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The Impact of Coral Bleaching on Coral Reef Fishes in Sekotong Bay, West Lombok Regency

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Abstract: Coral reef fish is one of the main components making up the ecosystem of coral reefs. There is a strong mutual dependence between reef-forming corals and fish that inhabit coral reefs. Various fish species use coral as food source and habitat. This article describes the impact of coral bleaching on the diversity, density, and biomass of coral reef fish in the waters of Sekotong Bay, West Lombok. Underwater visual census (UVC) methods are used to obtain data on species, the number of individuals per species, and fish size at transect length 70 meters and width 5 meters. Simple linear regression analysis that is used to assess the impact of coral bleaching on the condition of coral reef fish shows that coral bleaching affects the diversity and density of reef fish. This analysis also showed that coral bleaching affected herbivorous fish biomass but not carnivorous fish. This study concludes that the degradation of coral fish in the Sekotong Bay of West Lombok occurs due to various factors, especially the declining health conditions of coral reefs.

Keywords: Coral bleaching; Coral reef fish; West Lombok

Introduction

Reef fish are one of the main components of the coral reef ecosystem. The existence of reef fish gives its color to the unique ecosystem of this tropical area. Coral reef fish utilize various components of the ecosystem that exist in multiple forms. There is a strong interdependence between reef-building corals and the fish that inhabit coral reefs. Various species of fish use coral as a source of food and habitat. Meanwhile, corals depend on grazing by certain fish for reproductive success and to suppress the spread of coral disease.

Coral bleaching is a significant and increasingly common source of coral mortality, representing one of the most severe and widespread disturbances affecting coral reef ecosystems (Hoegh-Guldberg 1999). In recent years (mostly since 1998), coral bleaching has occurred on many coral reefs worldwide, killing 20-80% of zooxanthellate corals (including scleractinian and Alcyonacea) across large coral areas (e.g., Great Barrier Reef, Baird and Marshall 1998; Japan, Shibuno et al. 1999; Caribbean, Jackson et al. 2014). In addition to killing coral zooxanthellae, severe large-scale bleaching events can cause significant reductions in reef fish abundance, especially among reef fish species that depend on live coral for food or shelter (Shibuno et al. 1999). This study intends to assess the impact of coral bleaching on reef fish communities in the waters of Sekotong Bay, West Lombok.

Method

This research was conducted in the coral waters of Sekotong Bay, West Lombok. The map of the research location is presented in Figure 1. Data collection for coral reef fish using the belt transect method developed by English et al. (1997). Data collection was carried out by SCUBA diving on the same transect as the permanent coral monitoring transect. The size of the line transect for coral reef fish data collection was extended to 70 meters.

Data were collected using the underwater visual census (UVC) method. The species name, abundance, and estimated length of the coral reef fish that were the target of observation were recorded. The belt transect has a distance of 70 meters and a width of 5 meters, so the area is 350 m2. Coral reef fish that became the

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observation target was carried out by referring to the provisions set by P2O LIPI (Suharti et al. 2017).

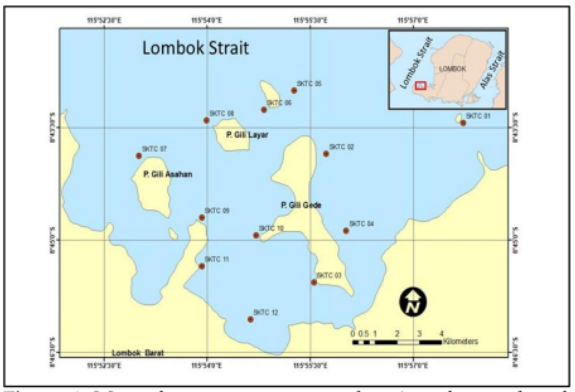

Figure 1. Map of permanent transect locations for coral reef fish data collection from 2015 to 2019.

Coral reef fish data analyzed include:

a) Species diversity

Species diversity or species diversity is the total number of coral reef fish species recorded in the belt transect during coral reef ecosystem monitoring.

b) Abundance

The abundance of coral reef fish is expressed in density or density (D). Figure D is obtained from the number of individuals of all species from a particular functional group divided by the area of the belt transect. The Abundance of fish presented in units of the number of individuals per hectare (ha) to be more communicative when compared to other research results.

c) Biomass

Biomass (B) is the weight of individual target fish (W) per observation area. Fish weight was estimated from the length of the fish (fork length, L). The equation in question 1 and 2:

$$W = a\ x\ L^b \quad (1)$$

$$B = \frac{W\ total\ setiap\ famili\ (gram)}{transek\ (350\ m^2)} \quad (2)$$

Where a = species-specific index (a), and b = species-specific index (b).

d) Impact of coral bleaching on reef fish condition

The impact of coral bleaching on the condition of coral reef fish was analyzed using simple linear regression analysis (RLS) with the following regression line equation 3:

$$Y' = b_0 + b_1X \quad (3)$$

where: Y = dependent variable (number of species, abundance, and fish biomass); b0 = constant; b1 = variable coefficient X, and X is live rock cover.

Coral and fish cover data were collected at the same location and time. The value of X is obtained from Bachtiar (2019).

Results and Discussion

Species diversity and abundance Corallivorous fish (indicator fish)

The species diversity and abundance of corallivorous fish (Family Chaetodontidae) found in the coral reefs of Sekotong Bay is presented in Figure 2. Based on this figure, it is seen that there is a tendency to decrease the number of indicator fish species in the study area.

The results of statistical analysis (regression) showed a significant relationship (P=0.00) between the number of indicator fish species (family Chaetodontidae) and live rock cover with the regression equation Y = 2.148 + 0.137X. This statistical analysis also shows that the t-test value is 5.115 with a significance of 0.00, which means that the diversity of indicator fish species (family Chaetodontidae) is highly dependent on live rock conditions.

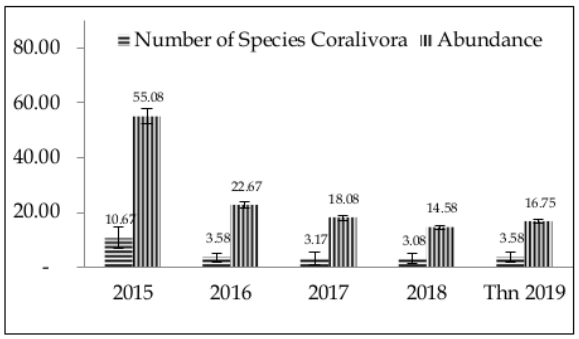

Figure 2. The average number of species and abundance of corallivorous fish in Sekotong Bay in 2015 – 2019

Meanwhile, the relationship between the abundance of indicator fish and the condition of live rock is described by the regression line equation Y = 11.479 + 0.714X. With t-test results and significance of 3.666 and 0.01, respectively, which means that the abundance of indicator fish is closely related to the condition of coral reefs in the waters of Sekotong Bay. Species diversity and abundance of herbivorous fish.

Figure 3 describes the dynamics of the number of species and abundance of herbivorous fish in the waters of Sekotong, West Lombok. Based on this picture, it can be seen that there is a very sharp decline in both the number of species and the abundance of herbivorous fish in Sekotong Bay.

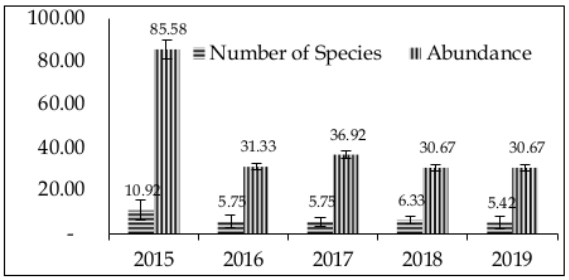

Figure 3. The average number of species and abundance of herbivorous fish in Sekotong waters, West Lombok in 2015 - 2019.

The regression analysis results showing the relationship between the number of herbivorous fish species and live rock cover in Sekotong Bay have the line equation Y = 4.917 + 0.098X. With t-test values and significance (P) of 3.417 and 0.001, respectively, it shows that the number of herbivorous fish species also depends on coral reef conditions. Here, the regression coefficient for the variable number of herbivorous fish species is 0.098, which is smaller than the regression coefficient for the varying number of indicator fish species (0.137). Meanwhile, the relationship between the abundance of herbivorous fish and the condition of coral reefs is shown by the regression line equation, namely Y = 24,265 + 0,960X with t-test values and significance of 3.141 and 0.003 respectively.

Species diversity and abundance of Carnivorous Fish

Figure 4 presents the average number of species and abundance of predatory or carnivorous fish in the waters of Sekotong Bay for the period 2015–2019. Similar to herbivorous fish, there is a sharp decline in the number of species and abundance of predatory fish between 2015 and the following year. In 2015, the average number of predatory fish species in Sekotong Bay was 3.92 species with an abundance of 10.17 individuals/transect, while in 2016 the average number of species was 0.83 with an abundance of 0.93 individuals/transect. This condition was relatively constant until 2018. In 2019, although the number of species was relatively the same as the previous year, there was a pretty good increase in abundance.

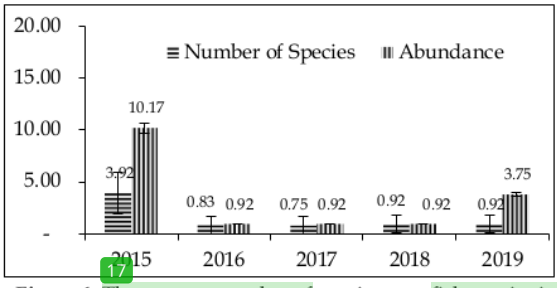

Figure 4. The average number of carnivorous fish species in Sekotong Bay in 2015 – 2019.

The correlation between the number of carnivorous fish species and the condition of live coral reefs is described by the regression line equation, namely, Y = 0.461 + 0.051X with the result of t-test = 4.012 and significance = 0.00. Meanwhile, the relationship between abundance and condition of live rock coral cover is described by a regression line equation model, namely Y = 1.029 + 0.118X with the result of t-test = 2.076 and a significance of 0.42. These results indicate that the abundance of carnivorous fish is not associated with live rock cover.

Biomass

Figure 5 presents the average biomass (grams/transect) of herbivorous and carnivorous fish in Sekotong Bay, West Lombok. Here, there was a sharp decline in biomass in these two groups of fish from 2015 to the following year (2016).

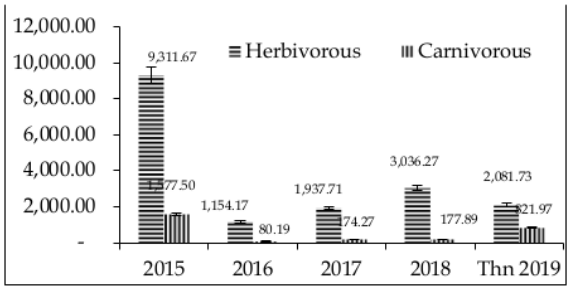

Figure 5. Average biomass (grams/transect) of herbivorous and carnivorous fish in Sekotong Bay in 2015 – 2019.

In line with the number and abundance of species which showed a decline from 2015 to 2016, the biomass of herbivorous and carnivorous fish also decreased. The correlation between herbivorous fish biomass and live rock coral cover conditions is described by the regression line equation Y = 472,942 + 155.079X. The t-test value obtained from this analysis is 4.578, with a significance of 0.00. This magnitude indicates a significant relationship between the health condition of coral reefs and the biomass of herbivorous fish in Sekotong Bay.

Meanwhile, the regression line equation of the relationship between carnivorous fish biomass and live rock coral cover is Y = 192.056 + 19.150X and the test value of t = 1.997 with a significance of 0.05. Statistically, this quantity shows a significant relationship between carnivorous fish biomass and live rock cover at the study site.

Discussion

Diversity and abundance of coral reef fis

The above analysis results show a close relationship between hard coral cover and coral reef fish diversity, both corallivorous fish (indicator fish) and target fish

(herbivores and carnivores). Meanwhile, the relationship between live rock cover and fish abundance did not all show a significant relationship. It can be seen that the abundance of corallivorous and herbivorous fish is closely related to live rock cover. The different condition shown by the results of this analysis is that live rock cover does not affect the abundance of carnivorous fish. This condition indicates that the overall condition of the diversity and abundance of reef fish in the waters of Sekotong Bay is experiencing degradation.

Many experts have put forward various opinions about the relationship between reefs and reef fish. The close relationship between live coral cover and coral reef fish occurs for various reasons. Sano (1989) stated that scleractinian corals are the main food source for butterflyfish (corallivore). In addition, Lindahl et al, (2001) described that fish abundance, species diversity and community composition were influenced by the complexity of the structure provided by live and dead corals. This happens because one of the main foods of this group of fish is coral polyps. Live coral cover has a more significant influence than the complexity of the structure formed (Coker et al 2012). This study confirms that live coral cover is critical for the maintenance of high biodiversity on tropical coral reefs and that the continued decline in coral cover will affect the recruitment of various reef fish species.

Coral habitats can vary in many characteristics, particularly live coral cover, topographical complexity and coral diversity, but the relative effects of these habitat characteristics are often undifferentiated. This change can also occur due to other environmental conditions, as described by Kane and Tishot (2017), that changes in the composition of reef fish communities from shallow to mesophotic environments are largely influenced by trophic position, coral habitat, and indirect effects of depth itself.

In this study, the condition of live coral cover had a positive effect on the diversity and abundance of coral reef fish. However, this condition is not for carnivorous fish. Komyakova (2013) explains that although the structure of coral reef habitats has a significant influence on the diversity, composition, and abundance of fish associated with reefs, the specific features of the most critical habitats are not always known. Khalil et al (2013) found densities of herbivorous fish were found to be significantly higher on the affected reefs, most likely due to the high density of algae on those reefs.

Biomass

The condition of target fish biomass in the waters of Sekotong Bay has seen a very sharp decline when entering 2016 (Figure 5). This image also shows that the biomass of predatory fish is very low.

Several studies have shown that fish biomass is not only affected by the condition of coral reefs but also by the exploitation or fishing pressures exerted on these fish. Wilson et al. (2008) mention that over-exploitation and habitat degradation are the main factors causing the extinction of local biota and the decline in environmental services. Market demand for fish resources is increasing. Brewer et al. (2012) say that fishing pressure is dominated by market access and local population density and has an apparent adverse effect on coral reef fish diversity and function.

Robinson et al. (2016) stated that fishing pressure on coral reef ecosystems is often associated with a decrease in the number of large fish and fish biomass. In his research on several Pacific islands affiliated with the United States, he found that the lowest reef fish biomass was found on the most populated islands.

To restore a better condition of reef fish, management that emphasizes efforts to reduce exploitation of coral reef fish resources, for example, by establishing marine conservation areas, needs to be done. Marine conservation areas can provide opportunities for the resources in this area to grow and develop better. Anticamara et al. (2010) found that a longer duration of protection for marine protected areas mainly impacts diversity by increasing the dominance of large body species and increasing total biomass. In addition to the period of protection, the reserve's location affects the species accumulation curve and the diversity index.

Conclusion

Of the description above, it is concluded that the condition of coral reef fish in Sekotong Bay is experiencing degradation due to the accumulation of various factors, especially the declining health condition of coral reefs.

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