Diversity of Reef Fish in Tapian Nauli Bay, Central Tapanuli

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Abstract Tapian Nauli Bay is along the coast of Sibolga Bay starting from the border of Sibolga City towards Barus, Tapanuli Tengah. In the Tapian Nauli Bay area there are plenty of fish biological resources and coral reef ecosystems. It is known that the reef fish community is a biotic component of the coral reef ecosystem that can be utilized as marine biological resources. This study aims to examine the diversity of reef fish. The method used in monitoring reef fish is a method *Underwater Visual Census* (UVC). The reef fishes observed were then grouped into 3 groups of fish, namely: target species, indicator species, and major species, then the structure of the reef fish community was calculated. The results showed that the composition of reef fish species in Sitardas Beach and Bakar island was dominated by major fish (97%), then followed by target fish (2%) and indicator fish (1%). And, overall the diversity of reef fish species in the Sitardas Beach and Bakar island waters shows a low level and shows a relatively unstable uniformity level.

1. Introductions
Fishes are one of the most important biotic components in the aquatic environment. They fill a very specific habitat by meeting a variety of waters substratum. Several studies have mentioned the importance of glittering fish communities in ecosystem processes through trophic relationships with other biotic components [1].

Reef fish community is a biotic component of the coral reef ecosystem that can be used as marine biological resources. Reef fish make the coral reef ecosystem as a habitat for shelter (shelter), a place to look for food (feeding ground), breed (spawning ground), and as a nursery ground. [2] The existence and diversity of reef fish is determined by the condition of coral reefs, this is because in the coral reef ecosystem the coral fish are the most numerous organisms found. Reef fish including resources that can be recovered, conserved and developed such as mangroves, coral reefs, seaweed and marine fisheries resources.

The fish group is the largest taxa of vertebrate animals that are symbiotic with coral reefs and generally have high species diversity. The condition of coral reefs reflects species diversity, the better the condition of the coral, the more diverse the types of fish that live in the ecosystem. Based on the utilization function and ecological aspects, reef fish can be grouped into three namely target fish, indicator fish, and other groups (major groups). Target fish is a group of types of fish that can be consumed and usually hunted by fishermen. Indicator fish are species of fish that have a very strong association with coral habitat. The Chaetodontidae family fish is an indicator of species for coral health. Major groups are groups of species not included in the first and second groups, and in general there is not much known role in nature, except as a food supply for predators (carnivora) [3].
This research was conducted in the Tapian Nauli Bay area along the coast of Sibolga Bay starting from the border of Sibolga City towards Barus, Tapteng. The main economic potentials are sourced from fisheries, tourism, services, trade and maritime industries. In the Tapian Nauli Bay area there are plenty of fish biological resources and coral reef ecosystems. The objective of this research was to record the condition of reef fish found in the Sitardas Beach and Bakar island by looking at the diversity of reef fish in the area.

2. Methodology

This research was conducted in June-July 2019, located in Tapian Nauli Bay, Central Tapanuli, Sibolga. Location of data collection is in Sitardas Beach and Bakar island with coordinates 01°03'59.77" - 01°03'17.79" LU and 09°044'43.67" - 09°044'38.11 BT" and administratively located in Sitardas village Tapian Nauli District Central Tapanuli Regency North Sumatra Province. Map of the research location can be seen in Figure 1.

![Figure 1. Map of research](image)

2.1. Observation data Reef Fish

The method used in monitoring reef fish is Underwater Visual Census (UVC) methods [4]. Monitoring is carried out on the same transect line as coral research activities, so as to obtain benthic data that describe their habitat. Observations were made along the transect line where fish that were at a distance of 2.5 m to the left and right of the 70 m transect line were recorded for their species and the number of individuals. The area of field observed per transect is (5 m x 70 m) = 350 m$^2$.

Determination of the observation station point is done by considering the overall representation of ecosystem characteristics in the study location. The reef fishes observed were further grouped into 3 fish groups, namely: (1) target species, (2) indicator species, and (3) major species. Identification of reef fish species is carried out directly in the field (for fish species recognized at the time of observation) according to [5][6].
2.2. Reef Fish Data Analysis
Fish data obtained were used to calculate the values of population density, relative density, frequency of attendance, Shannon-Wiener diversity index, equity index with the equation according to Effendi [7] as follows:

a. **Abundance (A)**

\[
A = \frac{\text{Number of total individual of species}}{\text{Area sampled (m}^2\text{)}}. \tag{1}
\]

b. **Relative Density (RA)**
Relative abundance was calculated using the formula, where RA is the relative abundance (%)

\[
\text{RD} = \frac{\text{A total number of types } i (\text{ind})}{\sum \text{number of individuals of all types (ind)}} \times 100 \% \tag{2}
\]

c. **Frequency of Attendance (FA)**

\[
\text{FA} = \frac{\text{Number of transects occupied by a type}}{\text{Total number of transects}} \times 100 \% \tag{3}
\]

FA: 0 - 25% = very rare
25 - 50% = rare
50 - 75% = often
> 75% = very often

d. **Diversity Index Shannon – Wiener (H')**
Diversity index was calculated using Shannon-Wiener index, where H’ is diversity index and Pi is proportion of the species-i. Categories of diversity are: \( H' < 1 \) = low, \( 1 < H' < 3 \) = moderate and \( H' > 3 \) = high

\[
H' = - \sum_{i=1}^{n} Pi \ln Pi \tag{4}
\]

e. **Evenness Index (E)**
Evenness index was calculated using the Evenness index formula, where E is evenness index H’ is Diversity index and S is number of types of organisms. Categories of Evenness index are: E < 0,4 = low, 0,4 < E < 0,6 = moderate and E > 0,6 = high

\[
E = \frac{H'}{\ln S} \tag{5}
\]
3. Results and Discussion

3.1. The composition of the group of reef fish

There are 5 families in the composition of reef fish, namely Pomacentridae, Lutjanidae, Apogonidae, Zanclidae and Acanthuridae as can be seen in Figure 2. The most commonly species found is from the Family Pomacentridae, as many as 97 species found in Sitardas Beach. The smallest number of species found is from the Zanclidae family of 1 species which is found in Sitardas beach. Later, species from the family of Apogonidae and Acanthuridae were only found on Bakar island and were not found on the Sitardas beach.

![Figure 2. Family of Reef Fish](image)

The visual census results of reef fish conducted in the waters of Sitardas Beach and Bakar Island can be seen in Figure 3. This figure indicates that the major fish group is the most dominant, found as many as 190 fishes or 97% of total reef fish, then the target fish group is 4 fish (2%) and the indicator fish group as many as 2 (1%).

![Figure 3. The composition of the group of reef fish](image)

In general, the composition of reef fish groups in Pantai Sitardas and Pulau Bakar is dominated by major fish groups, which shows a relatively stable condition in the ecosystem. The composition of the target fish group with the second highest percentage after the major fish group shows that it is still possible in its use but must be with the precautionary principle. The number of indicator fish groups is only one, indicating that the condition of coral reef ecosystems in the waters of the Tapian Nauli Bay is
not in good condition, because indicator fish are a guide to assessing whether or not the condition of coral reefs [8].

The major fish group with the highest frequency of occurrence is the Neopomacentrus azysron from the Pomachantridae family. Major fish groups are fish that play a role in the food chain, such as fish from the family Pomacentridae, Scaridae, Acanthuridae, Caesionidae, Labridae, Siganidae, Mullidae and Apogonidae [9]. (Lauwoie, 2010). Major fish are groups of species not included in the first and second groups, and in general there is not much known role in nature, except as a food supply for predators (carnivores) [3].

There are very few groups of indicator fish found. This shows that the fertility of coral reef ecosystems in the waters of Pantai Sitardas and Pulau Bakar is not in a good condition, because the indicator fish group is a typical reef fish species inhabiting relatively healthy coral reef areas. This is in accordance with [3] which states that indicator fish are fish species that have a very strong association with coral habitat, Chaetodontidae fish family as species indicator for coral health.

Reef fish for the target fish group only 1 species were found, namely in Pantai Sitardas. [10] [11] suggested that the species richness of the target fish from the predatory fish groups (piscivores) such as; Serranidae, Lutjanidae, lethrinidae, and Carangidae are low due to intensive fishing activities.

The results of research conducted at each study location, the value of Individual Density (ind / m²), Relative Density (RA%) and Frequency of Attendance (FA%). Can be seen from table 1.

| Table 1. Abundance (A), Relative Density (RD) dan Frequency of Attendance (FA) |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Spesies/Family                  | Group           | Abundance (A)   | Relatif Density (RD) | FA              |                  |
|                                 |                 | Sitardas Beach  | Bakar Island       | Sitardas        | Bakar Island     |
| Pomachantrida                   | Major           | 0,0000          | 0,0029             | 0,0000          | 1,1494           | 33,3333          |
| Abudefdufsexfasciatus           | Major           | 0,0086          | 0,0029             | 2,7778          | 1,1494           | 66,6667          |
| Chaetodontoplusmesoleucus       | Major           | 0,1800          | 0,0000             | 58,3334         | 0,0000           | 33,3333          |
| Neopomacentrusazysron           | Major           | 0,0029          | 0,0000             | 0,9259          | 0,0000           | 33,3333          |
| ChromisLineata                  | Major           | 0,0086          | 0,0029             | 2,7778          | 1,1494           | 66,6667          |
| Pomacentrusgeminospilos         | Major           | 0,0771          | 0,0314             | 25,0000         | 12,6437          | 66,6667          |
| PomacentrusLeptus               | Major           | 0,0029          | 0,0000             | 0,9259          | 0,0000           | 33,3333          |
| Lutjanidae                      | Target          | 0,0200          | 0,0800             | 6,4815          | 32,1840          | 66,6667          |
| Paracaesioxanthurus             | Major           | 0,0057          | 0,0000             | 1,8519          | 0,0000           | 33,3333          |
| Halichoereschrysoentaia         | Major           | 0,0200          | 0,0714             | 6,4815          | 32,1840          | 66,6667          |
| Halichoeres bicolor             | Major           | 0,0000          | 0,0457             | 0,0000          | 18,3908          | 33,3333          |
| Apogonidae                      |                 | 0,0000          | 0,0147             | 0,0000          | 28,7357          | 33,3333          |
| Cheilodipterusquinquelincatu     | Major           | 0,0000          | 0,0457             | 0,0000          | 18,3908          | 33,3333          |
| Apogon Compresus                | Indicato        | 0,0029          | 0,0000             | 0,9259          | 0,0000           | 33,3333          |
| Zanclidae                       |                 | 0,0000          | 0,0147             | 0,0000          | 28,7357          | 33,3333          |
| Zanclus cornutus                |                 | 0,0000          | 0,0114             | 0,0000          | 4,5977           | 33,3333          |
| Acanthuridae                    | Target          | 0,0000          | 0,0147             | 0,0000          | 28,7357          | 33,3333          |
| Chromisopercularis              |                 | 0,0000          | 0,0114             | 0,0000          | 4,5977           | 33,3333          |
| Total                           |                 | 0,3086          | 0,2486             | 100,0001        | 2                | 67               |
The highest individual density value in the Sitardas Beach is 0.18 ind / m² in the species of *Neopomacentrus azysron* family Pomachantridae, while in Bakar Island is 0.08 ind / m² in the *Halichoeres chrysotaenia* species of the Lutjanidae family. The highest relative density (RD) values in the Sitardas beach were found in *Neopomacentrus azysron* 58.33% and in Bakar Island found in *Halichoeres chrysotaenia* species 32.18%. The high and low values of Abundace and Relatif Density at these stations are influenced by environmental conditions or physical, chemical and biological factors as limiting factors that support the growth of reef fish. Besides these factors, the limited time of observation and the equipment used can influence it.

3.2. Reef Fish Diversity Index
Analysis of reef fish data was done descriptively by calculating the diversity index and uniformity index. Diversity index is a value that shows the balance of diversity in a number of individuals per species. Uniformity index is a value that shows the balance of uniformity in a number of individuals in each genus. Analysis of the diversity index and the uniformity index of reef fishes conducted at Pantai Sitardas and Pulau Bakar will be described in Table 2.

![Table 2. Ecological indicators of reef fish](image)

| Ecological Indicator                  | Sitardas Beach | Bakar Island |
|--------------------------------------|----------------|--------------|
| Number of Individuals                | 108            | 87           |
| Number of Family                     | 3              | 4            |
| Number of Species                    | 9              | 8            |
| Indicator Species Category           | 1              | 0            |
| Major Species Category               | 7              | 7            |
| Target Species Category              | 1              | 1            |
| Diversity Index (H')                 | 1.24135        | 1.59169      |
| Evennes Index (E)                    | 0.299616       | 0.477669     |

The results of the analysis of the diversity of reef fish species in the waters of Sitardas Beach and Pulau Bakar indicate that the diversity index (H') of the species is 1.24 and 1.59. The diversity index H '<2 indicates that the level of diversity of reef fish species is at a 'low' level as stated by [2] that high diversity values indicate a comfortable and stable environment while low diversity values indicate a stifling and changing environment. Odom [12] states that the greater the value of Uniformity indicates a high diversity of species

The index of coral fish uniformity was 0.299 and 0.478, indicating that the reef fish community in the waters of Sitardas Beach and Bakar Island were in 'low' condition. Uniformity index values close to 0, then in the ecosystem the distribution of individuals between species is not evenly distributed or there are certain types that are dominant caused by the instability of environmental and population factors. According to Giffar [13] the pattern of fluctuations in the abundance of target reef fishes does not always coincide with the pattern of fluctuations in the percentage of coral cover. The instability of the abundance of each family may occur due to anthropogenic and natural disturbance to the appearance of fish at the observation site.

Almost all fish that live on coral reefs have high dependence, both in terms of protection and food for corals. Therefore the number of individuals, species, and species composition are influenced by local conditions. There are many studies that have been proven the existence of a positive correlation between the complexity of coral reef topography with the distribution and abundance of fish. One study on coral reefs suggested that coral fish have a strong association with corals and can be used as an indicator of coral health [14]

Although there is a correlation between live coral cover with abundance of reef fish, this fish is less able to be used as a bioindicator because of the close relationship [13]. On the other hand, not all reef fish prey on corals (corallivore) directly. So, they are less sensitive to changes in a coral reef system.
4. Conclude
The results showed that the composition of reef fish species in Sitardas Beach and Bakar Island was dominated by major fish (97%), then followed by target fish (2%) and indicator fish (1%). And, overall the diversity of reef fish species in the Sitardas Beach and Bakar Island waters shows a low level and shows a relatively unstable uniformity level.

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