Methodology

Coral Reef

Data collection on the percentage of coral cover was using the Line Intercept Transect (LIT) English *et al.* (1997). Seventy meters transect lines were drawn parallel to the shoreline, and those transect has drawn consistently at the same depth

in one drag. Divers carried out observations, and every centimeter of biota traversed by the transect rope was recorded into table life form based on their categories and taxon. The level of accuracy is close to centimeters. If one or more dead parts separate a colony, each living piece is considered a separate individual. If two or more colonies grow on top of another colony, each colony is still counted as a separate colony. The primary conditions and presence of soft corals, dead corals or massive corals, and other biota found at the site should also be noted. The percentage cover of benthic life forms was calculated based on English *et al.* (1997) as follows:

$$\text{Percent Cover} = \left(\frac{\text{Total Length of Category}}{\text{Total of Transect area}} \right)$$

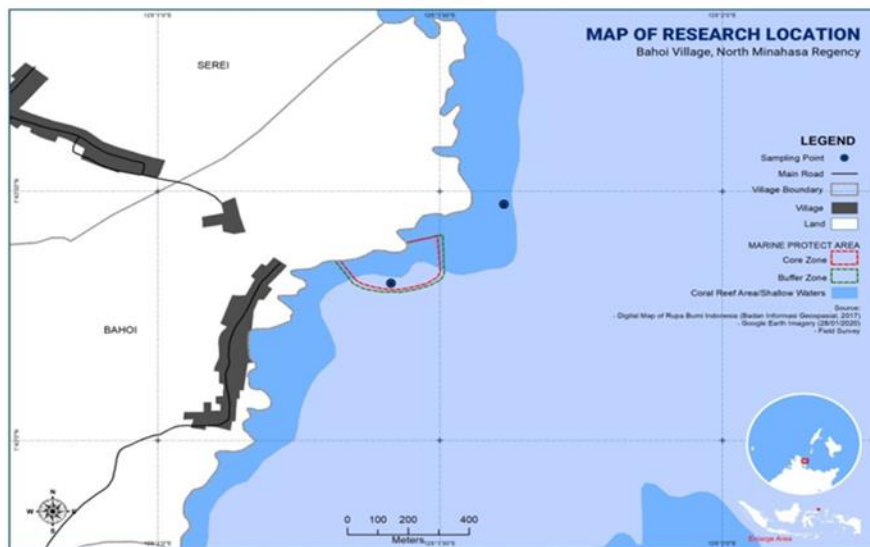


Figure 1. Map of study area

The assessment of coral reef health based on standards issued by the Minister of Environment of Republic Indonesia No. 4 of 2001; Gomez & Yap (1988) as follows (Table 1):

Diversity of Reef Fish

Data collection of reef fish diversity was using visual census and line transect methods (Manuputty & Djuwariah, 2009). Observations were carried out by using SCUBA gears. A seventy-meter-long transect was placed on the reef parallel to

the coastline. The observation distance length was 2.5 meters to the left and right of the transect line. The Genus of fish will be recorded and put into three major Groups, i.e., indicator species, target species, and other fish (major group).

- Target fish is a group of fish that fishermen target for fishing, generally for consumption with high market prices. The main target fish groups in the census were Serranidae (grouper fish group), Lutjanidae (snapper fish group), Lethrinidae, Haemulidae (thick lip fish

- group), Nemipteridae, Scaridae (parrot fish group), and Acanthuridae.
- Indicator fish: a group of reef fish that is used as an indicator of reef health. In this study, the indicator fish group was represented by the Chaetodontidae family.
 - Major fish are groups of reef fish always found on coral reefs that are not included

in the two categories mentioned above. These fish have a variety of colors, often referred to as ornamental fish. These fish are generally abundant in terms of the number of individuals and species. In general, their primary roles in the food chains are not known. This group consists of small fish <20 cm used as ornamental fish.

Table 1. Coral cover assessment criteria

Percentage Cover	Assessment criteria
Bad	0 -24,9 %
Fair enough	25 – 49,9 %
Good	50 – 74,9 %
Very Good	75 % - 100 %

Fish Data Analysis

The analysis of fish abundance data was carried out based on guidelines by COREMAP-LIPI II (Manuputty & Djuwariah, 2009). The criteria for coral reef fish abundance were categorized as follows:

1. "Low" if the number of individual target fish along the 70-meter transect is < 70 fish.
2. "Moderate" if the number of individual target fish along the 70-meter transect is 70 - 140 fish.
3. "High" if the number of individual target fish along the 70-meter transect is > 140 fish.

Fish abundance data was calculated based on Odum (1971) as follows:

$$Abundance = \left(\frac{\sum Individuals}{Transect\ area} \right)$$

RESULT AND DISCUSSION

Coral Cover

Data analysis shows that coral cover in the core zone of the MPA reached 70.60 %.

Based on The assessment of coral reef health by the Minister of Environment of Indonesia No. 4 of 2001; Gomez & Yap (1988), coral reefs in the Bahoi MPA are in a Good category, while the condition of coral cover outside of the MPA is only 7.60

%. It is in the Very Bad category (Figure 2). Acropora became the dominant life form inside the Bahoi Village MPA core zone, which was 68.60 %, while outside the Bahoi Village MPA area, coral rubble dominated the area with 59.40 %. RI Khasana *et al.* (2020) stated that corals from the Acropora group have a high growth rate and are often used to restore the degraded coral reef ecosystem. Based on information from MPA managers and field observations, the condition of coral reefs outside the MPA area is poor because, in the previous few years, it has become a location where fishing activities using bombs and poisons often occur (figure 3B).

The condition of the coral reef cover in Bahoi village has significantly improved over the last six years. In 2016 the coral cover condition of Bahoi Village MPA was 33.04 %, and currently, coral cover reaches 70.60 %. The contrasting coral health conditions in the two locations show that the marine protected area of Bahoi Village is proven to provide positive benefits and the coral reefs in Bahoi Village are well preserved.

It happened not only because of the rapid growth of Acropora but also because of the management group policy that prohibits the use of destructive fishing gear, and no fishing activities are allowed in the core zone area of MPA (Figure 3).

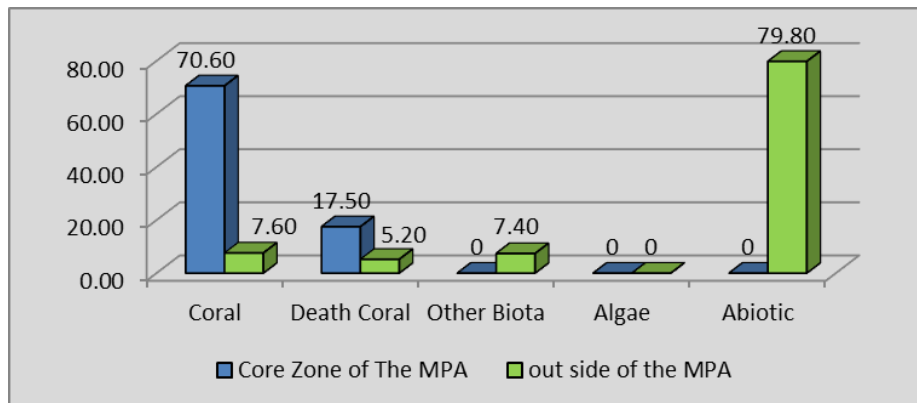


Figure 2. Graph of coral cover in the core zone and outside the MPA area (Source: Research Documentation)

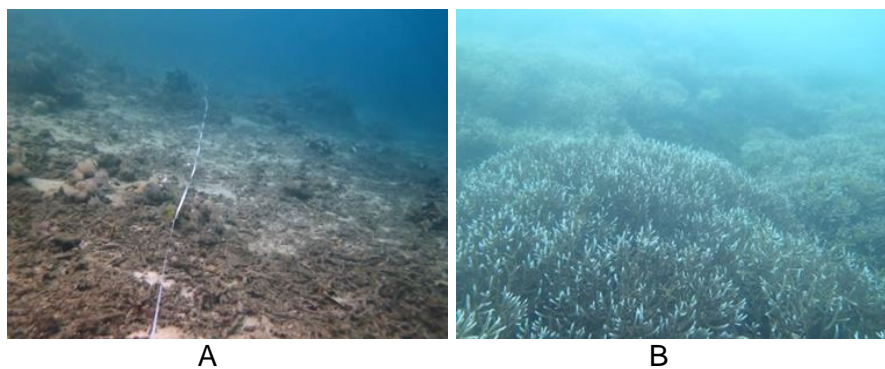


Figure 3. (A) Coral cover condition in the outside of The MPA. (B) Coral condition in the core zone of the MPA (Source: Research Documentation)

The policy of the Bahoi MPA prohibits fishery activities in the core zone, which causes no exploitation of the coral reef ecosystem in that location. It's very effective in reducing pressure and providing opportunities for coral reef ecosystems to recover from damage from fishing activities that are not environmentally friendly, such as the use of fish bombs or fish poison Figure 3 (B). On the other hand, many traces of damage to coral reef ecosystems were found outside the Bahoi Village marine protected area, caused by unsustainable fishing activities Figure 3 (A). MPA's will provide benefits to fisheries around the area for about 3-5 years and will provide changes in fish density and coral reefs only one year after implementation (Wirawan and Dermawan, 2006).

Fish Abundances

Indicator fish are fish species used as indicators of the health of coral reef ecosystems. The abundance of reef fish in

the MPA area of Bahoi Village is 125 fishes/350 m² or equivalent to 4.143 fishes/Ha and 108 fishes/350 m² or equivalent to 3.086 fishes/Ha outside of the MPA. Both locations inside and outside of the MPA are in the moderate category. Chaetodontidae fish is associated with coral reefs and is very sensitive to changes and degradation of coral reefs because it highly relies on coral reefs as food sources and shelters (Hourigan *et al.*, 1988).

The presence of fish from the Chaetodontidae family, which is high in the core zone of the MPA, shows that the coral reefs are pretty healthy and in line with the coral cover, which is also in the Good category. However, the presence of fish from the Chaetodontidae family is also high outside of the MPA, where coral cover is very low. It happens due to the impact of the existence of fish apartments which are not far from the data collection point.

Research conducted by Aldyza *et al.* (2022) stated that the abundance of the coral fish indicator was not always affected by high coral cover conditions. It indicated that other factors beyond the common variables could influence the abundance of coral fish. Another factor could be

alternative food resources such as benthic algae, small crustaceans, and polychaete. According to Prasetyananda *et al.* (2006), Chaetodontidae fish can survive in the declining condition of hard coral cover as Chaetodontidae fish can eat alternative food (*facultative corallivore*).

Table 1. Coral cover assessment criteria

Category	Family	Core Zone of The MPA (Individual)/ 350 m ²	Outside of The MPA (Individual) 350 m ²
Indicator Fish	Chaetodontidae	53	49
Target Fish	Scaridae	5	5
	Siganidae	3	0
	Acanthuridae	51	52
	Serranidae	5	0
	Lutjanidae	6	2
	Haemulidae	2	0
	Lethrinidae	0	0
	Total of Target Fish		125
		4.143 fishes/Ha	3.086 fishes/Ha
Fish Abundance Category		Moderate	Moderate

CONCLUSION

The coral cover of MPA Bahoi Village is in the Good category, and the abundance of reef fish in the MPA area is in the moderate category. Based on this assessment, the MPA of Bahoi Village has good development and is ecologically healthy. This condition also shows that the management of MPA has provided a positive outcome for restoring the ecological condition of Bahoi Village waters.

SUGGESTION

It is necessary to conduct similar research in the future and use this study results as an initial database to be a reference for evaluating the effectiveness of MPA management in Bahoi Village in terms of ecological perspective. So that progress can be compared to how far the Bahoi Village MPA has achieved its management goals in environmental recovery.

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