An assessment of small islands coral cover and coral-reef fish diversity at Oba Sub-district, Halmahera Island

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Abstract. Study on the percentage of coral cover four small islands of Oba Sub-district, Halmahera Island of North Maluku Utara Province was carried out in April 2021. The four small islands of Oba Sub-district studied are Woda Island, Raja Island, Tamin Island, and Guratu Island. The study applied systematic sampling method that included collecting coral reef data using UPT (Underwater Photo Transect) method and coral fish data collection using visual census method. Study results showed that live coral coverage of reefs on the four small islands of Oba Sub-district had the highest value of 5.41% and the lowest value of 4.29%. There was positive relationship between coral growth form diversity and fish diversity. High diversity of coral growth forms was significantly related to high diversity of target reef fish.

1. Introduction
Coral reefs grow and develop in shallow water, distributed at various depth contours. [1] Coral reefs grow optimally up to 25 m depth. Live coral reefs spread at various depths, depending on the topography of the waters. In general, coral reefs are divided into three types of coral reefs, namely fringing reefs, barrier reefs and ring reefs (atolls). Geographically, distribution of coral reefs is dominantly found in tropical areas [2].

North Maluku Province, which is located in eastern part of Indonesia, is an archipelago with an area of about 140,255.26 km² which consists of a water area of 106,977.32 km² and a land area of 33,278.04 km² and consists of a group of islands with a total of more than 800 islands both large and small [3]. This cluster of small islands includes coastal areas and waters that deviate a number of potential marine natural resources and environmental services that can be used as basic capital for future development.

Oba Sub-district is one of area in Halmahera Island that has extensive coral reef ecosystems. However, we found that there is limited data and information about coral reefs in the waters of Oba Sub-district, including in its four small islands complex. That was our goal to carry out this research to provide data and information about coral reef ecosystems of small island of Oba Sub-district.

2. Method
2.1. Research location
Sampling location was in four small islands of Oba Sub-district as shown in Figure 1.
2.2. Data sampling

2.2.1 Coral reefs
Data collection on coral reef ecosystems was carried out using the Underwater Photo Transect (UPT) method [4]. The UPT method utilizes technological developments, both digital camera technology and computer software technology. Data collection in the field was in form of underwater photographs that were taken using underwater digital camera, or ordinary digital camera that was given a waterproof camera housing. The photos from the shooting were then analyzed using computer software (CPCe application) to obtain quantitative data.

2.2.2 Diversity index
Shannon diversity index, $H'$ was used to describe coral species diversity in each sampling location [5]. Then, based on their Shannon diversity index, coral reefs can be classified into three groups [6], as follows:

- $H' \leq 1$ : Low diversity.
- $1 < H' < 3$ : Medium diversity.
- $H' \geq 3$ : High diversity.

2.2.3 Coral cover percentage
Coral cover data was collected using photo point method, where population was all organisms and substrates captured in photos. The data recorded was only organisms and substrates that were right at sampling point. Position of sampling point was determined randomly by the CPCe software. Taxonomic names were recorded at species level referred to [5]. Finally, based on the CPCe calculation results, data was grouped based on their coverage categories [7], as follows:

- Coral cover percentage 0 - 24.9 % : Bad coral cover
- Coral cover percentage 25 - 49.9 % : Fairly good coral cover
- Coral cover percentage 50 - 74.9 % : Good coral cover
- Coral cover percentage 75 - 100 % : Very good coral cover.

2.3. Data analysis
Calculation of the percentage of coral cover (Percent of Cover) for each category of live coral growth by comparing the total length of each category with the total transect length using the following equation [8]:

$$ r = \frac{n (EXY) - (EX)(EY)}{[n (EX2 - \frac{[EX]^2}{2})]^2 [n(EY2 - [EY2]^2)]/2} $$
Where \( n = \) Number of data pairs \( X \) and \( Y \), \( \Sigma x = \) Total Sum of Variable \( X \), \( \Sigma y = \) Total Sum of Variables \( Y \), \( \Sigma x^2 = \) Square of Total Number of Variables \( X \), \( \Sigma y^2 = \) Square of Total Number of Variables \( Y \), \( \Sigma xy = \) Multiplication of Total Amount, and Variable \( X \) and Variable \( Y \)

### 3. Result and discussion

Study result showed that the four small islands of Oba Subdistrict studied had difference species diversity of coral reefs. List of hard coral genus found on each small island of Oba Subdistrict was presented in Table 1 below. At Woda Island, 17 hard coral genus were found, 16 genus were found at Raja Island, and 12 and 15 genus were found at Tamim and Guratu islands, respectively. All in all, Woda Island had the highest coral diversity with 17 genus of hard corals.

| No | Woda Island | Raja Island | Tamim Island | Guratu Island |
|----|-------------|-------------|--------------|---------------|
| 1  | Acroporapalifera | Aroporidae | Acroporatenuis | Acroporapalifera |
| 2  | Montiporadanae | Montiporacapricornis | Euphyliaglabrescens | Acroporapalifera |
| 3  | Montiporaundata | Matiporadanae | Turbinariastellulata | Gonioporastutchburyi |
| 4  | Montipora stellate | Matiporaundata | Acroporapalifera | Palauastrearomosa |
| 5  | Euphyliaglabrescens | Montipora stellate | Gardineroserisplanulata | Acroporamillepora |
| 6  | Acroporatenus | Acroporatenus | Acroporaprestrata | Gonioporastutchburyi |
| 7  | Goniastrearamosa | Acroporagenulosa | Diploastreaheliopora | Montiporadanae |
| 8  | Montiporadanae | Loptoserisscabra | Faviarotumana | Acroporatenus |
| 9  | Loptoserisscabra | Acroporusuharsonoi | Goniastreacwardsi | Acroporagenulosa |
| 10 | Acroporaflorida | Acroporapalifera | Euphyliaglabrescens | Acroporapalifera |
| 11 | Aroporamillepora | Agriciidae | Foliosa | Aroporamillepora |
| 12 | Acroporagenulosa | Loptoserisscabra | Euphyliaglabrescens | Loptoserisscabra |
| 13 | Loptoserisscabra | Faviidae | Montiporadanae | Montiporadanae |
| 14 | Caryophyllidae | Caryophyllidae | | Acroporatenus |
| 15 | Gonioporastutchburyi | Catalaphylliajardinea | | |
| 16 | Faviidae | Gonioporastutchburyi | | |
| 17 | Palauastrearomosa | |

Study result showed that live coral coverage in all four small islands were in moderate category with live coral coverage percentages in range of 14.33% - 39.13%. Field observation suggested that human activities were a factor for coral reef degradation of the four small islands of Oba Subdistrict. Either directly or indirectly, human activities has caused many coral damages in those four island coral reefs. Human factors might also affect coral growth at the research site. Study of [9] showed that many human activities in coral reef areas, especially such as anchoring, were factor causing coral individuals or colonies to be damaged or broken. At some points over coral reefs at study sites, there were massive damages areas that was suspected to be caused by illegal blast fishing activities. Signs of use of non reef friendly trawls were also observed over coral reefs at the study sites.
Total average live coral cover percentages by genus at four small islands of Oba subdistrict are presented in Figure 2. The results showed that Woda and Raja islands had low coral cover categories, namely 23.14% and 14.64%. While higher coral cover percentages were found at Tamim and Guratu islands that reached 43.16% and 55.56%, respectively. Very poor cover and damaged coral condition was observed at station 21, which only had a live coral cover area of only 6%. Coral reefs of Woda Island had undergone bleaching, and the condition of the substrate was predominantly rubble and dead coral.

Results of fish visual census were to determine coral reef fish diversity and abundance. Total diversity of reef fish at 4 studied islands was 29 species of reef fish from 10 families. Of the 10 families of reef fish found, 1 family was a dominant group, namely Pomacentridae (6 species) that was classified as major fish. The type of fish that had high frequency of appearance at 4 islands coral reef was Chromis viridis from Pomacentridae family. This fish species was often found in large numbers and in groups.

Study result was in accordance with finding of [11] that Pomacentridae was one of the most abundant fish groups in tropical coral reefs, both in terms of number of species and number of individuals. Solitary fish was a type of fish that lives in pairs or aggregates to be common and depending on the species. This fish not only inhabited coral reefs and rocky reefs, but was also common in shallow water habitats and coral rubble piles, murky waters, harbor areas and seagrass beds.

Based on study results of the study, all 4 small islands had large target fish diversity of 09.05%, which was a low level. For medium target fish diversity, the value was 5%. None of island had high category of target fish diversity. Similar results were found for coral growth diversity that were ranged from 4 to 5%, or in low level category (Figure 4).
Figure 3. Coral characteristics.

Figure 4. Reef fish diversity
Figure 5. Dominance of reef fish

Figure 6. Dominance of reef fish.
Figure 5 shows the results of the analysis of the percentage of coral fish composition. The graph in Figure 5 shows that Guratu Island had a highest dominance values for most of fish species. High composition of coral reef fishes at Guratu Island was related to good coral cover and health coral reef condition. Based on the range of the number of target fish on each islands, it could be stated that at Tamim Island and Guratu Island had very significant fluctuations in numbers or a large range of fish numbers. At Tamim Island ranged between 2-57 fish and at Guratu island was around 4-67 fish, while at Raja Island ranged between 2-32 individuals and Woda Island of 1-33 individuals.

4. Conclusion
The average value of target reef fish diversity was low with a value of 5.42 individuals with a standard deviation of 0.25. The highest value of target fish diversity was 7.30 and the lowest value was 0.6 and had an average value of moderate diversity of coral growth forms with a value of 3.17 with a standard deviation of 0.15. The highest value of coral reefs was 5.41 and the lowest value was 4.29.

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