Comparing hard coral cover between Panggang and Kelapa Island Administrative Village, Seribu Islands National Park, Indonesia

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Abstract. The existence of coral communities as a critical components have been highly threatened. Marine national park as a part of the marine protected areas (MPAs) has been established to protect the diversity of the coastal ecosystem. However, the hard coral communities within the national park are consistently degraded. It is important in assessing the coral cover at the national park to provide the natural pattern of coral community structures. The aims of this study were to compare the coverage of coral and dead coral with algae cover at two different reef depths (crest and slope) among two administrative villages (Panggang and Kelapa Island) within the Seribu Islands National Park, Indonesia. Overall, the hard coral cover percentage in Kelapa and Panggang Islands was higher in reef crest. The highest percent cover in the Kelapa (45.25 ± 2.61\%) were higher than Panggang (26.86 ± 2.58\%) Islands. In terms of dead coral with algae (DCA), percent cover at Kelapa (30.25 ± 2.66\%) was higher than Panggang (24.16 ± 3.14\%) Islands. The different of two depths have proved to be significant predictors of hard coral and dead coral with algae between Kelapa and Panggang. A total of 52 genera belonging to 13 families of hard coral were found during this study.

1. Introduction
Coral structures and composition are important components of the coral reefs ecosystem [1]. Coral reef communities providing and contributing the structural of habitat for a wide diversity of reef fishes species [2]. However, the existences of coral reefs have been seriously threatened by severe disturbances [3]. These disturbances are related to anthropogenic activities [4], eutrophication [5], climate change [6] as well as other impacts from coral diseases outbreaks [7, 8]. The declining of the coral communities can ultimately affect the ecosystem function [9]. Therefore, the response on global declining of coral communities, Marine Protected Areas (MPAs) has become a key to managing and conserving marine biodiversity [10]. There are two types of MPAs, the government-managed MPAs and community-managed MPAs [11]. The marine national park is one of the government-managed MPAs in Indonesia. However, the National Park without better management and conservation have become a major challenge for the protection of the marine ecosystem, therefore the degradation of corals still occurred.
in the MPAs [12]. Yet, still it depends on early condition of the coral reefs and extent to which the cause of abasement has been eradicated [13].

Seribu Islands (Indonesian: Kepulauan Seribu) national park is located in the north of Jakarta bay [14]. Being the capital city of Indonesia, Jakarta city always contributing to environmental pollution that flowing through 13 rivers in the city to the Jakarta Bay [15, 16, 17]. The pollution of water quality has direct impacts on coral reefs in the Seribu Islands National Park [18]. In addition, local anthropogenic stressors in the small islands within the national park, such as tourism, coral mining, ship anchoring, destructive fishing are also contributing to the degradation of coral communities [19, 20]. There are three different administrative village (Indonesian: Kelurahan) located within the Seribu Islands National Park, comprised of Panggang, Kelapa, and Harapan islands administrative village [21].

Most of the people in the main islands rely heavily on coral reefs ecosystems, such as tourism [22], marine culture [23], and coral reef fisheries. These activities within the National Park without good management are also increasing the stresses on coral reefs. This study is part of a huge succession of studies appraising the historical impact of anthropology on coral reefs related to the Jakarta as a mainland. In order to maintain the existence of marine biodiversity, monitoring the condition of the reef and obtaining baseline knowledge are imperative to provide the indicators of reef resilience [24]. Coral reef complexity around Seribu islands has a unique condition as a research location due to the high number of research undertaken in this islands [19, 20, 16, 26, 27]. Thus, the aims of this study is to compare the coral and dead coral with algae cover at two different reef depths (crest and slope) between Panggang and Kelapa Islands administrative village in the Seribu Islands National Park.

2. Material and Methods

In Jakarta city, as the center of largest urban in Indonesia and the mainland in Jakarta Bay, several rivers accommodated the sewage and wastewater over a 2000 km2 catchment area to the seas [28]. Increasing the distance of the islands within the national park from the offshore of the Jakarta Bay, make less intense the influence of pollution from mainlands. During this present study, benthic communities around Panggang and Kelapa Islands administrative village, Seribu Islands were observed at 14 selected sites and conducted in August and October 2017 (table 1; figure1). In each site, the data was taken at the depth ranges between 3-5 m (crest) and 9-11 m (slope). Three replicates of 20 m transect were laid parallel along the shoreline, with a gap of 5 m at each transect. The benthic communities were assessed by using Line Intercept Transect method (LIT) and categorized based on the work of [29].

| Study Sites       | Latitude  | Longitude  | Study Sites       | Latitude  | Longitude  |
|-------------------|-----------|------------|-------------------|-----------|------------|
| Panggang Islands  |           |            | Kelapa Islands    |           |            |
| Pier 1 Pramuka    | 5°44’32.96” | 106°36’49.36” | Genteng          | 05°37’34.9”   | 106°32.1’38.1” |
| Pier 2 Pramuka    | 5°44’38.22” | 106°36’46.51” | Jukung           | 05°34’15.0”   | 106°31.0’31.6” |
| North Pramuka     | 5°44’14.28” | 106°37’18.84” | Macan            | 05°35’52.9”   | 106°32.0’46.2” |
| South Pramuka     | 5°45’5.91”   | 106°36’59.66” | Melintang 1      | 05°35’20.3”   | 106°32.0’36.8” |
| Panggang          | 5°44’42.32” | 106°35’18.06” | Melintang 2      | 05°35’09.8”   | 106°32.0’28.7” |
| Sekati            | 5°45’29.38” | 106°36’31.21” | Tongkeng 1       | 05°35’26.5”   | 106°32.0’26.0” |
| Air               | 5°46’7.46”   | 106°34’56.39” | Tongkeng 2       | 05°35’34.5”   | 106°32.0’39.5” |
Figure 1. Map of the selected study sites in the (a) Kelapa and (b) Panggang islands administrative village.

To calculated the percentages cover of benthic communities, all data were analyzed and averaged in Ms. Excel. Statistical analyses between hard coral and dead coral with algae percent cover data were used to perceive differences between variable group means among sites and depths by using two-way replication ANOVA [30]. Multivariate ecological analyses were conducted using the program PRIMER v7 [31] to examine benthic cover composition among sites and depth. A non-metric multidimensional scaling ordination (nMDS) ordination was constructed from a Bray-Curtis similarity matrix of square root transformed benthic cover to discern graphically demonstrate any difference in space utilization [32].

3. Results and Discussion
The percentages of hard coral were higher at the reef crest in the study sites and significantly differed among depths both of the two administrative villages (Table 2). The differences of hard corals cover between depths were associated with the coverage of other benthic substrates. Overall, the mean hard corals cover observed at Kelapa Islands (45.25 ± 2.61%) were higher than Panggang Islands (26.86 ± 2.58%). In Kelapa Islands administrative village, the highest mean percentages of hard coral cover were found in the Tongkeng 1 (61.60 ± 6.73%) at reef crest and in the Jukung Island (47.90 ± 9.12%) at reef...
While in Panggang Islands the highest mean percentages of hard coral cover were found in the Panggang site both of the reef crest (44.90 ± 8.80%) and reef slope (32.67 ± 6.36%). Figure 2 is showing the percentages of hard coral cover between all study sites.

Both of the two administrative villages are constitute in Seribu Islands National Park. The condition of coral communities in Panggang Islands was more threatened by tourism activities [33]. Most of the Islands in the northern Seribu Islands were a private Islands which having less tourist, therefore, Kelapa Islands coral cover in the study sites was higher than Panggang Islands. The present study reveals that at the sites within the reef crest at shallow depth was higher compared to those reefs at the reef slope which was deeper. Previous study around Pramuka Island was revealed the different of depth was affecting the number of coral structures and composition [34]. Depth was affecting the productivity and the growth of corals [35]. Light insensitivity was higher in shallow water, and it was needed to photosynthesis for the symbiotic-algae within the corals [36].

Table 2. Summaries of repeated-measures ANOVA for hard coral and dead coral with algae percent cover in the Panggang and Kelapa administrative villages. (*p<0.05,**p<0.005, n.s. not significant).

| Administrative Variable | Factor      | F   | df | p-value | Sig |
|-------------------------|-------------|-----|----|---------|-----|
| Panggang Island          | Hard Coral Cover | Site | 1.378 | 6 | 0.25797 | n.s |
|                         |             | Depth | 10.692 | 1 | 0.00285 | *  |
|                         |             | Site x Depth | 1.027 | 6 | 0.42842 | n.s |
| Dead Coral with Algae   | Site        | 25.273 | 6 | 0.00000 | ** |
|                         | Depth       | 5.081 | 1 | 0.03220 | *  |
|                         | Site x Depth | 6.701 | 6 | 0.00018 | ** |
| Kelapa Island            | Hard Coral Cover | Site | 0.698 | 6 | 0.65350 | n.s |
|                         |             | Depth | 9.333 | 1 | 0.00490 | *  |
|                         |             | Site x Depth | 0.341 | 6 | 0.90886 | n.s |
| Dead Coral with Algae   | Site        | 2.925 | 6 | 0.02418 | *  |
|                         | Depth       | 28.718 | 1 | 0.00001 | ** |
|                         | Site x Depth | 4.898 | 6 | 0.00155 | *  |

Kelapa, Panggang, and Pramuka Island were main islands with the densely populated compared to the other islands [15] within the Kelapa and Panggang Islands administrative villages. Local activities were giving a negative impact in seawater, such as sewage and household wastewater which was discharged directly to the sea around the main islands, therefore, the water quality parameter was increased due to the nutrient input [18]. This study also suggests the sedimentation have driven the stress of the corals. The combination of high nutrient and sedimentation were affecting the corals, and it increases the occurrences of coral mortality and diseases [37]. In addition, sedimentation also limiting the light intensity to the reefs. These kinds of pollution were threatening the coral reef health [38].

Dead coral with algae in Kelapa and Panggang Islands showed a significant difference amongst both sites and depths (table 2). The mean percentages of dead coral with algae varied from 3.8 ± % (Pier 1 Pramuka) to 58.42 ± % (Macan) in the reef slope, while in the reef crest were varied from 8.57 ± % (Pier 2 Pramuka) to 48.85 ± % (Panggang). Overall, the mean percentage cover of dead coral with algae at Kelapa (30.25 ± 2.66%) was higher than in the Panggang (24.16 ± 3.14%) Island administrative village. There was no dead coral with algae recorded across the reef crest in the Pier 1 Pramuka sites, this condition was related to the abiotic (rubble, sand, and rock) substrates which were dominated in the area. In addition, in the Pramuka Pier sites (1 and 2) were characterized with the low percentage cover of hard corals. A plausible explanation of this condition was due to the intense activities of the ships and boats within the area. Anchoring and the oil spill from the settled boat have affected the reefs around the area. The percentages cover of dead coral with algae at two different reef depths between Panggang and Kelapa administrative villages were depicted in Fig. 3.
Figure 2. Comparison of hard coral cover (Mean±SE) between (A) Panggang Islands and (B) Kelapa Island administrative villages at two different coral reef depths.

The algae cover associated with mortality of corals has been often occurred around the world [39]. The existence of algae in the ecosystem of the reef was a natural condition. During the outbreaks due to the enrichment of the nutrients, the algae were competing and often replaced the corals [40], it was commonly known as “coral-algal phase shift” [41, 42]. Sewage and wastewater pollution potentially increased the nutrients in the water and supported the growth of algae [43]. Most of the study sites in the Kelapa Islands administrative village was characterized with the high dead coral with algae cover. [44] stated that non-symbiotic microalgae are to be the first organisms to live in the coral after the mortality phase. However, it still discussed whether the algae obtain the space after the coral has died or it was already competing with live corals by overgrowing and then replaced it [45, 40]. High cover of algae could lead escalation of herbivorous fish throughout the ecosystem [46]. However, either the factor of coral communities recovery could undertake by maintaining the settlement space and demotion algae overgrowth through exertion of herbivores [47, 48, 49, 50], the fact of the correlation between those organisms are not habitually positive [51, 52].
In Seribu Islands, the characteristic of the specific location was highlighting a variety of coral genera. A total of 52 genera belonging to 13 families of hard coral were observed at study sites during this study. Based on the genera composition, the highest number of genera found was Faviidae (11 genera), followed by Fungiidae (8 genera), Acroporidae, and Agariciidae with similar portion (5 genera), while the other family were found below 5 genera (Dendrophyllidae, Euphyllidae, Merulinidae, Mussidae, Oculinidae, Pectiniidae, Pocilloporidae, Poritidae, Siderastreidae). The coral genera from family Poritidae were found at all study sites within the two administrative villages and depths. However, in term of genera composition, only 3 genera of Poritidae were found. Thus, in general, Acroporidae, Agariciidae, Fungiidae, and Faviidae family were the most commonly seen during this study (Table 3). The fact of Acroporidae, Fungiidae, and Faviidae corals that dominated and distributed across the Seribu Islands reefs also recorded by [53].

Table 3. List of hard coral genera in Panggang and Kelapa Islands administrative village.

| Genera            | Panggang | Kelapa |
|-------------------|----------|--------|
|                   | Crest    | Slope  | Crest  | Slope  |
| **Acroporidae**   |          |        |        |        |
| Acropora          | +        | +      | +      | +      |
| Anacropora        | +        | +      | +      | +      |
| Astreopora        | +        | +      |        |        |
| Isopora           |          |        | +      | +      |
| Montipora         | +        | +      | +      | +      |
| **Agariciidae**   |          |        |        |        |
| Coeloseris        | +        | +      | +      | +      |
| Genera                  | Panggang |             | Kelapa |             |
|------------------------|----------|-------------|--------|-------------|
|                        | Crest    | Slope       | Crest  | Slope       |
| Gardineroseris         | +        |             | +      |             |
| Leptoseris             | +        | +           | +      |             |
| Pachyseris             | +        | +           | +      | +           |
| Pavona                 | +        | +           | +      |             |
| **Dendrophylliidae**   |          |             |        |             |
| Turbinaria             | +        | +           | +      |             |
| **Euphyllidae**        |          |             |        |             |
| Catalaphyllia          | +        |             |        |             |
| Euphyllia              | +        | +           | +      |             |
| **Faviidae**           |          |             |        |             |
| Barabattoia            | +        |             |        |             |
| Cyphastrea             | +        | +           | +      |             |
| Diploastrea            | +        | +           | +      |             |
| Echinopora             | +        | +           | +      |             |
| Favia                  | +        | +           | +      |             |
| Favites                | +        | +           | +      | +           |
| Goniatrea              | +        | +           | +      |             |
| Leptoria               | +        | +           | +      |             |
| Montastrea             | +        | +           | +      |             |
| Oulophyllia            | +        |             |        |             |
| Platygyra              | +        | +           | +      |             |
| **Fungiidae**          |          |             |        |             |
| Cantharellus           | +        |             |        |             |
| Ctenactis              | +        | +           | +      |             |
| Cycloserris            | +        |             |        |             |
| Fungia                 | +        | +           | +      |             |
| Herpolitha             | +        | +           | +      |             |
| Podabacia              | +        |             |        |             |
| Polyphyllia            | +        | +           | +      |             |
| Sandalolitha           | +        | +           | +      |             |
| **Merulinidae**        |          |             |        |             |
| Hydnophora             | +        | +           | +      |             |
| Merulina               | +        |             |        |             |
| Paraclavarina          | +        |             |        |             |
| Millepora              | +        |             |        |             |
| **Mussidae**           |          |             |        |             |
| Acanthastrea           | +        | +           | +      |             |
| Lobophyllia            | +        | +           | +      |             |
| Symphyllia             | +        | +           | +      |             |
| **Oculinidae**         |          |             |        |             |
| Galaxea                | +        | +           | +      |             |
| **Pectiniidae**        |          |             |        |             |
| Genera               | Panggang Crest | Panggang Slope | Kelapa Crest | Kelapa Slope |
|---------------------|----------------|----------------|--------------|--------------|
| *Echinophyllia*     | +              | +              | +            | +            |
| *Oxypora*           | +              | +              | +            | +            |
| *Pectinia*          |                | +              | +            | +            |
| **Pocilloporidae**  |                | +              | +            | +            |
| *Pocillopora*       |                | +              | +            | +            |
| *Seriatopora*       | +              | +              | +            | +            |
| *Stylophora*        |                | +              | +            | +            |
| **Poritidae**       |                |                |              |              |
| *Alveopora*         | +              | +              | +            | +            |
| *Goniopora*         | +              | +              | +            | +            |
| *Porites*           | +              | +              | +            | +            |
| **Siderastreiidae** |                |                |              |              |
| *Coscinararea*      |                |                | +            | +            |
| *Psammocora*        |                |                | +            | +            |
| *Siderastrea*       |                |                | +            | +            |

Figure 4. Non-metric multidimensional scaling (nMDS) ordination for the hard coral and dead coral with algae at two different depths between Kelapa and Panggang Island administrative villages. Bubbles are proportional value which gives the root-transformed scale.

Univariate analyses (Table 2) was shown among the depths interaction between two variables gave a significant value, while the dead coral with algae was significantly different across the sites and depths. Multivariate analyses have visualized the patterns in non-metric multidimensional ordination that reveal
the separation of Panggang and Kelapa island administrative villages based on hard coral and dead coral with algae percentages cover (figure 4). Within the reef crest, Panggang islands are distinguished from Kelapa Islands by the higher coverage of hard corals and dead coral with algae. As well as on reef slope, the main dissimilarity between Kelapa and Panggang island communities also depicted from the higher hard coral and dead coral with algae cover in Kelapa Islands. Relatively, the hard coral and dead coral with algae are the primary environmental drivers of significant differences and community composition groups across the study sites. Based on the distance of the administrative villages to the mainland (Jakarta), Panggang Islands are closer to the Jakarta Bay [16]. The environmental stressor came from the Jakarta Bay are less impacted the coral reefs in offshore than nearshore the mainland [54].

4. Conclusion
Overall the hard coral and dead coral with algae cover within the Kelapa Islands administrative village were greater than Panggang Islands. The hard coral cover in the reef crest at all study sites were predominantly higher than in the reef slopes. Furthermore, this study suggested the coral community between Panggang and Kelapa being affected by the discharged nutrients (sewage and household wastewater) and tourism. Both of the administrative villages (Panggang and Kelapa), were located within the Seribu Islands National Park. Thus, in order to protect the diversity of the coral communities at this National Park, ongoing monitoring and conservation program are needed to mitigate the damage of human and environment.

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