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# TYPES AND ABUNDANCE OF MARINE DEBRIS IN THE CORAL REEF ECOSYSTEM OF PASUMPAHAN ISLAND, WEST SUMATRA

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## ABSTRACT

Debris has long been a worrying problem, especially in the marine environment. Human activities and marine tourism activities cause coral reef ecosystem damage. The research was carried out in June - September 2022 to determine the type and abundance of marine debris, lifeforms, and condition of coral cover, as well as the relationship between the abundance of marine debris and coral cover on Pasumpahan Island, West Sumatra. The research method used was a survey, and the data obtained was analyzed descriptively. The research location was divided into three observation stations by placing three transects at each station. Based on the research results, six types of marine waste were found, with abundance ranging from 0.01 to 0.085 units/m$^2$. The coral lifeforms found are *Acropora branching, Acropora encrusting, Acropora submassive, Coral encrusting, Coral foliose, Coral millepora, Coral mushroom,* and *Coral massive*, with a percentage of live coral cover ranging from 1.00-36.48%. A strong negative relationship exists between the abundance of marine debris and the percentage of coral cover in Pasumpahan Island, West Sumatra.

**Keywords:** Abundance, Relationship, Coral, Marine Debris, Pasumpahan Island

## 1. INTRODUCTION

Debris has long been a worrying problem, especially in the marine environment, because it poses a considerable risk to living things, including humans, animals, and plants. Marine debris is solid waste from human activities that enters the marine environment[1]. In the last decade, ecotourism has developed rapidly[2]; from the positive side, this is very good because it has an impact on the environment and society, but on the other hand, it can have adverse effects in the form of waste from tourism activities, which can reduce the quality of the environment[3-4].

Based on research by Rahmadani[5], it is explained that Pasumpahan Island has experienced quite worrying damage to the coral reef ecosystem. This is caused by human activity factors such as the large number of fishermen who carry out fishing that is not environmentally friendly and the large number of tourists who come to carry out marine tourism activities such as diving snorkelers who accidentally step on coral and throw rubbish into the sea.

Pasumpahan Island is known for its beautiful sea and attractive beaches, which makes local and foreign tourists interested in visiting it. Apart from the beach tourist attraction and its underwater potential, which attracts tourists, the Pasumpahan Island area is also a shelter or gathering place for fishermen[6].

According to NOAA[7], besides impacting the visualization of islands or waters, marine waste also impacts coral growth because rubbish attached to coral reefs will block the sunlight corals need to carry out photosynthesis. If coral cannot carry out photosynthesis properly, coral growth is hampered, and coral bleaching occurs.

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According to Lamb et al.[8], plastic waste on coral reefs can cause coral disease because plastic waste contains thousands of pathogenic microbes that are dangerous for coral health. Suppose coral reefs continue to experience damage caused by human activities due to pollution from land, tourism activities, sedimentation, and fishing that is not environmentally friendly. In that case, it will threaten the development and sustainability of coral reefs on Pasumpahan Island. For this reason, it is necessary to research the type and abundance of marine debris and its relationship with the condition of the coral reef ecosystem.

## 2. RESEARCH METHOD

### Time and Place

This research was conducted in July-September 2022. The data collection location was on Pasumpahan Island, West Sumatra, and data processing was carried out at the Marine Chemistry Laboratory, Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau, Pekanbaru.

### Method

The method used in the field is the survey method, and the method used for data processing is descriptive analysis, which explains data and conditions. Two types of data were collected for this research: primary and secondary.

### Procedure

### Types and Abundance of Marine Debris

The sampling unit is an imaginary box with dimensions of 50 m x 4 m wide, 5 m deep, or more KLHK[9], as in Figure 1.

**Figure 1.** Marine debris sampling unit

Data collection was carried out three times. The waste contained at each station is recorded, documented, and classified into NOAA[7] types of marine waste, as in Table 1.

**Table 1.** Types of marine debris

| No. | Types of Marine Debris |
|---|---|
| 1. | Plastic (Nets, ropes, plastic bottles, plastic bags, buoys, pipettes) |
| 2. | Metal/metal (bottle caps and drink cans) |
| 3. | Glass (glass bottles and light bulbs) |
| 4. | Rubber |
| 5. | Wood |
| 6. | Others (Organic, paper, clothing, and more) |

The amount and abundance of marine waste found were calculated for each type. An ANOVA test analysis was carried out to determine whether or not there were differences in the abundance of waste at each observation station.

### Coral Cover

The method that will be used to collect coral cover data is LIT (Line Intercept Transect)[10]. Data will be taken at three station points, with each station consisting of three transects with a distance between transects of 20 m and a transect length of 50 m, a depth of 5 m, and carried out by four divers.

Coral cover data processing is carried out using the following formula. Percentage of coral cover based on formulation[11]:

$$\%cover = \frac{Length\ of\ Intercept\ Genus}{Length\ of\ Transect\ (50\ m)} x\ 100\%$$

The standard criteria for coral reef damage can be seen in Table 2.

**Table 2.** Standard damage criteria for coral reefs

| Standard Criteria for Coral Reef Damage | |
|---|---|
| Damaged | 0.0% - 24.9% |
| Currently | 25.0% - 49.9% |
| Good | 50.0% - 74.9% |
| Very well | 75.0% - 100% |

Death index based on formula[11]:

$$IM = \frac{KM}{KM + KH}$$

Information:

IM = Mortality index/index of death
KM = Mortality index/index of death
KH = Coverage percentage of live coral

Coral reef death index categories[11] can be seen in Table 3.

**Table 3.** Coral reef death index categories

| Category | IM |
|---|---|
| Low | 0 - 0.249 |
| Currently | 0.25 - 0.499 |
| Tall | 0.50-0.749 |
| Very high | 0.75-100 |

**Relationship between the Abundance of Marine Debris and Coral Cover**

Analysis carried out on the relationship between marine debris abundance and coral cover was analyzed using linear regression:

$$Y' = a + bX$$

Information:

Y' = Dependent variable (predicted value)
X = Independent variable
a = Constant (Y' value when X = 0)
b = Regression coefficient (increasing or decreasing value)

**Water Quality Parameters**

Water quality parameters are measured to support research to determine the physical condition of the research location. Parameters that will be observed include temperature, degree of acidity (pH), salinity, current speed, and brightness. Observation time was 09.00-15.00 WIB with repetition three times at each station on the water surface.

## 3. RESULT AND DISCUSSION

**Types and Abundance of Marine Debris**

The abundance of marine debris found at the research location can be seen in Figure 2.

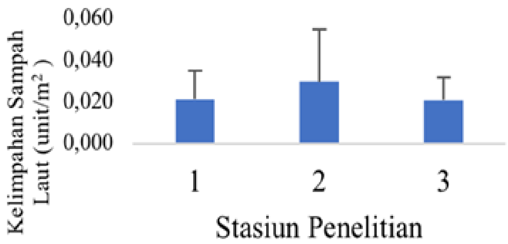


**Figure 2.** Abundance of marine debris

Marine waste around coral reefs is mainly found at Station 2, a dock area with six types of marine waste: plastic, metal, glass, wood, rubber, and paper. The total marine waste at Station 2 is 77 units. The abundance of marine waste from the three transects was plastic (0.18 units/$m^2$) in the form of drink sachets and snack packaging, metal (0.02 units/$m^2$) in the form of drink cans, glass (0.02 units/$m^2$) in the form of medium-sized glass fragments, rubber (0.035 units/$m^2$) in the form of vehicle tires, and wood (0.125 units/$m^2$) in the form of several pieces of wood and coconut tree branches.

Station 1, in the tourist area, is the second station where much marine debris is found. There are three types of marine debris: plastic, metal, and wood. The total marine waste at Station 1 is 34 units. The abundance of marine waste is in the form of plastic (0.105 units/$m^2$) in the form of several food and drink packages, drink glasses and large tarpaulins, metal (0.015 units/$m^2$) in the form of drink cans, and wood (0.05 units/$m^2$) in the form of small and medium-sized pieces of wooden planks.

Station 3, located in an area that is rare or far from human activity, is where marine waste is rarely found. Only two types of marine waste were found: plastic and wood. The total marine debris at Station 3 is 21 units. The abundance of marine waste includes plastic (0.025 units/m$^2$) in food and drink packaging and wood (0.08 units/m$^2$) as branches from coconut trees. The abundance of marine debris and the comparison of types of marine debris at each observation station can be seen in Figure 3.

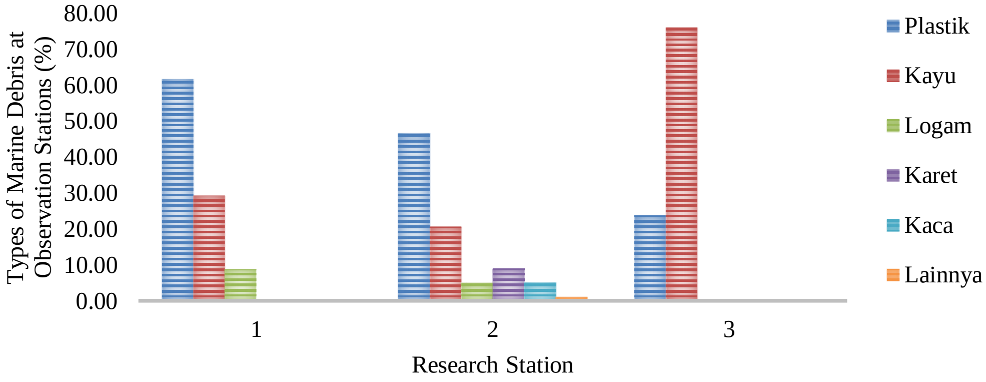


**Figure 3.** Comparison of types of marine debris

The results of the ANOVA test obtained a significant value of 0.044 where p<0.05, showing that the abundance of marine debris between stations is significantly different. Then, the Least Significant Difference (LSD) test was carried out. After carrying out further LSD tests, the results showed that the abundance of marine debris at Station 2 and Station 3 showed a significant value of p < 0.05, which was a significant difference (significantly different). In contrast, the abundance between Stations 1 and 2 and between Stations 1 and 3 was similar. Station 2 has a high abundance of marine debris compared to other stations. This is considered rubbish carried by currents and deposited around coral reefs, in addition to human activity, because Station 2 is a dock area or ship route.

Most marine debris found settles at the bottom of the waters, and only a few involve coral reefs or rocks; this is because the coral reef that dominates on Pasumpahan Island is a type of coral that does not have branches.

There is a slight possibility that marine waste can get on coral reefs. Marine waste will quickly get on coral reefs if the coral is a branching type of coral. This plastic waste is the most common marine waste in the three research stations. Pasumpahan Island is a tourist island. Many human activities on the island have adverse effects in the form of waste from tourist activities, which can reduce environmental quality, supported by research at Tanjung Bira Beach, South Sulawesi[3].

Apart from human activities, differences in the amount of rubbish on beaches and coral reefs can be influenced by natural factors such as season, currents, and wind[12]. According to Cózar et al.[13], waste originating from land is carried through rivers and spreads in coastal and offshore waters following surface currents.

Indirect impacts from marine waste, especially plastic, can damage coral reefs. Coral reefs function as a habitat for other organisms. Therefore, coral reefs' existence dramatically influences other marine organisms' lives.

Lamb et al.[8] stated that 89% of coral reefs that come into contact with plastic waste tend to contract disease because plastic waste can colonize pathogenic microbes. Plastic waste will get stuck and cover coral reefs, disrupting photosynthesis. According to Aini[14], apart from damaging coral reefs, plastic waste that is not managed correctly can emit methane and ethylene gas, which can cause wave warming.

Global warming will increase sea water's temperature and acidity, which can impact phytoplankton populations, which play a role in maintaining oxygen levels in seawaters and cooling the earth's temperature by releasing a sulfur component. This will reduce oxygen levels in the waters, impacting the lives of other marine organisms that need oxygen.

**Coral Cover**

Coral cover data was collected using the LIT method at a depth of 5 m, a transect line length of 50 m, and a distance between transects of 20 m parallel to the shoreline. The data taken is primary data by observing coral reefs based on their growth form (lifeform).

The percentage of coral cover at the research location ranges from 1.00-36.48%, with the highest percentage being 36.48% based on the percent coral cover category[11]. This percentage is included in the medium category, while the lowest percentage of coral cover, 1.00 %, is included in the damaged category. At Station 1 and Station 2, the condition of coral cover is classified as damaged, while at Station 3, the condition of coral cover is classified as moderate. The percentage of live and dead coral cover and the coral reef death index at the research station can be seen in Table 4.

**Table 4.** Percentage of live and dead coral cover and coral reef death index

| Research Station | Transect | Percentage (%) | | Index Death |
|---|---|---|---|---|
| | | Living Coral | Dead Coral | |
| 1 | 1 | 28.00 | 43.84 | 0.61 |
| | 2 | 1.00 | 70.40 | 0.99 |
| | 3 | 14.80 | 58.22 | 0.80 |
| Average | | 14.60 | | 0.80 |
| 2 | 1 | 5.24 | 38.46 | 0.88 |
| | 2 | 1.00 | 36.80 | 0.97 |
| | 3 | 2.08 | 37.50 | 0.95 |
| Average | | 2.77 | | 0.93 |
| 3 | 1 | 33.40 | 49.00 | 0.59 |
| | 2 | 28.98 | 50.40 | 0.63 |
| | 3 | 36.48 | 46.82 | 0.56 |
| Average | | 32.95 | | 0.59 |

Stations 1 and 2 are that the coral cover is classified as damaged; this is thought to be caused by human activity resulting in damage to coral reefs on Pasumpahan Island, West Sumatra. Station 3 is located in an area far from human activity; the area faces the open sea. Therefore, the Station 3 area is heavily influenced by natural factors such as waves and currents.

Coral life in the ocean is limited by a depth of less than 25 m and an area with a minimum average temperature in a year of 10$^{o}$C. Maximum growth of coral reefs occurs at a depth of less than 10 m and a temperature of 25$^{o}$C, because of this nature of life. Coral reefs are often found in Indonesia[15]. The percentage of coral cover at each research station is quite different.

The differences in coral reef conditions between stations are due to the research location not being far from residential areas and being a tourist spot with relatively high human activity, which affects the condition of coral reefs. The main human activities that can affect the condition of coral reefs are water flow from land, overfishing, recreational impacts, climate change, coral harvesting, and climate change[16].

The number of Non-Acropora found compared to Acropora at each research station is because Non-Acropora has a high sensitivity to the environment, supported by the opinion of Siringoringo et al.[17], states that Non-Acropora can live in groups found from the reef flats to the edge of harsh waves.

Based on observations at the research location, the low percentage of live coral cover at each station, especially at Station 1 and Station 2, is caused by natural factors and human activities. The condition of coral cover at the research location is that the waters of Pasumpahan Island are mostly in poor condition. The distribution of coral reef life depends on the physical and chemical conditions of the waters[18].

In addition to the data on the percentage of live coral cover, this research also obtained the coral reef death or mortality index results by adding up the dead coral, namely those overgrown with algae (Dead Coral with Alga) and dead coral at each observation station.

Table 4 shows that the coral reef death index level at the Pasumpahan Island research location from Station 1, Station 2, and Station 3 on each transect ranges from 0.56 to 0.99. The most extensive death index was at Station 1 on transect 2 at 0.99; according to category Mutmainah & Rani[11], the coral reef death index was very high.

Meanwhile, the lowest coral reef mortality index was at Station 3, transect 3, at 0.56. Even though it is the lowest among observation stations, this category is still in the high coral reef mortality index.

The results of the calculation of the coral reef death index show that the coral reef death ratio on Pasumpahan Island is close to 1.00, which is categorized as high, referring to the coral reef death ratio index is categorized based on a ratio of 0, small death index and close to 1, coral reef death index.

Forms of damage or negative impacts from human activities are (1) damage by trampling by tourists (trampling), (2) gouging coral, (3) throwing or dropping anchors on coral reef locations (anchoring), which causes coral to crack and break due to being hit by iron anchors, (4) various forms of water pollution due to increasing temperatures, petroleum and heavy metals which can cause death to coral reefs, (5) fishing using explosives such as dynamite, (6) development in coastal areas without paying attention to wisdom environment, (7) over-exploitation of coral production[19].

## Water Quality Parameters

Marine debris greatly influences marine ecosystems and can be seen through the quality of the waters, so to determine the comparison of the quality level of a water area, chemical, physical, and biological parameter tests are carried out[20]. The results of water quality parameter measurements that have been obtained consist of physical and chemical parameters, which can be seen in Table 5.

Table 5. Water quality parameters on Pasumpahan Island, West Sumatra

| Station | Coordinate | | Parameter | | | | |
|---|---|---|---|---|---|---|---|
| | L.U | BT | Salinity (‰) | Temperature (°C) | pH | Current speed (m/s) | Brightness (%) |
| 1 | 01.11989° | 100.3700° | 30 | 30 | 7 | 0.15 | 100 |
| 2 | 01.12037° | 100.3688° | 28 | 32 | 7 | 0.15 | 100 |
| 3 | 01.12009° | 100.3684° | 32 | 32 | 7 | 0.16 | 100 |

The results of water quality measurements at Station 1, Station 2, and Station 3 showed that the salinity was in the range of 28-32‰. According to PP Number 22 of 2021 concerning Implementation of Environmental Protection and Management, good salinity for coral reef growth is around 33-34‰.

The influence of salinity on coral life depends on the condition of the waters or natural influences, such as rain storm runoff, and the distribution of salinity in waters is influenced by several factors such as evaporation, rainfall, river flow, and water cycle patterns[21].

The water temperature of Pasumpahan Island is around 30-32 °C. According to Zurba[15], coral reefs are generally found in waters with a temperature of 18-36°C, and in tropical areas, the average annual temperature for optimal coral reef growth is 25-30°C. Thus, the water temperature on Pasumpahan Island is still high. Good condition.

pH measurements at the research location obtained values of 7 at all research stations. pH influences the growth of coral reefs; if there is a process of acidification of seawater or a drastic decrease in pH in the waters, it will be a threat to coral because the impact is reducing the ability of coral to form their skeletons[22].

The results of measuring the current speed at the research location were that at Stations 1 and 2, the current speed was 0.15 m/sec, and at Station 3, the current speed was 0.16 m/sec. Currents also play a role in coral growth because they carry a food supply for coral animals in the form of zooplankton[23]. The results of brightness measurements at the research location, namely at Station 1, Station 2, and Station 3, were 100%. The level of water brightness can influence the growth of coral reefs because brightness is directly related to the level of light intensity entering the water. High brightness positively impacts zooxanthellae because it makes it easier to carry out photosynthesis, which helps the growth of coral reefs[24].

Data on water quality parameters that have been obtained include salinity, temperature, pH, speed, and brightness. It can be seen that the water quality parameters of Pasumpahan Island, West Sumatra, do not affect the growth of coral because the water is still in good condition for coral growth.

## Debris Abundance Relationship with Coral Cover

Garbage in the sea harms marine ecosystems, one of which is the coral reef ecosystem. The amount of marine debris, which is not negligible and continues to increase, is predicted to cause a decline in coral reefs.

After getting the results of the abundance of marine debris and coral cover, the data was processed using linear regression, and the analysis results were obtained, which can be seen in Figure 4.

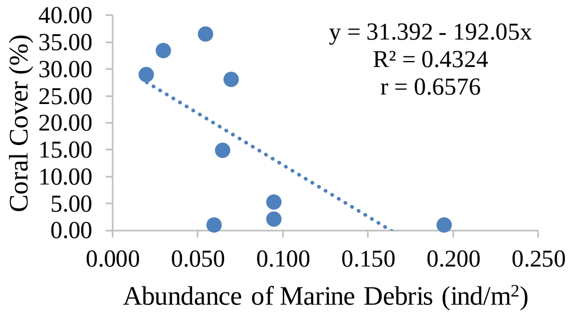


**Figure 4.** Relationship between marine debris abundance and coral cover

From the results of processing data on the abundance of marine debris with the percentage of coral cover, the correlation value (r) between coral cover and the abundance of marine debris is 0.6576, which, according to Safitri[25], states that this value is included in the strong category.

F significance is 0.0542 or > 0.05, which means H 0 is rejected, and H 1 is accepted, which means a significant influence exists between the abundance of marine debris and coral cover. From the results of the linear regression carried out, it was found that the R Square or determination in the analysis of the relationship between coral cover and the abundance of marine debris has a value of 0.4324 or 43.24%, which means that the amount of marine debris can influence coral cover by 43.24%. Other factors influence the rest.

Apart from being caused by marine debris in the waters of Pasumpahan Island, it is suspected that the coral damage that occurred on Pasumpahan Island, causing death on coral reefs, was also influenced by other factors, such as natural factors.

Based on Figure 4, the y value from the regression results is negative, meaning the relationship between marine debris abundance and coral cover is negative. The higher the abundance of marine debris, the lower the coral cover value. Coral reefs can experience damage and even death due to two factors, namely nature and humans.

Damage to coral reefs caused by nature, such as currents or waves that are too solid, climatic factors, or extreme weather changes, can cause the death of coral reefs. Damage or death of coral reefs on Pasumpahan Island is caused by human activities such as a lack of awareness of local communities and tourists regarding rubbish, the use of explosives for fishing, tourist activities such as diving or snorkeling who accidentally or accidentally touch or step on coral reefs and the physical form of Coral reefs are damaged to the point of death[19].

Few residents work as fishermen around coral reefs who lower anchors into areas where there are coral reefs, causing the coral to break and then die due to the government's lack of awareness and supervision to preserve the environment, especially coral reefs.

The relationship between the type and abundance of marine debris on live and dead coral cover is significant. The abundance of marine debris deposited on the bottom of the waters around coral reefs affects coral reefs, from causing injury to coral reef structures to causing death to coral reefs. To prevent further damage from occurring, an evaluation needs to be carried out.

## 4. CONCLUSION

Based on the research results on Pasumpahan Island, West Sumatra, it can be concluded that six types of marine debris were found. Namely plastic, metal, wood, glass, paper, and rubber, where plastic is the most common type of marine waste found at each observation station. Lifeforms found at the research location were *Acropora branching*, *Acropora encrusting*, *Acropora submassive*, *Coral encrusting*, *Coral foliose*, *Coral millepora*, *Coral mushroom*, and *Coral massive*. The condition of coral cover at Station 1 and Station 2 is in the poor category; however, at Station 3, the condition of coral cover is in moderate condition, with the percentage value of live coral cover in the waters of Pasumpahan Island ranging from 1.00-36.48%.

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