Current status of coral reef ecosystems in Brumbun Bay, Tulungagung

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Abstract. Coral reefs play a vital role in providing habitat for reef fish and other invertebrates, yet there is increasing pressure on the systems. Moreover, only a few studies and information were provided about coral reef’s status in Tulungagung. The purposes of this study were to determine substrate cover, diversity of reef fish, and invertebrates. The study was carried out in Brumbun Bay, Tulungagung in October 2017. The methods were done by diving at depths of 9 to 14 meters. The data obtained then were analyzed descriptively to describe the current status of coral reefs. The result showed that 34% of the substrate was covered by hard coral, 45% by sand, rock, coral fragments, soft corals, and algae. Snapper is known as a reef fish group that is more commonly found. The results showed that there were no invertebrates found during the dive. Based on the results, the status of coral reefs in Tulungagung was rated moderate. It is imperative to note down that trash nets and plastic waste were found frequently. This study provides crucial information about the current status of coral reefs in Brumbun Bay, Tulungagung which in the future can be used as a reference study.

Keywords: coral reefs; eco-diver; invertebrates; reef fish

1. Introduction

The distribution of the world's coral reefs is known to be centered in the world's coral triangle area, where the area includes several countries such as Papua New Guinea, Timor Leste, Malaysia, the Philippines, Brunei Darussalam, and Indonesia [1]. The distribution of coral reefs in Indonesia is very wide, that found almost along the coast. The condition of the coral reef ecosystem in Indonesia is reported to be 6.39% very good, 23.40% good, 35.06% sufficient, 35.15% damaged [2].

Coral reefs have important ecological functions in coastal and marine areas, including as a place to live, eat, and nursery, especially for various types of fish and benthos [3, 4]. This condition causes marine biodiversity in the coral reef ecosystem is very high.

The coral reef ecosystem has indirect values, such as a breakwater and a marine tourism destination. The majority of marine tourism is a diving activity in Indonesia is carried out in coral reef ecosystems
This makes coral reefs a high-value economic commodity. The World Coral Triangle Region is known to have an economic value of 2.3 US$ per year [6].

Tulungagung is one of the regencies that directly facing the Indian Ocean where the characteristics of coastal have strong currents and high waves. This condition is a limiting factor for the distribution of coral reefs on the coast. Brumbun Bay is the only place where coral reef ecosystems can be found in Tulungagung Regency. However, there have not been many studies related to this place. The purpose of this study was to determine substrate cover, diversity of reef fish species, and the presence of invertebrates.

2. Methodology
This research was conducted in Brumbun Bay, Tulungagung Regency, from August to November 2017. The site of this research can be seen in Figure 1. The tools used in this study were the SCUBA set, roller meter, slate, and pencil. The method used during the study refers to the Eco-Dive Reef Check [7]. Substrate cover data was taken using the Line Intercept Transect (LIT) method, including Hard Corals (HC), Soft Corals (SC), Nutrient Indicator Algae (NIA), Others (OT), Sponges (SP), Rock (RC), Recently Killed Coral (RKC), Rubble (RB), Silt (SI), and Sand (SD). The existence of reef fish in this ecosystem was observed using the Underwater Visual Census method. Important types of indicator fish to note are grouper, barramundi cod, snapper, sweetlips, butterflyfish, hump-head parrotfish, bump-head parrotfish, and moray eel. The observations of invertebrates were obtained by using the Belt Transect method, and the associated organisms as indicators include: banded coral shrimp, Diadema sea urchins, pencil sea urchins, consumption sea cucumbers, crown of thorns, clams, triton, lobster, and urchin collectors.

![Figure 1. The site of observation, The Brumbun Bay.](image-url)
3. Results and discussion

Coral reefs in Brumbun Bay can be found at a depth of 9-14 meters, with quite unclear water conditions and a fairly strong current. The result showed that 45% of the substrate at the observation location was sand, 34% hard coral, 13% soft coral, while the rest was sponges and rocks (figure 2). The low coral cover is thought to be caused by sedimentation as indicated by the value of the percentage of a sand substrate that is higher than the percentage of hard coral cover, also the condition of the waters that have a low visibility value. According to Muniaha et al. [8], visibility and transparency of the waters are some of the factors that can affect the growth of coral reefs.

![Figure 2. Substrate cover at Brumbun Bay.](image)

The condition of the coral reef ecosystem in Brumbun Bay is also not in good condition. It is evident from the observations that some of the damage is caused by the presence of fishing nets and other garbage. Figure 3 shows the causes and the frequency of finding the damage. The highest frequency but still in the moderate category is due to the presence of rubbish sticking to coral reefs so that it disturbs coral growth.

![Figure 3. Source of damage to coral reefs in Brumbun Bay.](image)
The coral recruitment is also rarely found at the site. This is supported by the small percentage of rock cover which is used as a substrate for growth. The newbie corals will grow well if supported by the good aquatic environmental conditions [9]. The water’s character of Brumbun Bay has a fairly strong current. This condition is also one of the obstacles to the growth of young corals.

Coral health was seen from the balancing between hard coral cover and other substrate covers [10], as well as support from other biota components that inhabit the ecosystem [11, 12]. Diversity of reef fish and invertebrate biota, such as Crown of Thorns (COT) and Drupella, which are coral predators, can be an indicator of the health of coral reef ecosystems.

Based on the observations, there are four groups of reef fish which are indicators of coral health in this method, namely Butterflyfish, Haemulidae (Grunts), Snapper, and Parrotfish (figure 4). The four groups of fish can be regrouped into two categories based on their value in the coral ecosystem, namely indicator fish and target fish [13, 14].

![Mean fish abundance for Brumbun Bay (9-14 m)](image)

**Figure 4.** Reef fish composition at Brumbun Bay.

The snapper designations for the snapper group is the reef fish group with the highest number of individuals found during the data collection period. This group generally comes from the Lutjanidae family and is included in the target fish category. Other target fish groups that are frequently encountered include Grunt fish, which are generally from the Haemulidae family and Parrot fish, which are generally from the Scaridae family. The butterfly fish group, which is generally from the Chaetodontidae family, is a category of indicator fish. Economically, the four fish are a group of consumption fish so that they are fish caught by fishermen.

Research results from Harsindhi et al. [14], fish from the Lutjanidae, Haemulidae, and Scaridae families are associated with hard coral species in life form, coral encrusting (CE), coral massive (CM), coral foliose (CF), and coral submassive (CS). This is related to the diet of these fish. The lifestyle of the four fish found included diurnal fish or fish that are active during the day. Lutjanidae and Haemulidae fish are carnivorous or predatory fish, while Scaridae and Chaetodontidae fish are herbivorous or algae-eating fish [15].

4. Conclusion
The coral reef ecosystem in Brumbun Bay, Tulungagung Regency is in moderate condition, seen from the coral cover which forms more than 30% of the reefs. The association organisms found indicate that this ecosystem is in an unhealthy condition, because the diversity of fish species is very lacking, and even invertebrates are not found which are indicators of the health of the coral reef ecosystem.
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