Influence of management status on the coral reef fish communities in Ujung Kulon National Park, Banten

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Abstract. Ujung Kulon National Park (TNUK) employs a management with the zonation system established to maintain the sustainability of resources, one of them are coral reef fish. This study aimed to identify the influence of management status on coral reef fish. Field observations were conducted on 14-22 October 2017 in Ujung Kulon using underwater visual census method, by recording the fish found in observation transects. The coral reef fish most frequently found in Core Zone was Caesionidae, while in The Marine Protection Zone is Acanthuridae. The Core Zone has higher species richness, and more abundance of coral reef fish than the Marine Protection Zone, although only species richness parameter shows a significant difference based on statistical tests. The management status that regulates the activities in each zoning has an impact on the coral reef ecosystem, including coral reef fish communities in it. Coral reef fish in the Core Zone have more diverse species than the Marine Protection Zone, because the coral reefs in the Core Zone are more preserved than the Marine Protection Zone.

Key words: coral reef fish, management status, structure community

1. Introduction

Indonesia is one of the world's coral reef diversity centers or called a coral triangle, which covers 15% of the total area of the world's coral reefs [1]. However, the condition of coral reef ecosystems in Indonesia has experienced a decline that continues to occur over time [2]. This is caused by natural conditions, such as global warming and human activities, including fisheries and tourism that are not environmentally friendly. Human activities in coastal ecosystems need to be regulated for the sustainability of fisheries resources [3]. An appropriate management is needed to regulate all activities in areas that have high
biodiversity potential, such as coral reef ecosystems. One form of management of areas with high diversity in Indonesia is the establishment of those habitat as a conservation area, such as a national park. Ujung Kulon National Park (TNUK) is one of six national parks in Java containing coastal areas.

Ujung Kulon National Park is a conservation area that is managed using a zoning system. For humans, the existence of zoning is made so there is no overlap between activities in the added area. These activities are preservation, utilization and customary activities. The formation of the zoning should have a positive impact on coral reefs and the community structure of coral reef fish in it. An assessment of the zonation success can be seen from the coral reef fish stocks in that location.

Coral reefs in Indonesia are home to more than 2,000 species of coral reef fish [4]. Coral reef fish are inhabitants of coral reef ecosystems found in various colors. Coral reef fish perform various activities based on their habits and functions, which then form a balanced pattern to support the existence of coral reef ecosystems [5]. The existence of coral reef fish is closely related to the availability of coral reefs as habitat [6-7]. These fish depend on the coral health to develop their population [8]. In contrast, the presence of coral reef fish also affects the condition of coral reefs. The existence of coral reef fish may also control the growth of algae in coral reef ecosystems [9].

In general, the major function of the marine national park was to conserve and enhance the natural environment within the area. These include reducing the hard coral and reef fish degradation. In order to understand the effectiveness of TNUK managed area on reef fish composition, it is important to conduct the research through these ecosystems. However, coral reef fish research was rarely conducted in TNUK littoral area. Thus, the objective of this study was to assess the effect of the management status on oral reef fish composition at TNUK, considering how important to understand the changes in coral reef fish composition within the area.

2. Methods

2.1. Location and time
Ujung Kulon National Park (TNUK) area is located in Sumur and Cimanggu Districts, Pandeglang Regency, Banten Province. Geographically, Ujung Kulon National Park is located between 102°02'32" - 105°37'37" BT and 06°30'43" - 06°52'17" LS. Field observations were carried out on October 14-22, 2017. Data collection of coral reef fish was carried out in TNUK, Banten.

TNUK management is carried out with a zoning system, based on the Decree of the Director General of Forest Protection and Nature Conservation No. SK 100/IV-SET/2011 concerning the Zoning of the Ujung Kulon National Park [10]. Of the eight zones stipulated, there are four zoning covering the coastal area of TNUK. The research locations that represent the TNUK region are Legon Lentah (Core Zone), and Ciapus (Marine Protection Zone). The core zone is an area formed to realize the function of conservation areas as protection of nature without direct use by humans, both for fisheries and tourism. While the marine protection zone is a protected area where human resources are still permitted. Map of the research location can be seen in figure 1.

2.2. Sampling method
Data collection on coral reefs and coral reef fish refers to [11] using the Line Intercept Transect (LIT) method for coral reef data and the Underwater Visual Census (UVC) method for coral reef fish. The LIT method is carried out by recording the growth of coral, and coral conditions along the observation transect.
The UVC method is carried out by conducting a coral reef fish census found on a 20-meter transect with an observation area of 2.5 meters from the left and right of the transect (figure 3). The tool used in this study is the Global Positioning System (GPS) to mark dive locations. SCUBA tools were used for diving. Roll meter, slate, water-repellent paper, stationery, and calibration stick as a tool for observing coral reef fish. Identification book was used as identification tool. Laptops with Microsoft Excel 2010 and PRIMER V7 applications were used as data analysis tools.

In this study, coral reef fish were divided into three categories based on functionality. These categories are indicator fish, major fish, and target fish [11]. Indicator fish categories include fish that can be used as indicators of coral health. Major fish are fish that are often found, associate well with being settlers, and have a large role in food webs in coral reef ecosystems. Target fish are fish that have high economic value and are targeted for capture [5].

2.3. Data Analysis

2.3.1. Percent cover. The calculation of the percentage cover refers to formula (1) [11]. The closer it is to 100%, it can indicate the higher the density of the coral in that location [12]. The results of coral reef observations also classified according to the categorical substrate. Substrates on coral reef ecosystems can be categorized through coral life forms, and other categories such as dead coral with macro algae, other fauna, rubble, sand, soft coral, sponge, turf algae. Life form corals include acropora branching, coral branching, coral encrusting, coral folioshe, coral massive, coral millepora, coral heliopora, coral mushroom, sub massive coral.

\[
\text{Percent cover} = \frac{A}{B} \times 100\%
\]  

Notes:
Percent cover = Percentage of base substrate cover (%); A = Length of base substrate category (cm); B = Transect length (cm).
2.3.2. Abundance. The abundance of coral reef fish was calculated based on the number of individuals of each type of fish found to be determined in the respective area. Abundance was used to see the distribution of the number of fish species or communities within certain coral reef areas [13]. Abundance is known by using the formula (2):

\[ D = \frac{N_i}{A} \]  

(2)

Notes:
- \( D \) = Abundance (ind/100 m\(^2\))
- \( N_i \) = The number of fish (individual)
- \( A \) = Area of observation (100 m\(^2\))

2.3.3. Species Richness. Species richness is the number of species or types of organisms found in a location [14]. Species richness was used to see the proportion of species in a community that is described in units of the number of species per area of observation. Species richness can be assessed using the formula (3) [15]:

\[ S = \frac{N_i}{A} \]  

(3)

Notes:
- \( S \) = Species richness (species/100 m\(^2\))
- \( N_i \) = Count species of fish
- \( A \) = Area of observation (100 m\(^2\))

2.3.4. Statistical Analysis. The values of abundances and species richness of coral reef fish were compared based on research location and depth using Analysis of Variance (ANOVA) with repetition, in Microsoft Excel 2010 software. ANOVA was performed to test the significance of the average differences between groups [16]. The maximum error limit used (\( \alpha \)) is 0.1. The reference variable used in this analysis is the depth and management area, while the measured variables are abundance, species richness, and diversity of coral reef fish.

The multivariate ecological analysis was carried out using PRIMER 7 software [17, 18]. Identification of the most contributed species to averaged similarity between core zone and marine protection zone was performed using SIMPER (Similarity Percentages) (This analysis was used to determine the characteristics of functional fish groups in each management area.

3. Result and Discussion

3.1. Management of each zone

Ujung Kulon National Park administrator (BTNUK) has determined the types of activities that are allowed in each zone. This form of activity is shown in table 1. There are differences in the management of each zoning. Resource utilization activities and limited natural tourism are not permitted in the Core Zone, while in the Marine Protection Zone they are allowed.
Table 1. Forms of activities allowed in each zone.

| No | Activities                                                                 | Core Zone | Marine Protection Zone |
|----|---------------------------------------------------------------------------|-----------|------------------------|
| 1  | Protection and security                                                   | ✓         | ✓                      |
| 2  | Inventory and monitoring of natural resources and their ecosystems        | ✓         | ✓                      |
| 3  | Development of habitat and population in order                            | ✓         | ✓                      |
| 4  | Scientific research and development                                       | ✓         | ✓                      |
| 5  | Development of limited management facilities and infrastructure to support conservation activities | ✓         | ✓                      |
| 6  | Resource utilization                                                      | -         | ✓                      |
| 7  | Tourism                                                                   | -         | ✓                      |

✓ = Allowed

3.2. Abundance

A total of 1624 individual coral reef fish were found from all study locations. The fish includes 41 genera from 18 families. The composition of coral reef fish with the highest number of individuals in all study locations can be seen in figure 2. In terms of reef fish abundance, the highest to the lowest was reef fish from the family of Caesionidae (469 ind/100 m²), followed by Pomacentridae (458 ind/100 m²), Acanthuridae (303 ind/100 m²), Lutjanidae (80 ind/100 m²), Labridae (78 ind/100 m²), Chaetodontidae (52 ind/100 m²), Mullidae (47 ind/100 m²), Scaridae (44 ind/100 m²), Nemipteridae (47 ind/100 m²), Balistidae (12 ind/100 m²), and the other remaining families were below 12 ind/100 m². Lethrinidae, Zanclidae, Holocentridae, Pomacanthidae, Apogonidae, Siganidae, Serranidae, and Tetraodontidae were grouped into Others.

![Figure 2. The highest composition of coral reef fish.](image)

Fish from the family Caesionidae were the most abundant. A total of 469 individual Caesionidae fish were found during observation. This fish is found in the grouping (schooling fish). Fish from the family Caesionidae used to live together in groups and used zooplankton as their food [19]. The presence of zooplankton is very influenced to Caesionidae family [20]. The abundance of aquatic biota can be affected
by the abundance of plankton in these waters and indicates that the waters have a good supply of nutrients [21].

The family of Pomacentridae are coral reef fish with the second highest number of individuals in the Ujung Kulon coral reef ecosystem. A total of 458 individual coral reef fish were observed included in the family (figure 2). In coral reefs with an abundance of high coral fish, it is usually dominated by major fish groups [5, 22]. The abundance of fish from the Pomacentridae family in the coral reef ecosystem can be attributed to the fish's eating habits [23, 24]. The Pomacentridae family use plankton and algae found in the coral reef ecosystem as food [25].

![Figure 3. The average of abundance coral reef fish in each zone, ■ = shallow, □ = deep.](image)

The abundance of coral reef fish, both in shallow and deep depths in each zone is presented in figure 3. The highest abundance of coral reef fish is in the inner depth Core Zone, which is 188±88 ind/100 m². In term of hard coral percent coverage, it was ranged between 31.8% (Marine Protection Zone) and 44.9% (Core Zone). The abundance of the average of abundance coral reef fish and hard coral cover in the Core Zone was predominantly higher compared to the marine protection zone (31.8%; figure 4). These results may correspond to the restriction and limitation of anthropogenic activities within the Core Zone. Therefore, high coral coverage and high abundance of coral reef fish was found in these areas. There is a negative relationship between anthropogenic factors on hard coral and coral reef fish composition changes due to the fishing or tourism activities [26].

3.3. Species richness

Species richness illustrates the number of species of coral reef fish in a location. The higher the value of species richness, the more fish species were found in that location. The average species richness of coral reef fish in each zone is presented in figure 5. The highest average of species richness was in shallow depth is in the Core Zone, which is 23±6 species/100 m². The Core Zone has the highest average of species richness (33±9 species/100 m²) at deep depths. The Core Zone is a location that has the highest species richness, both at shallow and deep depths.
The shape of the water base substrate in each zone is shown in table 2. The Core Zone has a greater number of substrate categories, which are 16 categories, while in the Marine Protection Zone only 12 substrate forms of water are found.

The structures of the substrate in each zone are shown in table 2. The Core Zone has a greater number of basic substrate categories, which are 16 categories, while in the Marine Protection Zone only 12 substrate forms were found. Based on figure 5, it can be seen that there are differences in the average species richness of coral reef fish in each zone. The difference in the value of coral reef fish species richness can be caused by the condition of the coral reefs. Coral reefs in the Core Zone have a greater number of basic substrate forms than the Marine Protection Zone (table 2). This indicates that the Core Zone has higher habitat complexity. The previous study in Seribu Islands National Park reveals the effect of the difference in sites may affect the structures and composition of corals [7]. There are three things that influence the community structure of coral reef fish, namely the factors of coral reef conditions, the position of location factors on the hydrodynamics of the waters, and factors of the position of the observation location (open or closed) [8]. Habitat complexity which can be seen from the base substrate cover may influence the spatial distribution of the value of the richness of coral reef fish species in water [27]. The more complex coral
reefs occur in an area, the more species will be found than in non-complex locations. Species richness or the number of fish found in the observation area can also be used to determine the suitability index value for snorkeling and diving in ecotourism planning [28].

Table 2. Substrate shapes in each zone.

| No | Category                  | Coral zone | Marine protection zone |
|----|---------------------------|------------|------------------------|
| 1  | Acropora branching        | ✓          | ✓                      |
| 2  | Coral branching           | ✓          | ✓                      |
| 3  | Coral encrusting          | ✓          | ✓                      |
| 4  | Coral folioshe            | ✓          | -                      |
| 5  | Coral massive             | ✓          | ✓                      |
| 6  | Coral millepora           | ✓          | ✓                      |
| 7  | Coral mushroom            | ✓          | -                      |
| 8  | Coral submassive          | ✓          | ✓                      |
| 9  | Dead coral with algae     | ✓          | ✓                      |
| 10 | Makro algae               | ✓          | -                      |
| 11 | Other fauna               | ✓          | ✓                      |
| 12 | Rubble                    | ✓          | ✓                      |
| 13 | Sand                      | ✓          | ✓                      |
| 14 | Soft coral                | ✓          | ✓                      |
| 15 | Sponge                    | ✓          | ✓                      |
| 16 | Turft algae               | ✓          | -                      |

The abundance of coral reef fish in each zoning and depth did not show significantly different values (table 3). Unless the value of the richness of coral reef fish species in each zoning shows a significant difference (α 0.1). This indicates that the presence of zoning in TNUK only affects the number of coral reef fish species. The existence of management forms that limit activities in the Core Zone causes more maintenance of coral reef ecosystems in these locations so that coral reef fish found in the Core Zone are more abundant and varied [29, 30].

Table 3. Two-way ANOVA for abundance and species richness.

| Variable          | Factor              | F       | F crit | P-value |
|-------------------|---------------------|---------|--------|---------|
| Abundance         | Zonation            | 2.4287  | 3.4579 | 0.1578  |
|                   | Depth               | 0.0002  | 3.4579 | 0.9890  |
|                   | Zonation × depth    | 0.4963  | 3.4579 | 0.5011  |
| Species richness  | Zonation            | 8.7039  | 3.4579 | 0.0184* |
|                   | Depth               | 1.8443  | 3.4579 | 0.2115  |
|                   | Zonation × depth    | 2.1075  | 3.4579 | 0.1846  |

*significantly different (P-value < 0.1)

The SIMPER analysis results are shown in table 4. SIMPER analysis is used to see the characteristics of functional fish in each management area based on similarity and species contribution. The composition of the five species with the highest contribution based on zoning (table 4).
Based on table 4, it can be seen that five species of coral reef fish that have the highest contribution in the core zone and marine protection zone consist of major and target categories. Fish that have the highest contribution to the core zone are *Amblyglyphidodon curacao* (major category), while in the marine protection zone is *Acanthurus nigrofuscus* (target category).

Judging from the five species that make up the highest contribution in table 4, the core zone is arranged by the fish in the major category, followed by the target category. Inversely proportional to the marine protection zone, more coral reef fish in the marine protection zone are arranged by target categories followed by major categories. This indicates that the core zone provides an abundance of high coral reef fish from various categories of fish. It can be presumed that the absence of an arrest ban on the marine protection zone causes a low presence of target fish in the zone.

### Table 4. The composition of five species with the highest contribution in each zone using SIMPER (similarity percentage-species contribution).

| Species                        | Average of abundance | Average of similarity | % Contribution | % Cumulative |
|-------------------------------|----------------------|-----------------------|----------------|--------------|
| Core zone, Average of similarity: 30.51 |                      |                       |                |              |
| *Amblyglyphidodon curacao*    | 3.3                  | 5.28                  | 17.32          | 17.32        |
| *Amblyglyphidodon leucogaster*| 3.10                 | 4.82                  | 15.82          | 33.14        |
| *Acanthurus nigrofuscus*      | 1.96                 | 3.13                  | 10.27          | 43.41        |
| *Pterocaesio pisang*          | 3.61                 | 2.50                  | 8.18           | 51.59        |
| *Pomacebtrus moluccensis*     | 1.79                 | 1.84                  | 6.04           | 57.63        |
| Marine protection zone, Average of similarity: 15.42 |                      |                       |                |              |
| *Acanthurus nigrofuscus*      | 2.30                 | 4.00                  | 25.93          | 25.93        |
| *Pomacentrus simsiang*        | 1.24                 | 1.49                  | 9.68           | 35.61        |
| *Dascyllus aruanus*           | 1.01                 | 1.22                  | 7.88           | 43.49        |
| *Thalassoma lunare*           | 0.91                 | 0.99                  | 6.43           | 49.92        |
| *Halichoeres hortulanus*      | 0.57                 | 0.78                  | 5.09           | 55.01        |

### 4. Conclusion

The core zone has higher species richness, and abundance of coral reef fish than the marine protection zone, although only species richness parameter shows a significant difference based statistical tests. The management status that regulates the activities in each zoning has an impact on the coral reef ecosystem, including coral reef fish communities in it. Coral reef fish in the core zone have more diverse species than the marine protection zone, because the coral reefs in the core zone are more preserved than the marine protection zone. The management status of the Ujung Kulon National Park is quite good, but it is necessary to increase the supervision of human activities in the area to optimize the benefits of management status there.

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