Communities Structure of Fish in Some Mangrove Ecosystem as a Result of the Restoration in Southern Beach of Malang, East Java Indonesia

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Abstract. The change of function of mangrove ecosystem land for other purposes and logging can affect the community structure of aquatic biota, especially fish. The research objective was to determine the community structure and diversity of fish species in the mangrove ecosystem as result of restoration activity in the southern beach of Malang. Sampling were done in mangrove ecosystem of Bajulmati, Clungup, Kondang Buntung, Tamban, and Sendiki which have different restoration time. Fish sampling methods used net sampling and visual encounters. The results of fish sampling then be used to determined taxa richness, total abundance and indices of dominance, evenness, and diversity. The research results indicated that we found eight fish species in all location with different taxa richness at each location. Total of fish abundance in the range between 51-744 individu/100m². Periopthalmus and Oryzias javanicus can be found at all of research location. Based on the value of the Diversity Index of fish in the research location, we found that mangrove ecosystem in the southern beach Malang had low diversity index (less than 1) with high dominance index 0.4-0.9 and low of evenness value between 0.03-0.09. It is indicated that restoration of mangrove ecosystem in Malang Southern beach still unsuccessful

1. Introduction

Mangroves are very productive plants can form tropical coastal ecosystems which include estuaries, tributaries, lagoons, black waters, mudflats, salt pans and islands, and contain large aquatic and terrestrial biodiversity [1]. The area of mangrove forests in the southern Malang region has decreased due to land conversion for other uses and logging activities. The area of mangrove forest in Malang Regency in 2015 was around 64.7 ha [2]. The area of mangrove forest is significantly reduced when compared to 2007, which was around 340 ha [3]. The decrease of mangrove ecosystem in Malang made society committed to do the restoration with re-plant mangrove in degradation area. It was done in different years. Mangrove restoration in Tamban begun on 2009, restoration in Clungup begun since 2005 until 2018, and Bajulmati in 2010, 2014, and 2016.
The change of function of mangrove ecosystem land for other purposes and logging can affect the community structure of aquatic biota, especially fish. Judging from the biological function of the mangrove ecosystem. One function of the mangrove ecosystem is as a habitat of aquatic biota, especially fish. This function is specifically obtained through the release of nutrients from the litter produced by mangroves that fall to the bottom of the waters and play an important role as a supply in nutrient cycling (N and P) which ultimately determines fish stocks [4].

Fish behavior in mangrove forest areas is an interesting topic to study because the movement of fish populations rapidly follows food availability, and is influenced by tidal currents, the presence of sand predators and other diversity factors in the ecosystem [5]. The species diversity of fish including the diet of herbivores, omnivores and carnivores is found around the mangroves [2]. The relationship between the ecological function of mangroves and the structure of fish communities is very important to be reviewed. So, this research was conducted to obtain information about the diversity of fish in the mangrove ecosystems of Clungup, Bajulmati, Kondang Buntung, Tamban, and Sendiki.

2. Methods
2.1 Research Location
The research was conducted in five mangrove ecosystems located on the south coast of Malang, East Java Province, Indonesia included mangrove ecosystems on Bajulmati Beach which planted begun in 2010, 2014, and 2016, Clungup planted in 2013, 2015 and two natural location, Tamban Beach planted in 2009-2014, Sendiki and Kondang Buntung which are natural location (Figure 1). Fish identification was carried out in the Ecology and Animal Diversity Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Brawijaya Malang. The research was conducted in June-August 2020.

![Figure 1](image.png)

Figure. 1 Sampling Location, (1) Bajulmati Beach, (2) Clungup Beach, (3) Tamban Beach, and (4) Sendiki Beach, (5) Kondang Buntung

2.2 Fish Sampling Method
Fish sampling used a net with a size of 5 m x 2 m that be stretched and left at least 1x24 hours. After 1x24 hours the net was taken, and the fish samples were put in bottles with 70% alcohol to observe the species of fish. Every sampling station repeated three times in every sampling plot.

2.3 Data Analysis
Data from the identification and calculation of fish density from all stations were then compiled. The data used to determine the value of the Importance Value Index (IV), the Evenness index, Simpson
dominance index and Shannon Wiener diversity index, according to the formula based on [6] and [7]. Index of species diversity was analyzed used Shannon-Wiener formula:

\[
H' = - \sum \left( \frac{n_i}{N} \log \frac{n_i}{N} \right),
\]

Whereas:

- \( H' \): Index of species diversity from Shannon Wiener
- \( n_i \): Abundance of i-species
- \( N \): Total abundance of all species found

3. Result and Discussions

3.1. Fish Found in the Mangrove Ecosystem as a Result of the Restoration in the Shouthern Beach Malang

This research only found eight species of fish in the mangrove ecosystem which the result of the restoration was located on the south beach of Malang. Kind of fish found in location were Tetraodontida sp, Oryzias javanicus, Ambassis sp, Mugil cephalus, Lutjanida sp, Periopthalmus sp, Penaeus merguiensis, and Lutjanus sebae (Figure 2). All of the research locations were dominated by Periopthalmus and Oryzias javanicus except Sendiki dominated by Mugil cephalus (Figure 3). These two species of fish dominance in mangrove ecosystem due to the muddy substrate and the location of the mangrove ecosystem in the estuary. The muddy substrate is suitable for the habitat of Periopthalmus and Oryzias javanicus. The habitats of these two species generally live in estuary that connected between river flow and sea water. The fish in the mangrove area are closely related to the eating habits of herbivores and epiphytic carnivores [8]. The existence of fish larvae and juveniles in the estuary includes mangroves as a functional role of mangroves as a spawning area, enlargement, protection, and a place to find food [9].

![Figure 2. Species of Fish Found in this research, (1) Tetraodontida sp, (2) Oryzias javanicus, (3) Ambassis sp, (4) Mugil cephalus, (5) Lutjanida sp, (6) Periopthalmus sp, (7) Penaeus merguiensis, (8) Lutjanus sebae Source: Personal document and [10].](image)

3.2. Important Value Index of Fish in the Mangrove Ecosystem as a Result of the Restoration of the Shouthern Beach Malang

The Important Value Index (IVI) of Fish in each location is slightly different (Figure 3). When viewed from each location the fish IVI is almost evenly distributed. IVI is used to calculate and estimate all species in the community. This IVI provides an overview of the influence or role of a species in the community, the higher the value, the greater the role in the community.
3.3 Taxa Richness and Total Abundance of Fish in the Mangrove Ecosystem as a Result of the Restoration of the Southern Beach Malang

The results of total abundance and taxa richness showed in Figure 4. The highest total abundance was found in CMC Natural II. This CMC Natural II is a mangrove location that has been managed by the local community. However, the highest taxa richness was found in Sendiki. Mangrove ecosystem in Sendiki was natural which was managed by the local community. The existence of natural mangroves that have grown for years provides their own habitat for aquatic fauna because in the mangrove ecosystem there is a food chain. So this is in accordance with states that the diversity will be high if a population is equal to one another in abundance and not some are very dominant, while others are very rare [11]. Judging from the results of data analysis, the total abundance at CMC Natural II locations was higher than that in other locations. This is because the CMC Natural II has long been cared for by the surrounding community so that the mangroves are maintained. So that the long-time existence of mangroves have a function as habitat of aquatic organisms, especially fish. This is consistent with result of research before which states that the diversity will be high if the populations are equal with their abundance and some are not very dominant, while others are very rare [11].
3.4 Evenness, Dominance index, and Diversity Index of Fish in the Mangrove Ecosystem as a Result of the Restoration of the Southern Beach Malang

The indices of dominance, evenness and species diversity can be seen in Table 1. The highest index of fish dominance in mangrove ecosystem restoration results on the southern beach of Malang is in Kondang Buntung location when compared to other locations. There are many species of fish caught but these types dominate the existence of other fish. Most of the fish caught in mangrove areas are still juvenile. Most of the fish caught in that location were still juvenile, except for *Periophthalmus*. The dominance index is inversely related to the diversity index. The higher the value of dominance, the less the value of diversity, and conversely the higher the value of diversity, the lower the value of dominance [12].

The Shannon-Wiener diversity index of fish species in the mangrove ecosystem location restoration of the southern coast of Malang from eight different samples showed a strong relationship with overall species richness, showing variation and ranging from 0.029-0.144 (Table 1). The highest fish diversity was found in the location of Bajulmati 2014 followed by Bajulmati 2016, CMC 2013, CMC 2015, CMC Natural II, Bajulmati 2010, Kondang Buntung, and Tamban. Meanwhile, CMC Natural I and Sendiki have the same species diversity index value. The value of diversity affects the level of evenness of a community in the environment. The value of diversity index in all locations of the restoration mangrove ecosystem on the beach of South Malang is low category [1] [13] with the value less than 1.

The level of diversity, uniformity/evenness and dominance of a fauna were influenced by water physics-chemical and availability of fish feed in the environment [14]. In addition, another thing that affects the Diversity index (H'), the Evenness index (E), and the Dominance Index (C) is the time of data collection. This research was conducted during the dry season, when the coastal waters near the estuary where we took a fish sample were low tide.
Table 1. Evenness, Dominance Index, and Diversity Index Fish in the Mangrove Ecosystem as a Result of the Restoration of the Southern Beach Malang

| Location          | Time Restoration | Evenness | Dominance Index | Diversity Index |
|-------------------|------------------|----------|-----------------|-----------------|
|                  |                  | 2013     | 0.074           | 0.453           | 0.117           |
| CMC               | Natural I        | 0.047    | 0.698           | 0.075           |
|                  | 2015             | 0.056    | 0.555           | 0.112           |
|                  | Natural II       | 0.073    | 0.628           | 0.073           |
|                  |                  | 2010     | 0.082           | 0.407           | 0.130           |
| Bajulmati         | 2014             | 0.091    | 0.329           | 0.144           |
|                  | 2016             | 0.081    | 0.391           | 0.128           |
| Kondang Buntung   | Natural          | 0.029    | 0.892           | 0.029           |
| Sendiki           | Natural          | 0.032    | 0.748           | 0.075           |
| Tamban            | 2009 & 2014      | 0.076    | 0.442           | 0.120           |

4. Conclusion
The research results indicated that we found eight fish species in all research location with different taxa richness at each location. Total of fish abundance in the range between 51-744 individu/100m². *Periophthalmus* and *Oryzias javanicus* can be found at all of research location. Based on the value of the Diversity Index of fish in the research location, we found that mangrove ecosystem in the southern beach Malang had low diversity index with high dominance index and low of evenness value. It is indicated that restoration of mangrove ecosystem in Malang Southern beach still unsuccessful

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