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Diversity, evenness and dominance index reef fish in Krueng Raya Water, Aceh Besar

M Ulfah^{1,4*}, S N Fajri^{1,5}, M Nasir², K Hamsah³ and S Purnawan¹

¹Marine Science Department, Faculty of Marine and Fisheries, Universitas Syiah Kuala , Banda Aceh – Indonesia, 23111.

²Departement of Biology, Faculty of Mathematics and Natural Science, Universitas Syiah Kuala , Banda Aceh – Indonesia, 23111.

³Marine Sciences Studies Program Sciences, Sekolah Tinggi Pertanian Kutai Timur, East Kalimantan

*Email: mariaulfah@unsyiah.ac.id

Abstract. Coral reef ecosystem is considered as a very complex ecosystem and a habitat for marine biota, included reef fish community. The purpose of this study is to obtain the value of diversity, evenness and dominance index of reef fish in Krueng Raya Waters (KRW). This research was conducted annually during 2014, 2015, 2016 using the UVS (underwater Visual Census) method. The diversity index of reef fish in the KRW is categorized as stable ($1 < H' < 3$), yet it was decreased from 2.6 in 2014 to 2.1 in 2016. the value of uniformity index is ranged 0.8 to 0.62 (2014 to 2016) as it categorized as low. Furthermore, the dominance index is also indicated in the low category.

1. Introduction

Krueng Raya is administratively located in Aceh Besar Regency and has a very high biodiversity, one of which is reef fish diversity [1]. The reef fish community plays important role in coral reefs ecosystem [2,3]. Krueng Raya waters is a busy areas within ship traffic, tourism and industry . As a result of the activities that are mostly carried out in the waters of Krueng Raya, it can be feared that damage or decline in coral reef ecosystems will have an impact on the decline in fishery resources in the waters of Krueng Raya Aceh. This research becomes important considering the absence of reef fish data in the area, as the outcome may provide information to the community and related parties regarding diversity, evenness and dominance index values of reef fish in the waters of Krueng Raya.

2. Materials and Methods

The main tools and materials used in this research are Scuba, roll meter (150 m) and reef fish identification book [4]. Reef fish data was collected using the UVS (under water Visual Census) method within a 150 m x 5 m transect. The number of reef fish found only along the transect was recorded to calculate the index value of diversity, evenness, and dominance as equations below:



2.1. Diversity Index

Diversity index (H') states the circumstances of the organism's population mathematically to analyze the number of individuals in each growth step or genus in a habitat community. The most commonly used diversity index is the Shannon-Weiner index [5]

$$H' = - \sum_{i=1}^s P_i \ln P_i$$

Where H' = Shannon-Weiner index, $P_i = \frac{n_i}{N}$, n_i = Number of individuals of a species, N = Total individuals of all species

The diversity index criteria are as follows:

$H' \leq 1$	= Low diversity
$1 < H' \leq 3$	= Moderate diversity
$H' > 3$	= high diversity

2.2. Evenness Index

The evenness index (E) describes the number of individuals between species in a fish community. The more evenly distributed individuals between species, the more balanced the ecosystem will be. The formula used is [5]:

$$E = \frac{H'}{H_{max}}$$

Where E = Evenness index, H' = Diversity index, $H_{max} = \ln S$, S = Number of species found

The evenness index value ranges from 0-1. Furthermore, the evenness index based on Krebs [6] is categorized as follows:

$0 < E \leq 0.5$	= Depressed community
$0.5 < E \leq 0.75$	= Unstable community
$0.75 < E \leq 1$	= Stable community

The smaller the evenness index, the population uniformity smaller as well. It shows the distribution of the number of individuals of each species is not similar so there is a tendency for one species to dominate. The greater the uniformity value describes the number of biota in each species the same or not much different.

2.3. Dominance Index

An uniformity index and small diversity indicates a high dominance of a species against other species. The dominance index formula as follows [5]:

$$C = \sum_{i=1}^s P_i^2$$

Where C = Dominance Index, P_i = The proportion of individuals in reef fish species, $I = 1, 2, \dots, n$

Index values range from 0 - 1 by the following categories:

$0 < C < 0,5$ = Low Dominance.

$0,5 < C \leq 0,75$ = Moderate Dominance.

$0,75 < C \leq 1,0$ = High Dominance.

3. Results and Discussions

Diversity Index (H')

The diversity index (H') a waters is where in these waters has a diverse community of biota species, there is no one biota that dominates in a waters. Uniformity Index (E) is the distribution of an individual in the same amount, or spread evenly in a waters. The diversity value affects the level of evenness of a community in the waters.

Dominance index (C) where in a waters there is one of biota species that is more or dominating. Dominance index is inversely proportional to diversity index. The higher the dominance value of a waters, the diversity value of a water will decrease, and and conversely, the higher diversity value of a waters, the dominance value will decrease.

The high and low of diversity values, uniformity and dominance in a waters show an influence on physical chemical factors and availability of fish feed. It is revealed that, other things that affect the Diversity index (H'), Uniformity index (E), and Dominance index (C) can also be affected in the data collection process (Visual Census) [7, 8, 9].

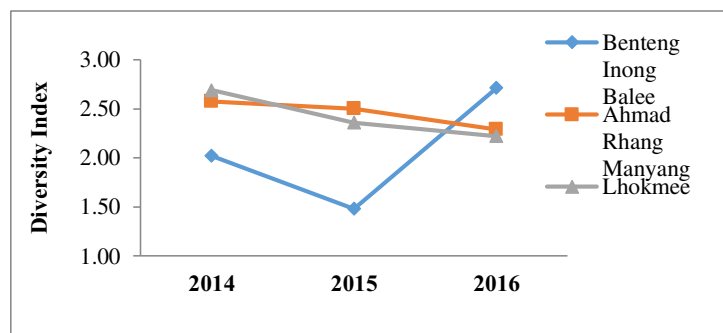


Figure 1. Diversity index on Krueng Raya Water

Figure 1. shows that the results of the calculation of the diversity index (H') in the Krueng Raya waters for 3 years (2014-2016). On station 1, Benteng Inong Balee diversity index value (H') varied annually. The highest level of diversity is in the year 2016 2,71, and the lowest in the year 2015 1,48. Diversity values in the Benteng Inong Balee waters were in stable category. In accordance with Odum's statement [10], the diversity index $1 < H' < 3$ was in the moderate category, in the sense that the ecosystem is still in a stable condition. The high of diversity value is due to the abundance of fish species and the absence of fish species that dominate in these waters.

On station 2, Ahmad Rhang Manyang waters, the diversity index value ranged from 2,29 to 2,58. The highest value is in the year 2014 of 2,58, and the lowest is in the year 2016 of 2,29. The diversity index value (H') at station 2 slow decline in every year, but for now the diversity index values at station 2 is still in a stable category.

On station 3 Lhokmee, the diversity index value ranged from 2,22 to 2,69. The highest diversity index in the year 2014 was 2,69, and the lowest diversity index was in the year 2016 was 2,22. This shows the station 3 diversity index of Lhokmee waters that was once high then decline to be stable. The high and low diversity value (H') in water is influenced by the productivity of the coral ecosystem. Diversity values depend on variations in the number of reef fish species found in water [2,11]. According to Barus's statement [12], if $H' \geq 3$, so the waters by a diversity of fish communities are in the high category.

Evenness Index (E)

The evenness index (E) is a distribution of individuals between different species [8, 13]. On Station 1 it ranges from 0,45 to 0,78, the uniformity index value varies from the year 2014-2016. The highest evenness value is in the year 2016 was 0,78, and the lowest evenness index value is in the year 2015 was 0,45. According to (9) [14], if $0 < E \leq 0,5$, the reef fish community is in the low category, so in the year 2015 the Benteng Inong Balee waters experienced uneven distribution of reef fish due to external pressure on reef fish such as coral damage. Then in the year 2016, the evenness index (E) was at a high position 0,78, the Benteng Inong Balee waters were still in stable condition.

On station 2, the highest evenness index in the year 2016 was 0.76, and the lowest was in the year 2015 was 0,69. Ahmad Rhang Manyang waters are in a good category or stable conditions, there is no pressure on the aquatic environment at station 2. Station 3, the evenness index value ranges from 0,81 to 0,82. The highest evenness index (E) is in the year 2016 was 0,83, and the lowest evenness index value is in the year 2014 was 0,81. On Station 3 in the year 2015-2016, the evenness value has increased by around 0,1, the condition of the water at station 3 is still in a stable category.

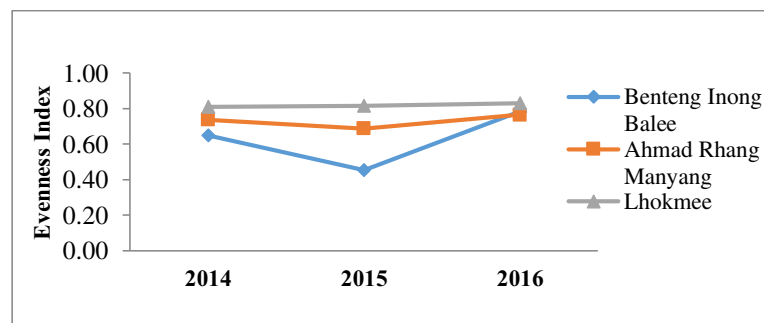


Figure 2. Evenness index of Krueng Raya Waters

The evenness index (E) describes the number of individual sizes between species in a fish community, the more evenly distributed individuals between species, the more balanced the ecosystem will be. According to Setiawan [11], that other factors that influence the high and low diversity value and evenness, are the migration of fish out or in the observation area, so not all fish are recorded, the booming reproductive of species in the month when data was retrieved. Viewed from the biology aspect, there is interference from the waters such as the presence of crown-of-thorns starfish (*Acanthaster planci*) which feed on coral polyps so that the coral dies and makes the fish migrate outside looking for food sources during observation.

Dominance Index (C)

Dominance index (C) which indicates a dominant tendency for a particular species in the reef fish community. On Krueng Raya waters, station 1 in the year 2014 the dominance value was 0,21, in the year 2015 the dominance index was 0,47 and in the year 2016 was 0,13. Station 1 has a variable dominance value.

Dominance index at station 1, was in the low category. According to Odum [10], $0 < C < 0,5$, these waters are in the category of low dominance.

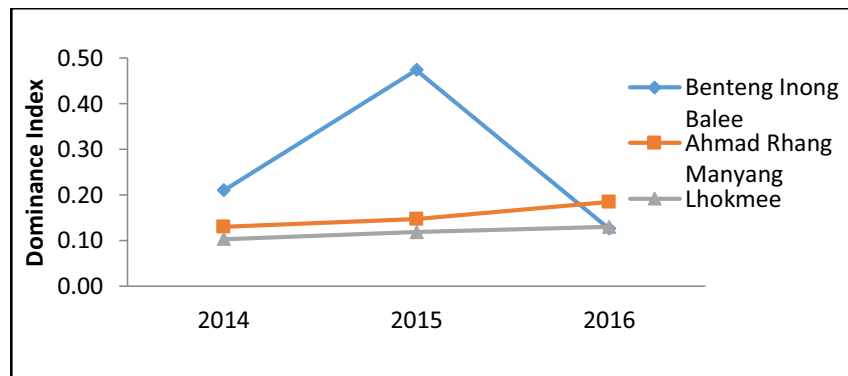


Figure 3. Dominance index of Krueng Raya Waters

Station 2, Ahmad Rhang Manyang waters, dominance index in the year 2014 was 0,13, the year 2015 was 0,15 and the year 2016 was 0,18. Ahmad Rhang Manyang waters every year experience an increase in dominance index, although station 2 is still in the low dominance category. Station 3 in Lhokmee waters, in the year 2014-2016 had a dominance value of 0.11, 0.14, 0.18. Station 3 also experienced an increase in dominance values for 3 years. Lhokmee waters are in low dominance. The high dominance index is influenced by the diversity value. The higher the diversity value, the lower dominance value, and conversely, the higher of dominance value, the diversity will decrease. This is due to the fact that the wrong community of reef fish species dominates so that the dominance index value increases.

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