The study of reef fish community in the outer islets of Sekotong Bay, Indonesia

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Abstract. The northern region of Sekotong Bay is well known for its secluded, and it potentially provides a unique habitat for the coral reef ecosystem. There are only two islets located in that outermost area, namely Gili Rengit and Gili Layar. This study aims to describe the reef fish community structure in both islands. The study was conducted in the northern and southern parts of each islet using UVC (Underwater Visual Census) method along a 50×5 m belt transect. A total of 64 species of reef fish from 18 families were identified. The majority of fish found were resident obligate and dwellers. Moderate diversity index, as well as the low presence of indicator and targeted fish species, indicates the susceptible stability of reef fish community in the outer islet of Sekotong Bay.

1. Introduction
The reef fish community holds an important role based on an ecological and economic point of view. The reef fish community contributes to maintaining the stability of the coral reef ecosystem. Several herbivorous fish, such as parrotfish and surgeonfish, can significantly reduce the abundance of competitively superior algae, thus enabling corals to survive [1, 2]. On the other hand, the loss of predatory fish (piscivorous fish) can lead to the reef trophic destruction [3]. Some reef fish groups were also known to have a high economic value as a food source, such as lujtanid, serranid, and scarrid [4]. Protecting reef fish community against over-exploitation may support the sustainability of both reef fish and coral reef ecosystems.

Gili Rengit and Gili Layar are two islets located in the northern region of Sekotong Bay, which is rarely visited by tourists and habitants. So far, the two islets are very likely to become a safe haven for marine biodiversity in the area. However, tourism development in Sekotong Bay can be a future threat to the marine ecosystem. High tourism activities, such as SCUBA diving, snorkeling, game fishing, and boating, directly impact environmental damage [5, 6]. In fact, Muhidin et al. [7] reported that unlicensed diving and snorkeling activities had caused severe damage to the coral reef ecosystem by 13.55% per year. Shipping on nearshore also contributes to water acidification and pollution, resulting in a less productive coral-depleted ecosystem state [8].

Based on Díaz-Pérez et al [9], reef fish is an accurate indicator of coral reef health and may represent the condition of coral reef ecosystems. The existence of diverse (high diversity) reef fish indicates healthy coral reefs in an area. So, this research was aimed to describe the reef fish community in Gili Rengit and Gili Layar, by inventorying the reef fish species and assessing the condition of the reef fish community found in both islets.
2. Methods

2.1. Overview
The research was conducted on April 2019. There are 4 stations of study, each located in the northern and southern part of Gili Rengit and Gili Layar as shown in Figure 1. There is a narrow waters connecting the two islets. The northern part of both islets is directly adjacent to the Lombok Strait and in the south it is bordered by narrow waters that face the northern part of Gili Gede. The western part of Gili Layar is facing the Gili Asahan, while the eastern part of Gili Rengit faces a sand dune called Gili Anyaran, which will sink when the tide rises.

![Figure 1. A map of study site location.](image)

2.2. Data collection
The physical and chemical parameters at all stations were recorded before data collection. Data collection was done during daytime using the UVC method [10] with minor modifications. The UVC method was carried out along a belt transect with 50 m length and 5 m width, so the observation area will be 250 m². Belt transect was placed at 6-9 m depth, lined the reef slope. All fish species and number of individual found inside transect were recorded. Unique and rare species as well as species that are difficult to identify in situ were photographed for further identification. Identification to species level for all reef fish found refer to Allen et al [11], Kuiter & Tonozuka [12], and Allen et al [13].
2.3. Data analysis
Species richness, functional group composition, as well as diversity index of reef fish community were analysed. Analysis of species richness was done by identifying the presence of species and number of individual at each station. Data analysis was also carried out by calculating the percentage of functional groups within the reef fish community. The functional group identified as herbivores, carnivores (piscivores), indicators (corallivores), major (planktivores and omnivores) and cryptic (cryptobenthic) fish, as mentioned by Edrus & Abrar [14] and Cadena-Estrada et al [15]. The diversity index (H') states the level of species diversity of each organism in a community which is calculated based on Shannon & Weaver [16]. The diversity value (H’ value) categorized according to Maduppa [17], as presented in Table 1.

| H’ value | Category       |
|----------|----------------|
| H’≤2     | Low diversity  |
| 2< H’≤3  | Moderate diversity |
| H’>3     | High diversity |

3. Results and Discussions
3.1. Physical and chemical condition
In general, physical and chemical parameters at all stations did not show any significant differences. Underwater visibility at all stations ranges from 8-10 m, making it easy to conduct research. Details of physical and chemical parameters at the stations are shown in Table 2.

Table 2. Physical and chemical parameters at study site

| Parameter | SGR 1 | SGR 2 | SGL 1 | SGL 2 |
|-----------|-------|-------|-------|-------|
| **Physical** |       |       |       |       |
| Wind direction | Windward | Leeward | Leeward | Windward |
| Water temperature | 28.0°C | 28.5°C | 28.0°C | 27.3°C |
| Type of substrate | Dominated by massive and foliose corals | Dominated by massive and foliose corals | Dominated by massive and foliose corals | Dominated by massive and foliose corals |
| **Chemical** |       |       |       |       |
| pH | 7 | 6.8 | 6.7 | 6.9 |
| Salinity | 33.5 ppt | 34.0 ppt | 33.8 ppt | 34.2 ppt |

3.2. Reef fish community
This study successfully recorded as many as 64 species from 18 families of reef fish. The fish found consisted of all functional groups and majority of reef fish found are resident obligate and dwellers, as shown in Table 3.

Table 3. Species and family of reef fish encountered during field study

| No. | Family | Functional Group | Species Encountered | Number of Individual | SGR1 | SGR2 | SGL1 | SGL2 |
|-----|--------|------------------|---------------------|---------------------|------|------|------|------|
| 1   | Acanthuridae | Herbivore | Acanthurus lineolatus | 1 | | | | |
|     |         |       | Acanthurus nigrifuscus | 25 | 7 | 12 | | | |
|     |         |       | Acanthurus pyroferus | 7 | 1 | 1 | | | |
|     |         |       | Ctenochaetus striatus | 9 | | 3 | | |
|     |         |       | Zebrasoma flavescens | | | | 1 | |
|     |         |       | Zebrasoma scopas | | 2 | | | |
| 2   | Apogonidae | Major | Apogon chrysopomus | | | | 3 | |
| 3   | Aulostomidae | Major | Aulostomus chinensis | | | 1 | 2 | |
|     |         |       | Aulostomus taeniatus | | | 1 | | |
| No. | Family             | Functional Group | Species Encountered                          | Number of Individual |
|-----|--------------------|------------------|---------------------------------------------|---------------------|
|     |                    |                  |                                             | SGR1 | SGR2 | SGL1 | SGL2 |
| 4   | Blenniidae         | Cryptic          | Aspidontus taeniatus                        | 4    | 3    |      |      |
|     |                    |                  | Petroscirteus mirratus                      | 1    |      |      |      |
|     |                    |                  | Plagiotremus rhinorhynchos                   | 4    |      |      |      |
| 5   | Chaetodontidae     | Indicator        | Chaetodon kleinii                           | 36   | 6    | 10   |      |
|     |                    |                  | Chaetodon lanulatus                          | 1    |      |      |      |
|     |                    |                  | Chaetodon lanulatus                          | 4    | 7    | 1    |      |
|     |                    |                  | Chaetodon melanotastr                        | 1    |      |      |      |
|     |                    |                  | Chaetodon punctatofasciatus                  | 1    |      |      |      |
|     |                    |                  | Chaetodon rafflesii                          | 1    |      |      |      |
|     |                    |                  | Chaetodon trifascialis                       | 5    |      |      |      |
|     |                    |                  | Chaetodon trifasciatus                       | 1    |      |      |      |
|     |                    |                  | Chaetodon vagabundus                         | 1    | 2    |      |      |
|     |                    |                  | Heniocus varius                              | 1    | 3    |      |      |
| 6   | Haemulidae         | Carnivore        | Plectorhinchus chaetodonoides                | 4    |      |      |      |
| 7   | Holocentridae      | Major            | Myripristis hexagonatus                     | 6    | 5    |      |      |
| 8   | Labridae           | Major            | Epibulus insidiator                         | 1    |      |      |      |
|     |                    |                  | Helichoeres schwartzii                      | 1    |      |      |      |
|     |                    |                  | Hemigymnus fasciatus                        | 1    | 1    | 2    |      |
|     |                    |                  | Hemigymnus melapterus                       | 19   |      |      |      |
|     |                    |                  | Labroides bicintus                          | 1    | 1    |      |      |
|     |                    |                  | Labroides dimidiatus                        | 4    |      |      |      |
|     |                    |                  | Pseudocheilinus hexataenia                  | 2    |      |      |      |
|     |                    |                  | Pseudojuloides cerasinus                    | 3    | 8    | 25   |      |
|     |                    |                  | Thalassoma lunare                           | 7    | 16   |      |      |
| 9   | Mullidae           | Major            | Parupeneus barberinus                       | 1    |      |      |      |
| 10  | Nemipteridae       | Major            | Scelopris lineata                           | 1    |      |      |      |
| 11  | Pempheridae        | Major            | Pempheris vanicolensis                      | 2    |      |      |      |
| 12  | Pinguipedidae      | Cryptic          | Parapercis sp.                              | 11   |      |      |      |
| 13  | Pomacanthidae      | Major            | Pomacanthus imperator                       | 1    |      |      |      |
| 14  | Pomacentridera     | Major            | Abudelfd sexafasciatis                      | 15   | 34   |      |      |
|     |                    |                  | Abudelfd vaigiousis                         | 47   |      |      |      |
|     |                    |                  | Acanthochromis polyanchus                   | 13   | 9    |      |      |
|     |                    |                  | Amblyglyphidodon curacao                    | 50   | 7    | 57   |      |
|     |                    |                  | Amblyglyphidodon leucogaster                | 12   |      |      |      |
|     |                    |                  | Amphioprin Clarkii                          | 5    | 2    | 4    |      |
|     |                    |                  | Amphioprin sabei                           | 3    |      |      |      |
|     |                    |                  | Chromis viridis                            | 73   |      |      |      |
|     |                    |                  | Chrysiptera oxycephala                      | 5    |      |      |      |
|     |                    |                  | Chrysiptera paraseuma                       | 6    | 1    | 19   |      |
|     |                    |                  | Dasylus aramnus                             | 3    |      |      |      |
|     |                    |                  | Dasyllus melanicus                          | 7    | 2    |      |      |
|     |                    |                  | Neoglyphidodon thoracotaenius               | 1    |      |      |      |
|     |                    |                  | Neopomacentrider filamentosus               | 5    |      |      |      |
|     |                    |                  | Parma alboscoparlis                         | 7    |      |      |      |
|     |                    |                  | Plectrophyidodon lacrymatius                | 35   | 21   |      |      |
|     |                    |                  | Pomacentrider coelestis                    | 15   | 20   |      |      |
|     |                    |                  | Pomacentrider molaccensis                  | 149  | 32   | 1    |      |
|     |                    |                  | Pomacentrider tarnatensis                  | 129  | 187  |      |      |
| 15  | Scaridae           | Herbivore        | Cetoscaros bicolor                          | 1    |      |      |      |
|     |                    |                  | Chloraros sordidas                          | 9    | 16   |      |      |
|     |                    |                  | Scarus dimidiatus                           | 3    |      |      |      |
| 16  | Synodontidae       | Cryptic          | Synodus variegatus                          | 4    |      |      |      |
| 17  | Tetraodontidae     | Major            | Canthigaster valentini                     | 1    | 4    |      |      |
| 18  | Zanclidae          | Major            | Zanclus cornutus                            | 8    | 9    | 11   |      |

| Total | 459 | 369 | 453 | 136 |
|-------|-----|-----|-----|-----|
| H'    | 2.42| 2.29| 2.27| 2.33|
The diversity index at both stations is classified as moderate. As shown in Tabel 3., the value of diversity index of reef fish community in Gili Rengit and Gili Layar does not differ greatly. The uniformity of diversity index categories at the two islets is supported by physical (temperature) and chemical (salinity and pH) data parameters in both locations which are almost conformable. In addition, visual observations show that the two stations have almost identical habitat conditions, which are a combination of massive and foliose corals. According to Palacios & Zapata [18], the architecture of coral reef habitats mostly determine the diversity of reef fish community. The condition of environmental parameters does not differ much at each stations, and it might create of almost the same habitat conditions, causing the level of reef fish diversity in the same state for both islet.

Unlike the previously expected, the diversity index shows that the reef fish communities in both locations have moderate stability, even if the community live in the very isolated place in Sekotong Bay. This condition might be driven by repeated coral bleaching that hit Sekotong Bay in 2010 and 2016 [19, 20]. Pratchett et al [21] explains that bleaching phenomena can disturb the stability of reef fish community, as well as changing biodiversity and function of reef fish in coral reef ecosystems.

Almost all reef fish families that are commonly found in coral reef ecosystem are recorded in this study. As mention by Allen [22], the Gobiidae, Labridae, Pomacentridae, Apogonidae, Serranidae, Acanthuridae, Blennidae, Chaetodontidae, Lutjanidae, Syngnathidae, and Scaridae are common family of reef fish that found in Indonesian coral reefs. Based on this study, the pomacentrid occupies the largest percentage of family composition in the two data set, followed by the labrid and the chaetodontid, respectively.

Some known-common families, such as syngnathid, gobid, serranid and lutjanid, were not found at the two islets. The cryptic nature of the syngnathid [23] is most likely to cause a rare encounter and difficulty in distinguishing the members of this family with their surroundings. The absence of serranid and lutjanid at the two islets was allegedly due to hunting by fishermen which caused the scarcity of this target fish in the Sekotong Bay. This conjecture was confirmed by Karnan [24], who reported the decreasing number and biomass of lutjanid and serranid members in Sekotong Bay over the past 3 years (2016–2019) due to a massive target fishing activities. The declined number of target fish due to unsustainable fishing was also reported by Pears [25], Stalings [26], and de la Guardia et al [27]. However, the data that generated in this study is not to conclude that overfishing has occurred in the Sekotong Bay area.

The results also showed differences in the condition of coral reef fish communities in the separate part of the islet. Some species of fish that dominated in SGR 1 were not found in SGR 2, such as Abudefduf vaigiensis and Acanthurus nigrifuscus. Other abundant species, such as Pomacentrus ternatensis are only found in SGR 2. Closely related species, such as Dascyllus melanurus only found in Gili Layar, but their cousin D. aruanus only found in Gili Rengit. Fish species that dominate both stations, are planktivorous and herbivorous fish. This is in accordance with Andradi–Brown et al [28], who reported that planktivorous fish have high abundance in various types and depths of coral reef. Floeter et al [29] state that the composition of coral reef communities is generally influenced by hydrodynamic factors, especially to the areas that are directly connected to broad waters. The two islets are reported to have almost similar turbidity levels, and both are dominated by planktivorous and herbivorous fish. Turbidity does not appear to have a negative effect on the presence of planktivorous and herbivorous fish, as reported by Moustaka et al [30]. Water flow actually provides food supplies, especially for fish that like bright areas and are dependent on currents in terms of food supply [31]. In addition, coral reef areas that have extensive algal cover and low levels of predator presence causing herbivorous fish to be abundant [32].

3.3. The present of indicator fish

This study revealed that the family composition at the two stations had almost the same percentage, but differed in terms of species richness. For example, SGR 1 has 4 types of Chaetodontidae family, while SGR 2 has 5 types of Chaetodontidae family, as shown in Figure 3. Chaetodon kleinii, C. melannotus, C. vagabundus, and Heniochus varius were found in both locations, with the highest abundance of C. kleinii at SGR 1. C. lunula and Chelmon rostratus were only found in SGR 2. Referring to Pratchett et al [33], Chaetodon kleinii, C. lunula, and Heniochus varius are facultative
corallivore which means that <80% of their food composition originates from coral polyps, while *C. melannotus* and *C. vagabundus* are obligate corallivore, which means that their diet depends entirely on coral polyps. *Chelmon rostratus* is a benthic-eating chaetodontid, which do not depend on corals as food source. Photograph of several chaetodontid members found in both islet as shown in Figure 4.

Figure 2. Different indicator species that present in each station.

Figure 3. Photograph of several chaetodontid encountered in the field: a) *Chaetodon lunulatus*, b) *C. rafflesi*, c) *C. kleini*, d) *C. trifascialis*, e) *C. vagabundus* (juv), dan f) *Chelmon rostratus*. 
In general, the two observation islets have a diversity of Chaetodontidae family species that are categorized as low (n species <10), according to Giyanto et al [34]. It could be an indication of the present of coral reef ecosystem disturbances in Gili Layar and Gili Rengit. In addition, it also supports the previously explained results regarding the unstable community of reef fish in both islets. Joint efforts between the government and the community are needed to maintain the environmental sustainability [35]. Thus, supporting the stability of the coral reef ecosystem and reef fish communities of Sekotong Bay in the near future.

4. Conclusion
It can be concluded that there are 64 species of coral reef fish belonging to 18 families, which are grouped into four major groups, namely target fish (herbivores and carnivores fish), indicator fish, major fish, and cryptic fish. The piscivores fish is a rare group and only be found in Gili Rengit, possibly due to massive fishing activities. The composition of families in the two stations are different. Nevertheless, the diversity index (H’) at all stations are included in the same category, classify as moderate diversity.

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