Coral reef condition at the Putri Island, Bangka Regency

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Abstract. Putri Island is one of the unique islands which is located in the Bangka Regency. Putri Island has biodiversity ecosystem except for mangrove ecosystems. This study aims to analyze the extent of coral reefs in the shallow waters of Putri Island, and analyze the condition of coral reefs (percentage of cover, life form and coral mortality index). The research was conducted in April – September 2021 at Putri Island with using Line Intercept Transect (LIT) method. The research station divided in to 4 stations where was determined by purposive sampling The results show a map of the distribution of coral reefs in the Putri Island, Bangka Regency. Result show that condition of coral reefs at the research location is a good condition.

1. Introduction
Coral reefs are a unique ecosystem found in the tropics. This ecosystem has high organic productivity. The most important biota component in a coral reef is stony coral, an animal belonging to Sclerectinia whose skeleton is made of limestone. Therefore, there are many other types of organism whose lives are closely related to this stone. All of them are intertwined in a harmonious functional relationship in an ecosystem known as the coral reef ecosystem [1]. Coral reefs in Indonesia are only 7% in very good condition, 24% in good condition, 29% in moderate condition and 40% in poor condition. If the rate of damage to coral reefs does not decrease, it is estimated that in the next few decades around 70% of the world’s coral reefs will experience destruction if management is not carried out immediately [2]. One of the area in Bangka Belitung Province that has coral reef ecosystems is a Putri Island, Bangka Regency. Putri Island has high potential natural resources consisting of a diversity of fish species in coral reef ecosystems, mangrove ecosystems, seagrass, and algae. Putri Island is an inhabited island. Coral reef surrounded by mangrove ecosystems and seagrass at the shallow waters.

Accurate and up-to-date information regarding the existence of resources such as coral reefs in coastal areas is still lacking and very much needed, because the areas are widespread and most of them are difficult to reach especially in Putri Island, Bangka Regency. Coral reef data collection requires technology that can provide information about coral reefs effectively and efficiently also relatively accurate and comprehensive. This information needs to support coastal and coral reefs management in the future time. Therefore it’s needed to research about coral reef condition at the Putri Island with using Line Intercept Transect (LIT) Methods.

2. Methodology
2.1. Place and Time
This research was conducted from April 2021 to September 2021 at Putri Island, Belinyu District, Bangka Regency with using LIT Method for look at the coral reef life forms. Based on survey, Putri Island is located in Bangka Regency. Putri Island is located geographically in 0577450 S and 9830826
E. Administratively, Putri Island is bordered with the Java Sea at the North, bordered with Jebus at the East, bordered with Kelabat Bay at the South and bordered with Lampu Island at the West.

2.2. Tools and Materials
The tools and materials used in this study consists of Global Positioning System (GPS), water quality checker, underwater camera, identification book, bottle sample, roll meter 100 m, first aid kit, scuba diving, a permanen transect, and sheet data.

2.3. Method
2.3.1. Data Sampling of Coral Reef Ecology
This research used purposive sampling method. Field sampling was carried out by measuring the physico–chemical parameters of sea water. A sampling of coral reefs used Line Intercept Transect method. LIT is used to determine sessile benthic communities on coral reefs based on growth form in percent, and records the number of benthic biota present along the transect line. Communities are characterized by using the category of growth forms which provide a descriptive description of the morphology of the coral community.

LIT is also used to monitor the condition of coral reefs in detail by placing permanent transects. The advantages of using this method include the simple category of coral growth forms, making it quite easy for recorders who have limited knowledge in identifying benthic communities on coral reefs. In addition, LIT is an efficient and simple sampling method with easy equipment to obtain coral cover percentage data. LIT can also provide information about the spatial patterns of benthic communities. If LIT is carried out repeatedly, it can provide information on temporal changes in coral reef conditions [3]. A list of coral life forms is presented in the Table 1.

The LIT method is a method of observing coral reef ecosystems using a transect in the form of a meter with the principle of recording the basic substrate pertaining to the transect. The specifications of the expected corals are recorded with a transect of at least 50 meters [3]. LIT Procedure in this research could be explained as follows:

a. Determine the area that is considered representative of the coral community around the reef area and is safe for diving activities.

b. Record the coordinates of the data collection location using GPS

c. The transect was installed parallel to the line in the mid-reef slope area on the basis that stable coral conditions were in that area. The length of the transect is 30 m with 10 m intervals. The 0 m LIT point is a submerged permanent transect.

d. Try to place the transect line as close to the substrate as possible (0-15 cm) so that the transect does not hover too much in the water

e. Coral data was collected by moving slowly along the transect while noting the lifeform and type of substrate found directly below the line (transect)

f. Record the place of change in centimeters where the growth form, organism, substrate changes

g. After the coral data collection was completed the transect was rolled up and brought ashore

### Table 1. List of Classification Forms of Growth of Coral Reef Basic Habitat Biota and Codes Used

| Category            | Code | Information                                      |
|---------------------|------|-------------------------------------------------|
| Dead Coral          | DC   | Freshly dead coral, white color                 |
| Dead Coral with Algae | DCA  | Dead coral overgrown with algae                 |
| **Acropora**        |      |                                                 |
| Acropora Branching  | ACB  | Branching like tree branch                      |
| Encrusting          | ACE  | Creeping forms such as crust or rudimentary Acropora |
| Submassive          | ACS  | Branch shaped club / plate and sturdy           |
| Digitate            | ACD  | Branches tightly like fingers                   |
| Tabulate            | ACT  | Branching horizontal direction, shape resembling a table |
| Category       | Code | Information                                                                 |
|----------------|------|-----------------------------------------------------------------------------|
| Non-Acropora   |      |                                                                             |
| Branching      | CB   | The branching model is continuous & has a pointed branch tip               |
| Encrusting     | CE   | Creeping form, attached to the substrate and small holes                    |
| Foliose        | CF   | The shape resembles sheets that protrude, are small and form folds or circles |
| Massive        | CM   | Shape like a big stone, smooth and solid surface                           |
| Submassive     | CS   | Sturdy form with small bumps or columns                                    |
| Mushroom       | CMR  | Shape like mushrooms, solitary life                                         |
| Millepora      | CME  | All types of fire coral, yellow color at the end of the colony              |
| Heliopora      | CHL  | Blue coral, the presence of blue in the skeleton                            |
| Other Fauna    |      |                                                                             |
| Soft Coral     | SC   | Corals with soft bodies                                                    |
| Sponge         | SP   | At the end of the skeleton has a hole                                      |
| Zoanthids      | ZO   |                                                                           |
| Others         | OT   | Anemon, teripang, gorgonian, kima                                          |
| Algae          |      |                                                                             |
| Alga Assemblage| AA   | Consists of more than one type of algae                                    |
| Coralline Algae| CA   | Algae with a lime structure                                                |
| Halimeda       | HA   | Alga from genus Halimeda                                                   |
| Macroalgae     | MA   | Alga has a big size                                                        |
| Turf Algae     | TA   | Resembling fine grass.                                                     |
| Abiotic        |      |                                                                             |
| Sand           | S    | Sand, white color                                                          |
| Rubble         | R    | Scattered coral shards                                                     |
| Silt           | SI   | Silt                                                                        |
| Water          | WA   | Water column with a depth of more than 50 cm                               |
| Rock           | RCK  | Rock                                                                        |
| Other          | DDD  | Unrecorded or lost data                                                    |

2.4. Data Analysis
2.4.1. Measurements of LIT Method
From the results of recording coral data, preliminary data processing was carried out to obtain the length of each basic type [4].

\[
\begin{align*}
\text{Lifeform A} & = R2-R1 \\
\text{Lifeform B} & = R4-R3 \\
\text{Lifeform C} & = R6-R5 \\
\text{Lifeform D} & = R8-R7 \\
\text{Lifeform P} & = P1+P2+P3+P4+P5
\end{align*}
\]

Calculating the cover percentage each lifeform [4].

\[
\% \text{ Life Form Cover} = \frac{\text{Total length of each life form}}{\text{Total Transect Length}} \times 100\% \tag{1}
\]
Calculating the percentage of live coral cover [4].

\[
\% \text{ Live Coral Cover} = \frac{\text{Total length of live coral}}{\text{Total length of transect}} \times 100\% \tag{2}
\]

For the category of coral reef condition, it is obtained from the percentage of live coral cover obtained from the category [5] and the Decree of the Minister of the Environment Number 04/2001 [6] concerning Standard Criteria for Coral Reef Damage. Coral Mortality Index (CMI) is used to determine the ratio of coral mortality. This index shows the magnitude of the change from live coral to dead coral [4].

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\text{CMI} = \frac{\text{Percent cover (dead coral + coral debris)}}{\text{Percent cover (dead coral + coral fragments + live coral)}} \tag{3}
\]

The value of the mortality index if it is close to 0.0 means that there is almost no coral mortality, whereas if value is close to 1.0, it indicates that there has been a significant change from live-dead coral.

3. Result and Discussion
In general, the percentage of live coral on Putri Island ranges from 75.40% - 79.67% (Good Category) based on Decree of Minister of the Environment Number 04/2001 concerning standard criteria for coral reef damage (Figure 1). The high live coral cover is suspected because Putri Island is located in a protected area and close to the Main Island, in addition to human activities such as tin mining activities, and high fishing activities and tourism activities are thought to not have a significant impact. Coral reefs in the sea waters of Putri Island are found at a depth of between 2-7 meters. The basic substrate is sand.

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The results showed that there were 18 genera found at the three (3) location site. The dominant genera are Merulina, Acropora and Montipora (Look at Table 2). These genera are mainly included in the growth form of coral foliose which is a common species and is easily adaptable to turbid and sedimentary water conditions. The shape of corals that are flat like leaves and wide like an umbrella allows zooxanthellae to absorb maximum sunlight for the process of photosynthesis. Its wide shape like an umbrella can also make this coral easier to compete for light and food when compared to other types of coral. Sub-massive and massive corals are also types of coral that have high adaptation to slightly cloudy water conditions [6].

Table 2. Life Form of Coral Reef in The Putri Island

| No | Categories       | Coral Life Form              | Length (cm) | % Cover |
|----|-----------------|------------------------------|-------------|---------|
|    |                 |                              | I    | II   | III  | I    | II   | III  |
| 1  | Hard coral      | Acropora Branching (ACB)     | 0    | 796  | 64   | 0    | 26,533 | 2,133 |
| 2  | Acropora Digitate (ACD) | 1029 | 566  | 1317 | 26,767 | 18,867 | 43,900 |
| 3  | Acropora Encrusting (ACE) | 43   | 25   | 43   | 0,717  | 0,833  | 1,433  |
| 4  | Acropora Sub massive (ACS) | 47   | 0    | 0    | 0,783  | 0      | 0      |
| 5  | Acropora Tabulate (ACT) | 16   | 0    | 0    | 0,267  | 0      | 0      |
| 6  | Coral Branching (CB) | 204  | 0    | 0    | 3,4    | 0      | 0      |
| 7  | Coral Encrusting (CE) | 79   | 41   | 151  | 1,317  | 1,367  | 5,033  |
| 8  | Coral Foliose (CF) | 123  | 205  | 128  | 2,05   | 6,833  | 4,267  |
| 9  | Coral Massive (CM) | 628  | 516  | 535  | 10,47  | 17,200 | 17,833 |
| 10 | Coral Massrom (CMR) | 52   | 139  | 102  | 0,867  | 4,633  | 3,400  |
| 11 | Coral Submassive (CS) | 41   | 5    | 50   | 0,683  | 0,167  | 1,667  |
| 12 | Dead Coral      | Dead Coral (DC)              | 0    | 16   | 18   | 0    | 0,533 | 0,600 |
| 13 | Dead Coral With Algae (DCA) | 0    | 55   | 36   | 0      | 1,833  | 1,200  |
| 14 | Abiotic         | Silt (SI)                    | 689  | 198  | 197  | 11,48 | 6,600 | 6,567 |
| 15 | Algae           | Water (W)                    | 49   | 241  | 184  | 0,817 | 8,033 | 6,133 |
| 16 | Algae           | Algae Assemblage (AA)        | 0    | 20   | 65   | 0    | 0,667 | 2,167 |
| 17 | Turf Algae (TA) | 0    | 76   | 110  | 0    | 2,533 | 3,667 |
| 18 | Other           | Zoanthids (ZO)               | 0    | 101  | 0    | 0    | 3,367 | 0     |

Total 3000 3000 3000 100 100 100

% Live Coral Cover: 75,40% (Site I); 76,433% (Site II); 79,667% (Site III), Coral Mortality Index (CMI): 0,023 (Site I) 0,086 (Site II); 0,084 (Site III)

The form of coral reef growth in the Putri Island location was still dominated by coral species Massiv (CM) and Acropora Digitate (ACD) were 10.47% and 26.77%, respectively. However, other types of growth forms are Coral Branching (CB) by 3.4%. Silt value (SI) is quite high at this location, namely by 11.48%. This condition indicates that the coral has been dead long enough so that overgrown with algae. In general, the condition of coral reefs in this location is still very good with quite the diverse compositions. Even though it is famous as a marine tourism area, it is proven damage to coral reefs due to this activity is not significant.

In the Site II, In general, the type of coral life form found on Putri Island was dominated by coral species Acropora Branching (ACB) by 26.533% and Acropora Digitate (ACD) by 18.867%. The value of this composition is quite different when compared to the type of other corals. This indicates that the location of data collection is more suitable for the two types of coral. The condition of coral reefs on Putri Island is categorized as “Very Good” because there hasn't been much damage in the island area as
for if there is coral damage in the Putri Island area it is due to sediment sedimentation scattered on the reef, although it is well known as a marine tourism area. This matter proves the damage to coral reefs due to this activity is not significant.

In the Site III, the life form of coral reefs at the Putri Island location was still dominated by Acropora Digitate 43,900% and Coral Massive (17,833%). However, other types of growth forms was Coral Encrusting (CE) of 5,033%. Silt (SI) value as category abiotic was quite high (6,567%) at this location compared to the abiotic category other. The value of Turf Algae (TA) was 3,667% which that the coral has long enough to die so that algae will grow. A higher algae affects the lower dominance of coral reefs. Before experiencing death, first coral reefs will be exposed to diseases both from natural and environmental factors. Coral reefs can recover when they get sick, but it takes a long time. When coral reefs are sick, algae will grow on the coral reefs. When these algae have dominated individual coral reefs, it will be difficult for coral reefs to recover from disease [7]. In general, the condition of coral reefs in this location still very good with a live coral cover value of 79,667% and a sufficient composition various. Even though it is known as a marine tourism area, it is proven that the damage to the reef is coralline due to this activity is not significant. Brumo et al (2017) [8] added that a high algal value indicates that many substrates have been covered with algae. Space competition between algae and corals shows that this location has a high nutrient content so that algae can thrive.

The results of research on the coral reefs of Putri Island have a mortality rate ranging from 0,023 to 0,086. The coral reef area with the lowest mortality rate is at Site I. According to Tomascik et al. (1997) [9] a mortality index value close to 0,0 indicates almost no coral mortality, while a value close to 1.0 indicates a significant change in coral reefs live to dead coral. The station with the highest death rate is at station 2 with a value of 0.086. According to Syari 2008 [10] and Puspitasari et al. (2016) [11] this shows that the coral mortality rate is in the low category. However, this value is quite worrying because there is a fairly constant ecological pressure, and this can cause coral mortality to continue to occur. This ecological pressure can be in the form of natural and/or anthropological pressures such as fishing practices that are not environmentally friendly.

4. Conclusion
This research concludes that coral reef distribution could be well classified using Sentinel 2B with accuracy of approximately 85%. The condition of coral reef ecosystems in Putri Island in 2021 is 75,43% (Good Category). The Mortality Index (Death rate) ranged from 0.012 – 0.486. The number of species diversity found in 19 genera.

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