Community structure of target reef fish at four tiny islands coral reefs in inner Kotania bay, Maluku Province, Indonesia

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Abstract. Study on community structure of target reef fish at four tiny islands coral reefs in inner Kotania bay was conducted from September 2017 to February 2018. Underwater Visual Census method was used to collect and examine data concerning several parameters of target reef fish community structure. At least 18 families of target reef fish which consist of 37 genera and 105 species were found during the study. Good and excellent categories of coral reefs condition had higher species richness and individual abundance of target reef fish, while lower in fair category. Seven target reef fish species have a wide distribution, while other 15 species were limited. In general, target reef fish community at four tiny islands coral reefs had high species diversity and evenness indexes with low species dominance value. It can be concluded that target reef fish community in the area in stable or in steady state condition.

1. Introduction
Kotania bay can be classified as a specific bay in the Western Seram Regency because it has five tiny islands, where four of those are in inner bay while one tiny island is in outer bay. Kotania bay has three tropical ecosystems i.e. mangroves, seagrass and coral reefs [1], as well as 11 very small to medium lagoons [2]. Kotania bay has some ecological functions, namely spawning, nursery and feeding grounds, as well as shelters of various species of economically important finfish [1, 2]. Therefore, the Kotania bay become important habitat of various marine biotas.

Kotania bay by has 736 ha of coral reefs which is distributed surrounding the four tiny islands and lagoon edge in inner bay. Based on ecological and production functions, coral reefs in inner Kotania bay become potential habitat for variety of fisheries resource, especially reef food fishes. Based on utilization function and ecological aspects, reef fish were classified into three groups, namely target, indicator and major reef fish [3, 4]. Target reef fish are group of consumable fish species and usually caught by fishers [4]. Exploitation of target reef fish in Kotania bay has been done for long time by artisanal fishers and this activity continues to increase because of market demand and local consumption needs [1]. It is a common thing found in Indonesia, where the exploitation or utilization of target reef fish was carried out without data base of potency and the condition of target reef fish itself, as well as their living habitat. As the results, the population of target reef fish becomes decreased and their coral reefs habitat becomes damaged due to fishing activities.

Previous studies on target reef fish (reef food fish) resources at Kotania bay coral reefs has been done that describe status of grouper fisheries [1], the sustainability of adult fish populations in Kotania bay [2] and the potency and condition of reef fish [5]. However, there is no research on community structure of target reef fish in the coral reefs of Kotania bay. Therefore, this study was conducted with the objective to examine the community structure of target reef fish, i.e. taxa composition, species richness, individual abundance, species distribution, species diversity, dominance and species evenness index at four tiny islands coral reefs in inner Kotania bay.
2. Materials and Methods

The research was carried out at four tiny islands coral reefs in inner Kotania bay, Western Ceram Regency, Maluku Province (Figure 1) from September 2017 to February 2018. Taxa composition and species richness, individual abundance of target reef fish species data were obtained through survey on 11 coral reef stations using Underwater Visual Census method [3, 6, 7].

![Figure 1. The map showing research station at four tiny islands coral reefs in inner Kotania Bay](image)

Species of target reef fish at four tiny islands coral reefs was identified according to Kuiter (1992)[8], Heemstra and Randall (1993)[9], Kuiter and Tanozuka (2001)[10], Allen et al (2003)[11], Peristiwady (2006)[12] and White (2013)[13]. Data of taxa composition, species richness and individual abundance of target reef fish species was tabulated, presented in graph and explained descriptively. Species diversity, dominance and species evenness index of target reef fish were analyzed following Odum (1975)[14] while the assessment criteria of each ecological index were determined following Deget (1976)[15]. The Formula and criteria of these three ecological indexes are as follows:

**Shannon (Species Diversity) Index :**

\[ H = - \sum (pi) \ln (pi) \]

where : \( H \) = Shannon (species diversity) Index
\( pi = (ni/N) \), \( ni = \) individu number of i-species, \( N = \) total individu of all species,

Assessment criteria of Shannon Index [15] as follows :
If \( H' \leq 2.1 \) : low species diversity index;
If \( 2 < H' < 3.0 \) : moderate species diversity index;
If \( H' \geq 3.0 \) : high species diversity index

**Simpson (Species Dominance) Index :**

\[ D = \sum (pi)^2 \]

Assessment criteria of Simpson Index [15] as follows :
If \( 0.00 < D \leq 0.50 \) : low species dominance index;
If $0.50 < D \leq 0.75$: moderate species dominance; 
If $0.75 < D \leq 1.00$: high species dominance index

**Evenness (Species Evenness) Index**: $E = H/H_{\text{max}}$ 

where: $H_{\text{max}} = \ln S$; $S$ = number of species

Assessment criteria of Evenness Index [15] as follows:
If $0.00 < D \leq 0.50$: high species evenness index; 
If $0.50 < D \leq 0.75$: moderate species evenness index; 
If $0.75 < D \leq 1.00$: high species evenness index

### 3. Results and Discussion

#### 3.1. Taxon composition, species richness and individual abundance

There are 105 species of target reef fish belong to 37 genera and 18 families identified occupy coral reefs of four tiny islands in inner Kotania bay. Serranidae (groupers), Acanthuridae (surgeonfish) and Scaridae (parrotfish) families had high species richness, however, Kyphosidae (lowfin drummer) and Scombridae (Mackerel) families have low species richness (Figure 2). Species richness of target reef fish found in this study is higher than 49 species found at the coral reefs of Marsegu island [5] in outer Kotania bay and 89 species at coral reefs of Wetar, Southwest Maluku Regency [4]. Furthermore, species richness of target reef fish at four tiny islands coral reefs are higher than 91 species of the small islands coral reef of Eastern Seram Regency [16] and 77 species of target reef fish in Tuhaha bay coral reefs, Central Maluku Regency [7].

![Figure 2. Species richness of 18 families of reef food fishes at four tiny islands coral reefs](image)

One family of reef fish which commonly called target fish is Lutjanidae. Species richness of Lujanidae (9 species) at coral reefs of four tiny islands (exploited area) were lower than 10 species at coral reefs (exploited area) of Tuhaha bay waters[7], 12 species at the small islands coral reefs (unexploited area) of Eastern Seram Regency [16] and 14 species at coral reefs of Wetar (unexploited area), Southwest Maluku Regency [4]. Based on the above description, predictable the utilization activities of target reef fish at four tiny islands coral reefs were relatively intensive. Species richness of target reef fish which belongs to viscivores group such as Serranidae, Lutjanidae, Lethrinidae and Carangidae become lower because of intensive fishing activities [17].

Species richness of groupers found in 11 coral reef stations (15 species) were lower than 35 grouper species was found by [1] in Kotania Bay and relatively lower than 19 species of groupers found in coral reefs of Tuhaha bay waters [7]. This is due to the use of UVC method which is limited on the reef margin to slope zone of the four tiny islands coral reefs, while groupers which fishing by
Kotania bay fishers are carried out in relatively deep waters surrounding coral reefs of these four tiny islands. In addition, when species and individuals data of target reef fish species collected using UVC method, it is possible some species of groupers were not seen due to they are sheltered under or in the crevices of coral colonies [18].

Species richness of target reef fish at coral reefs ST10, ST3 and ST9 were relatively higher than other eight coral reef station, while lower at coral reefs ST11 (Figure 3 and Table 1) because the only 19 species of target reef fish were found at this station. Good and excellent categories of coral reefs condition (ST10, ST3 and ST9) had higher species richness of target reef fish, while fair category (ST11) has lower one. This fact shows that the higher and lower species richness of target reef fish depending on coral reef conditions as their living habitat [19, 20]. In this case, good until excellent categories of coral reef conditions and high variation of coral species has also have higher species richness of the reef fishes [20, 21].

**Figure 3.** Species richness of target reef fish at eleven coral reef stations in inner Kotania bay

Individual abundance of target reef fish at coral reefs ST9, ST3, ST10 dan ST1 were relatively higher, while lower at coral reefs ST11 (Figure 4 and Table 1). Good and Excellent categories of coral reefs condition in ST1, ST10, ST3 and ST9 had higher individual abundance of target reef fish, while fair category (ST11) has lower individual abundance (Figure 4 and Table 1). This fact indicate that the higher and lower individual abundance of target reef fish are depending on coral reef conditions as their living habitat [19, 20].

*Caesio teres* (Fusiliers) has higher individual abundance at five coral reefs stations (ST1, ST4, ST7, ST9, ST10), *Pterocaesio tile* (Fusiliers) at two coral reef stations (ST5, ST8), *Ratreliger kanagurta* (Long Jawed Mackerel) also at two coral reefs stations (ST2, ST3). Individual abundance (250 m² coral reefs area) of target reef fish are highest at nine coral reef stations due to *Caesio teres, Pterocaesio tile* and *Rastreliger kanagurta* on coral reefs form aggregation with large schooling [10, 11]. In additions, *Hyposcarus longiceps* dan *Ctenochaetus striatus* have higher individual abundance at coral reefs ST6 and *Siganus canaliculatus* at ST11 because those three target reef fish species were also form aggregations with large schooling [11, 12, 22]. *Caesio cuning, Siganus vulpinus* and *Ctenochaetus striatus* are indigeneous species in coral reefs [4] although *Siganus vulpinus* has lower abundance and limited distribution. Generally, *Caesio cuning* found in schooling [10, 11], however, individual number in this study were lower (< 30 individu) and only found at six coral reef stations.

Data on the presence of target reef fish species at sampling sites shows that there are seven species of target reef fish, namely *Ctenochaetus striatus, Lethrinus harak, Scolopsis bilineatus, Chlorurus sordidus, Cephalopholis argus, Epinephelus merra* and *Siganus gutattus* which have a wide distribution because they are found at all coral reef stations. It can be theoretically stated that the seven species of target reef fish were able to adapted and associated [23] with the biophysical environment of the eleven coral reef stations in inner Kotania bay. In addition, 15 species of target reef fish, namely...
Acanthurus triostegus, Caesio caerulea, Caranx melampygus, Platax teira, Plectorhinchus orientalis, Myripristis kuntee, Myripristis violaceus, Lutjanus madras, Pinjalo pinjalo, Scolopsis trivittatus, Scarus quoy, Epinephelus lancelatus, Siganus coralinus, Siganus oramin and Siganus puellus have limited distribution because it is only found on one of the observed coral reef station. It can be stated that these 15 species of target reef fish live on microhabitat of coral reefs. Data on taxa composition shows that the seven coral reef station have limited distribution of target reef fish species with the relatively high number of species at coral reefs ST9 (4 species) and ST10 (3 species). On the contrary, other four coral reef stations do not have limited distribution of target reef fish species.

![Figure 4](image)

**Figure 4.** Individual abundance of target reef fish at 11 coral reef stations in inner Kotania bay

### 3.2. Species diversity, dominance and evenness indexes

Values of species diversity index (H) of target reef fish at the four tiny islands coral reefs range of 2.2 to 3.6 (Table 1). Species diversity index of target reef fish at these four tiny islands coral reefs is higher than coral reefs of eastern Flores Regency, Nusa Tenggara Timur Province [24]. Based on the assessment criteria of species diversity index value [15], species diversity index of target reef fish were high at seven coral reef station, while other four coral reef stations have moderate species diversity index (Table 1).

Rare species of biota (low individual number) provide a big contribution on value of species diversity index in its community [14]. Contribution of rare target reef fish species category on species diversity index in target reef fish community at eight coral reef stations ranged from 50.2% to 67%. On the contrary, contribution of 1-2 dominant species of reef fish on species diversity index in target reef fish community were only 12% (ST3, ST9) to 32% (ST11). Moreover, contribution of rare target reef fish species on species diversity index in target reef fish community at three coral reef stations were lower, i.e. 42% (ST4), 47% (ST7) and 30% (ST11).

Value of species dominance index (D) of target reef fish among coral reef station in inner Kotania bay ranged from 0.05 to 0.18. Based on assessment criteria of the value of species dominance index [15], the dominance of target reef fish species in the community of each coral reef station is low (Table 1). Dominant species of biota (many number of individuals) provide a big contribution on value of species dominance index in its community [14]. Contributions of dominant species on value of species Dominance Index (D) of target reef fish community were high, which range from 62% (ST10) to 95% (ST3). In this case, Rastreliger kanagurta has high individual numbers at coral reefs ST3, while Caesio teres at coral reefs ST10.

Evenness index (E) values of target reef fish among coral reef stations of four tiny islands range from 0.72 to 0.87 (Table 1). Species evenness index of target reef fish at the four tiny island coral reefs is higher than coral reefs of eastern Flores Regency, Nusa Tenggara Timur Province [24]. Based
on assessment criteria of value of species evenness index [15], target reef fish community are high at eight coral reef stations and moderate at three coral reef stations (Table 1).

| Station | No. of Species | No. of Ind. | Diversity Index (H) | Criteria | Dominance Index (D) | Criteria | Evenness Index (E) | Criteria |
|---------|----------------|-------------|---------------------|----------|---------------------|----------|-------------------|----------|
| ST1     | 50             | 298         | 3.3                 | High     | 0.07                | Low      | 0.85              | High     |
| ST2     | 47             | 243         | 3.0                 | High     | 0.08                | Low      | 0.78              | High     |
| ST3     | 61             | 320         | 3.0                 | High     | 0.10                | Low      | 0.75              | Moderate |
| ST4     | 32             | 197         | 2.5                 | Moderate | 0.15                | Low      | 0.72              | Moderate |
| ST5     | 31             | 131         | 2.7                 | Moderate | 0.11                | Low      | 0.80              | High     |
| ST6     | 51             | 199         | 3.2                 | High     | 0.06                | Low      | 0.87              | High     |
| ST7     | 31             | 123         | 2.8                 | Moderate | 0.12                | Low      | 0.82              | High     |
| ST8     | 39             | 145         | 3.0                 | High     | 0.09                | Low      | 0.81              | High     |
| ST9     | 59             | 412         | 3.0                 | High     | 0.11                | Low      | 0.76              | High     |
| ST10    | 62             | 304         | 3.6                 | High     | 0.05                | Low      | 0.87              | High     |
| ST11    | 19             | 65          | 2.2                 | Moderate | 0.18                | Low      | 0.73              | Moderate |
| Total   | 105            | 2437        | 3.1                 | High     | 0.10                | Low      | 0.80              | High     |

Odum (1975)[14] stated that a community of biota is in steady state condition if the value of evenness index ≥ 0.6. Based on this statement, the target reef fish community in inner Kotania bay are in steady state condition (Table 1), although the utilization of target reef fish has been done for long time [1,2] and the condition of four coral reef stations were in fair category.

4. Conclusion
A total of 105 target reef fish species which belong to 37 genera and 18 families were identified during the study at coral reefs of four tiny islands in inner Kotania bay. Target reef fish families of Serranidae, Acanthuridae and Scaridae had high species richness. Species richness and individual abundance of target reef fish were higher at coral reef condition belongs to good and excellent category than those at fair category. Seven of target reef fish species have a wide distribution, while distribution of other 15 species have limited at coral reefs habitat. Generally, the community of target reef fish at coral reefs in inner Kotania bay had high species diversity with low species dominance, and moderate to high values of species evenness index or target reef fish community in inner Kotania bay are stable or in steady state condition.

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