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Distribution of Macro Debris at Pangandaran Beach, Indonesia

Noir P. Purba^{1,3}, Izza M. Apriliani², Lantun P. Dewanti²,
Hetti Herawati², Ibnu Faizal^{1,3,*}

¹Marine Research Laboratory (MEAL), Universitas Padjadjaran,
Jatinangor 45363, West Java, Indonesia

²Fisheries and Management Technology Laboratory, Universitas Padjadjaran,
Jatinangor 45363, West Java, Indonesia

³Department of Marine Science, Universitas Padjadjaran,
Jatinangor 45363, West Java, Indonesia

*E-mail address: ibnu.faizal@unpad.ac.id

ABSTRACT

This research was to assess of marine debris in Pangandaran beach. Marine debris sampled from 2016 and 2017 around west Pangandaran using Ocean Conservancy (OC) form to find information about distribution, abundance, and types. The result is debris on the West coast of Pangandaran is originally comes from settlements, tourists, traders, and fishermen. The highest accumulation of marine debris happened in October with total weight 44.385 kilos, while the lowest accumulation happened in May with total weight 38 kilos. this is due to Citumang River had overflowed due to heavy rain and then was swept away along the coastline and piled up an area near the bay in October. In May and August the debris which most find is cigarette with the percentage 28% in May and 35% in August. While in October the debris which most find is a plastic bag with percentage 33%. From six types of debris, the dominant debris per types as follows: Most likely to find items is cigarette butts, Fishing gear is rope, Packaging material is other plastic/foam packaging, Personal hygiene is diapers, Other trash is cigarettes lighters, and Tiny trash less than 2.5 cm is foam pieces. The specific debris at Pangandaran beach is the fisheries tools like a rope and net, the rope embedded in the ground and make it hard to take out. One of the factor the large number of debris in Pangandaran is tourism

activity and fisheries activity. In addition, the study indicates that there is a strong relationship between human activities and spreading of debris.

Keywords: Beach litter, Citumang river, fishing gear, marine pollution, ocean currents, plastics packaging, Pangandaran beach

1. INTRODUCTION

Efforts to assess the global distribution of marine debris over the last years are now allowing for a comprehensive depiction of global patterns [1]. This likely becomes a global challenge due to its impact to ecosystem [2], human [3, 4], marine life [5-7], conflict (trans border issue), and aesthetic [8, 9]. The issue of marine debris become leading after climate change and deforestation. It is justify that this issue will lead at least until the next 50 years. The time span of marine debris has stretched since 1820 when industrial revolution occurred in Europe.

Based on previous studies reported, the distribution of marine debris has yet to find a significant pattern because there has not been much research to create a good conclusion. It noted that only less than 100 research in marine debris since 1970 but double rises research from 2011. In Indonesia, numerous research investigates on the distribution of debris are relatively rare, approximately under 10 researchers. The detailed research about debris in some area in Indonesia comes from [10-13] found that there is the correlation between spreading of debris and human population.

The scientists predicted spreading of debris via ocean currents [14, 15], modeling the waste management [16], numerical modeling [17, 18]. But, Studies on temporal or seasonal variations in the abundance and distribution of debris are relatively scarce [19]. Marine debris abundance in Indonesia comes from two main sources, via ocean currents that linked Pacific to Indian Ocean and rivers. Debris in Biawak Island in Java Seas were identified that also come from several sources eg. Singapore, Batam, Borneo, and Semarang [15]. Dispersal debris in Indonesia based on some cases between 4 km to 20 km [20, 21].

One of the environmental areas that are most affected include open oceans and beaches area [22] and between 4.8 and 12.7 millionmetric tons of debris ended up in the beach areas [16]. The present study focused to assess debris in Pangandaraan Beach (PB). This study focus on the west side with complex activities (tourism, merchant, fisheries, and residential area). With the complex activities in this area, is the key role of distribution of debris. The objective of this study was to characterize of beach litter found on Pangandaraan Beach. This research becomes first identification and monitoring activity that become important to management strategies, legislation, to control this pollution [23, 24].

2. METHODS

The usual method to know the presence of debris in beaches can counted by beach clean. This is the effective method that can reflect the amount, type, and abundance of debris. It is designed for long term monitoring and could be supported by society with short training.

2. 1. General Information Of The Site

Pangandaran located in the south of West Java province and become boundary to Indian Ocean. The PB is important for marine tourism, with boats being listed as operational vessels, mostly for fishing and tourism activity. PB is one the best for tourism in Indonesia with approximately 15 km for beach activities. PB consists of two main area, in the west as tourism activities and in the east as fisheries activity, that separates from MPA (Marine Protected Areas). The shoreline is composed of sandy beaches and sand dunes covering the low backshore. Pangandaraan also links to open Indian Ocean with affected by monsoon, South Java Currents (SJV) and from rivers.

2. 2. Data Collection

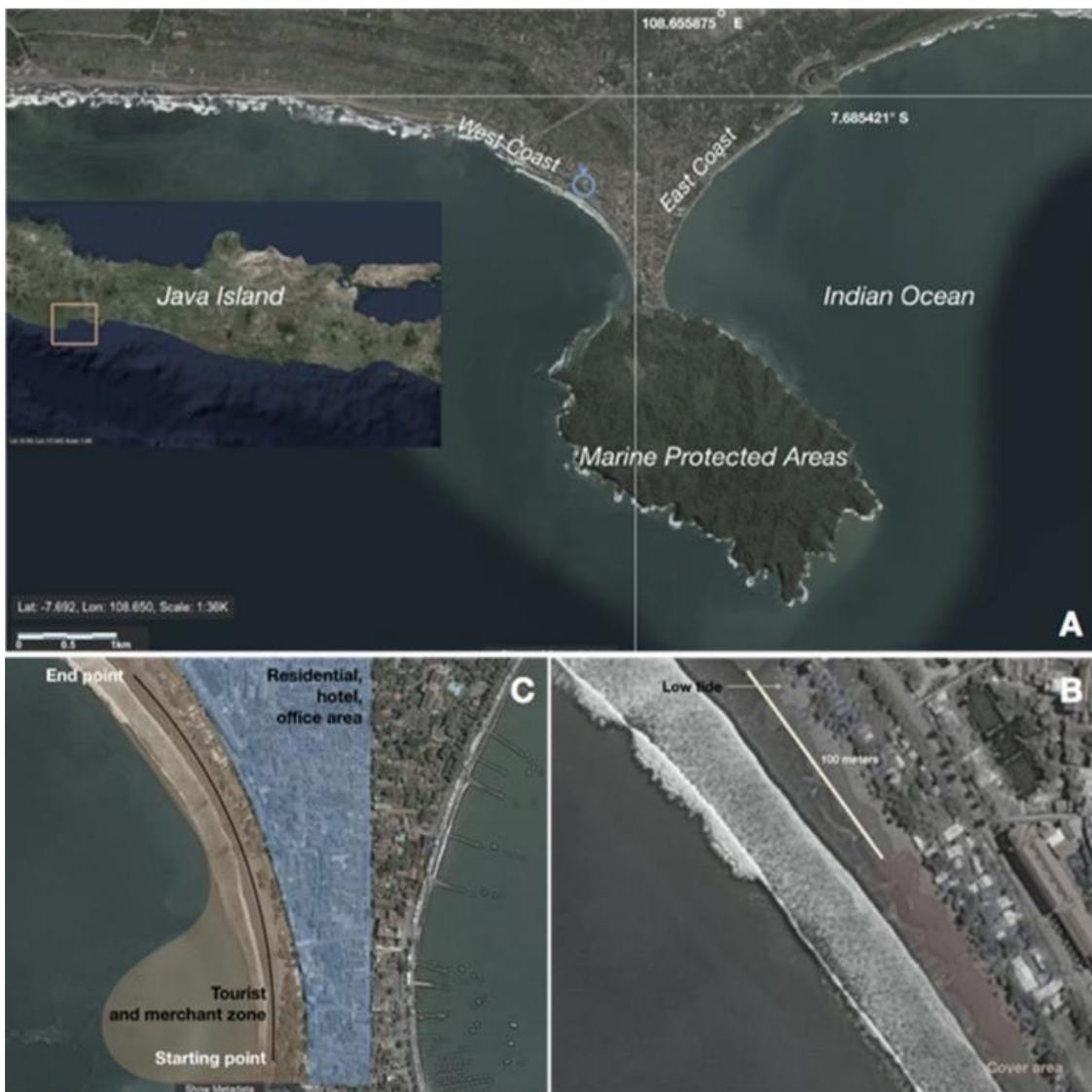


Figure 1. Site Description, A. The location of Pangandaraan Beach in Indonesia, along Indian Ocean and consist of two beach, B. Transect line in low tide, and C. The activities at West beach Pangandaran

This study was conducted at West Pangandaran Beach (WPB), in the total of 5 stations (4 stations in May) and was collected during May, August, and October 2017, respectively (Figure 1). May and August represent tourism season and October represents fishing activities. Each station consists of 100-meter line transect and starts from a boundary of Marine Protected Areas (MPA) to WPB. The total of 500 meters respectively from transect one to transect five from 2.7 km main tourism activities in west beach. This research use of Ocean Conservancy (OC) form (see [http:// www.oceanconservancy.org](http://www.oceanconservancy.org)) used to conduct site sampling.

The form contains identification sample, weight, location, and the width of the sampling area. Using Line Transect between 100 meters each side [25], all debris > 2 cm (macro debris) were collected, categorized, counted, and weight. The items were sorted into categories according to OC form (a. most likely to find items, b. fishing gear, c. packaging material, d. personal hygiene, e. other trash, f. Tiny trash less than 2.5. cm). 5-10 person involved to collect the debris and need 2-3 hours.

Technically, surveyors (Fishery and Marine Science undergraduate students). They were divided into several groups consist of three to five persons. A total of 25 students and 5 lecturers (advisors) participated in three surveys. Collected trash bags were weighed and recorded on the card. Debris that has been collected, also been categorized, counted, and then weighted. Then calculated the density and its abundance from each station. To calculate debris density, the weight of the debris is divides based on the area were taken to get debris weight per square meter.

Debris abundance counted with count the amount of debris item compared with the area were taken to get the value of abundance per square meter. To analyze, researcher sees the station with high density and abundance then analyze the factors. Dividing based on observed station characteristics (tourism, settlement, and MPA) also being done to see the phenomenon which happened in each station.

3. RESULTS

Marine debris accumulation in the seashore also will be higher in place that had been build up [26]. Debris on the West coast of Pangandaran is originally coming from settlements, tourists, traders, and fishermen. It can be seen, spreading near the coastline, meaning that the debris is not accumulated previously nor as a landfill area. Debris sampling was conducted in May, August, and October. In May and August, the spread of debris was classified as normal, while in October the quantity was increasing, especially the debris on the beach near the sea (Figure 2).

Thus indicating that, aside from the settlements, tourists, etc, debris was also originated from others area. The results of the interview stated that there was a heavy rain around the Citumang River in October, making it be overflowed and swept all the debris along the river to the sea. Later, sea currents swept it to the west coast where the accumulation of debris finally landed on the West Coast of Pangandaran.

One thing that took into attention was debris originated from fishermen which are in the form of rope used to bind the ship when anchored. The rope was nailed firmly to the ground, making it hard to detached, and found it very difficult to remove even by using tools (pliers). The ropes were only used once and then will be disposable due to its vulnerable properties

when the rope was tied with the new one, making the fishermen always create a new spot to nail the anchor.



Figure 2. Marine Debris found in Pangandaraan (A) in May and August, (B) October, and (C and D) Ropes with plastic packages, (E) straw

The next debris to be considered is a straw. This kind of debris is small in size and may soon be buried and easier to pick than the anchor rope. But when it may cause a problem when the straw is buried in a vertical state. As know, some straws have a sharp side to pierce through beverage packaging. This property becomes dangerous because most people do not wear footwear while walking on the beach. In addition, this straw is made of plastic that is difficult to decompose.

The same problem may occur if the straw is scattered in the waters, causing it to be dangerous for people who swim. Sampling time was indicated as vacation time, so it can be assumed that this month is the month with the most tourist traffic (Figure 3).

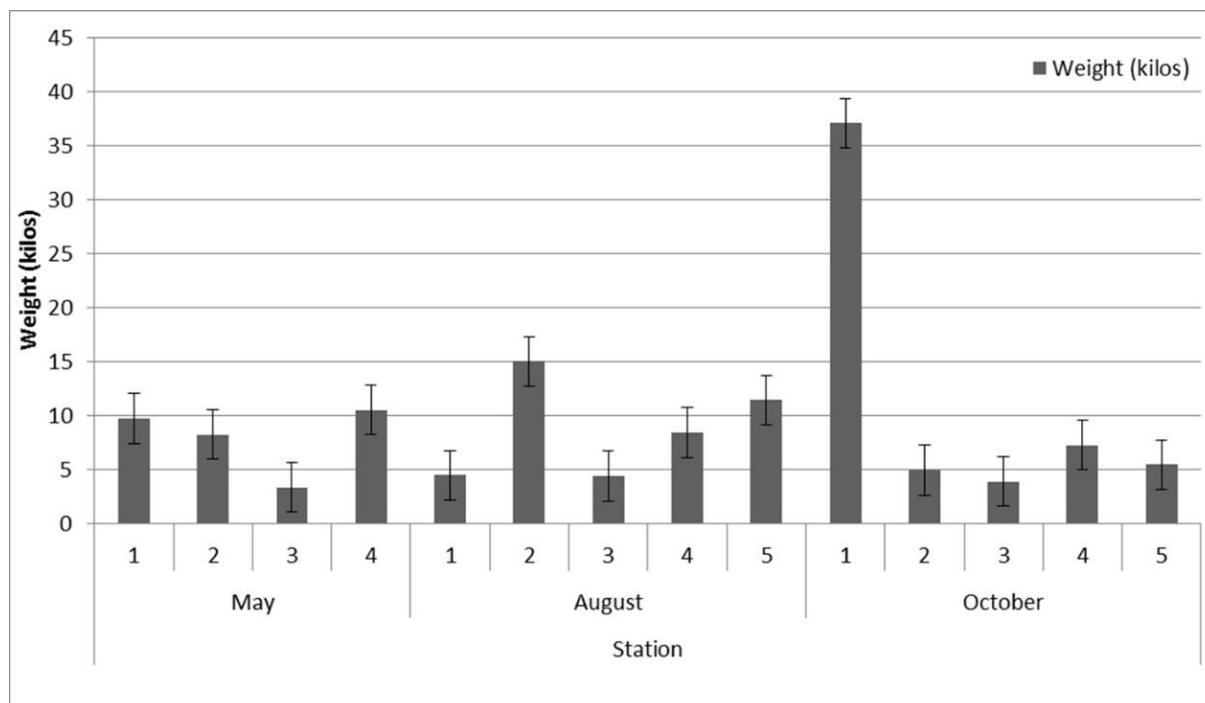


Figure 3. Total weight of debris per station in three different months

In May, debris found at station 4 amounted to 10,5 kg while the lowest debris was found at station 3 weighing of 3.3 kg. The average weight of garbage collected in May is approximately of 7,9 kg, with a total weight for all stations of 31.7 kg. The total weight of debris collected in August was 43.58 kg, with an average of 8.7 kg. The difference in the amount of weight, which is higher compared to May, is caused by additional stations in August. The highest amount debris was found at station 2, reaching 15 kg, while the lowest was found at station 3 which amounted to 3.8 kg. There is an increase of debris at station 2 of 4.5 kg, however, the fluctuation of debris weight quantity for station 1, 3 and 4 was decreasing. In October, debris sampling was performed at five stations. The highest weight debris was found at station 1 with a total of 23 kg, while on the other station, the amount of debris found dropped significantly. The lowest weights of debris were found at station 3 with a value of 3.86 kg. Total weight in five stations in this month was 44.38 kg with an average of 8.87 kg. A significant increase of debris found occurred in October, which is precisely at station 1. This station is located at the most southeast of all stations. Citumang River that overflowed due to heavy rain and then was swept away along the coastline and piled up an area near the bay. The higher rainfall during the wet season likely explains these differences because surface runoff can transport plastic litter from inland areas to streams and rivers [20, 27, 28]. Thus, this event causing the amount of debris collected in October to be significantly increased. However, the quantity of debris found in other station was decreased compared to previous months. The most abundant debris found in May and August is cigarettes, whereas in October the most debris found is a plastic bag. The types of waste that are found vary from small things such as cigarettes to unusual ones. Debris profiles which belong to the most frequently found category are shown in Figure 4.

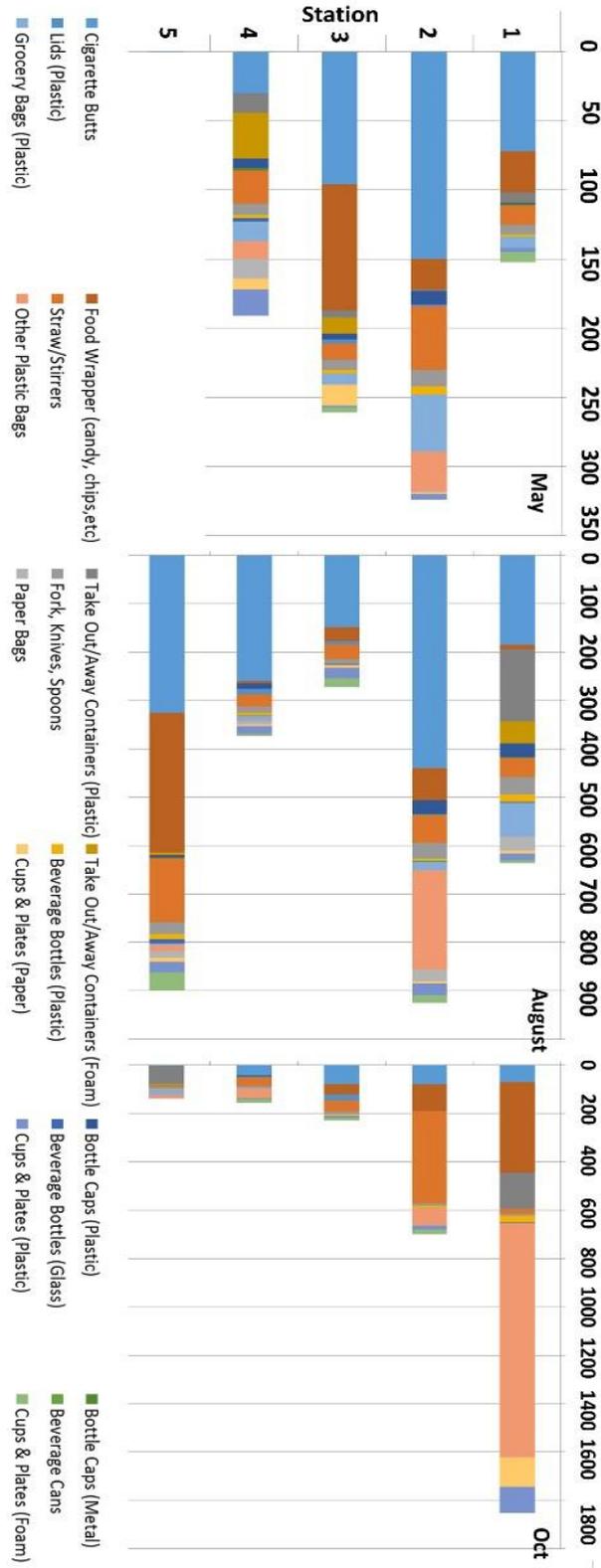


Figure 4. Most frequently found debris

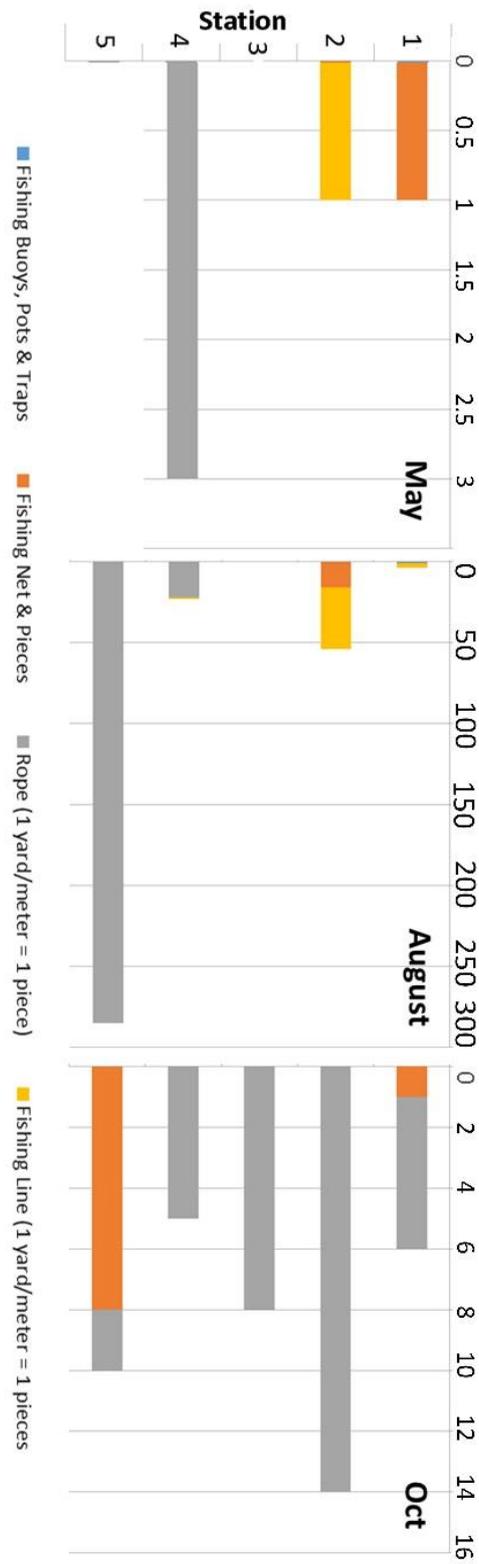


Figure 5. Debris from fishing activity

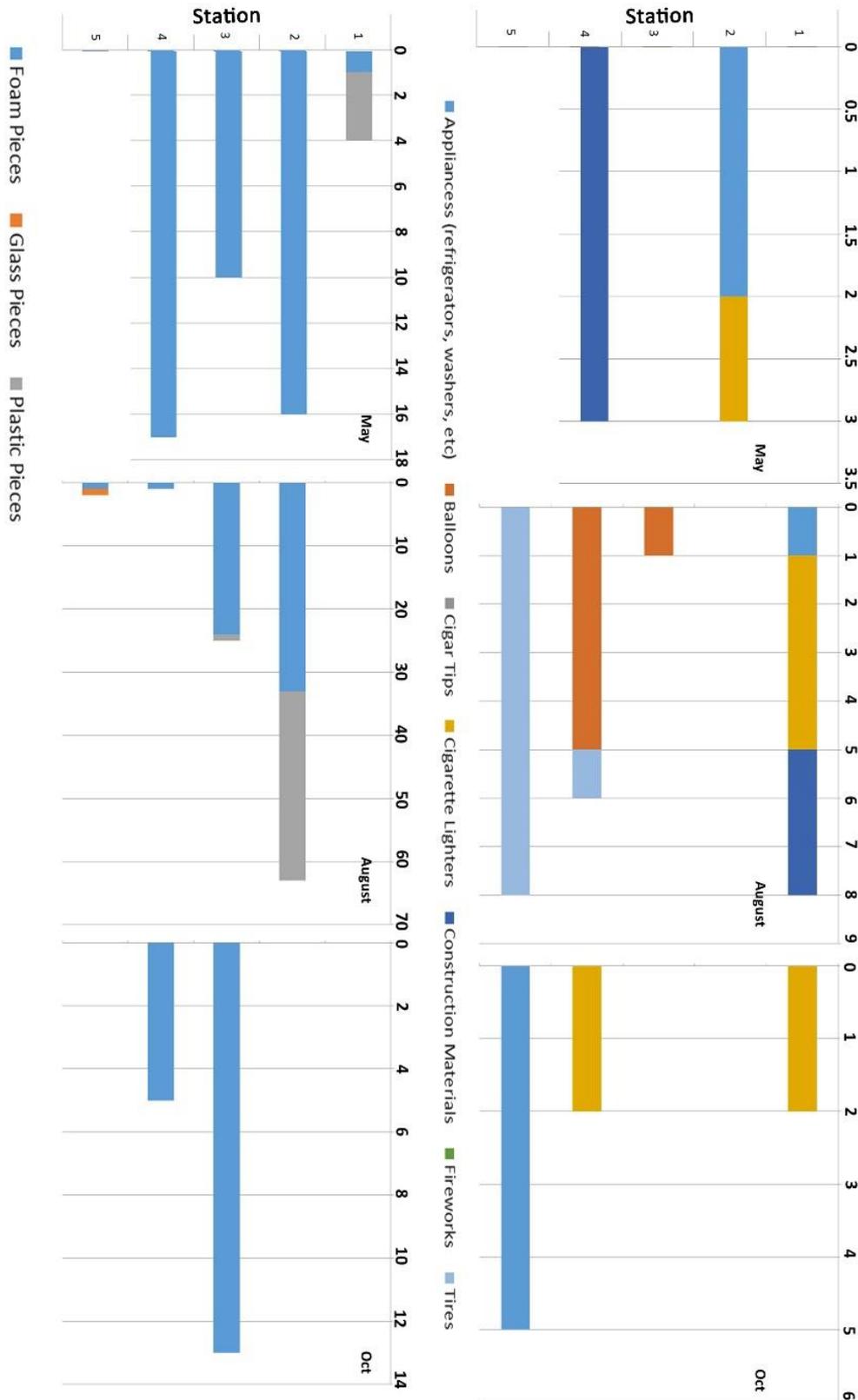


Figure 6. Materials and Other trash

Of the three data retrieval times, the highest quantity of debris was found in October as in the previous discussion. Type of debris dominating in this month is a plastic bag which is allegedly due to the overflowing river stream which brings plastic waste from a household waste. In addition, bottle debris is found to be higher in quantity compared to other months, causing the weight of debris weighed in October to be a lot higher than in other months.

In May and August, the most commonly found debris is cigarettes. The source of this cigarette is likely the tourists, residents, and fishermen. There are fluctuations in the number of types of debris found in each month, however, the largest amount of debris found is plastic bags taken in October. This is allegedly due to the light properties of plastic bags, making it can float in water, causing it to be the heavily stranded on the coast. For other types of debris such as cigarettes, which is drowned in the water, it is probably drawn to the bottom of the waters by the current, in addition, cigarettes also small in size. It can be seen that there is a decrease in the number of cigarettes found from August to October. Another source of debris found on the beach is the fishermen because the beach is identical with fishermen catching for fish (Figure 5).

The most common type of debris found in August is the rope wasted by fishermen. This is due to a fishing season which likely occurred in this month that the fishermen use the fishing boats more often compared to other months. Besides, there are also many fishing nets found in this month. This type of rope debris is found mostly at station 5, which indicates that this station is the place where the ship is being docked. In August, the amount of balloon debris was higher compared to others. Debris in this category was found with higher quantity at stations 4 and 5, in every month, than any other station.

The most common debris found in this category are construction materials, matches, tools (cleaning), and balloons. Debris from fireworks was not found in all stations in any month. As for debris in the category of < 2.5 cm are a plastic piece, glass piece, and foam piece. The highest amount of debris found in this area is pieces of foam, followed by plastic pieces and glass pieces. These piece of debris are found mostly in August and rarely in October. While these pieces of debris are mostly stagnant in May for each garbage collection station (Figure 6).

4. DISCUSSION

This is the first assessment to study about abundance, distribution of beach debris in different months. One of source of debris in this place was indicated coming from another area, taken by the current that passed this place. Marine debris can be distributed far away from its source taken by the wind and currents [29]. In the left side of PB, there is Citumang river that assume to be source of debris in October because of heavy rain and monsoonal pattern. Distance affects the debris abundance, as the closer of the source, so as higher debris abundance [30]. Observation in one location differ based on the difference of season can be applied on the next research. The difference of season can affect density value and the debris abundance in the same location [28, 31]. Types of debris can also differ by the season, there are two types of debris which can be found in drought seasons such as plastic cutlery, straws, and small plastic bags [32]. In summer, debris type like Cigarette Butts is encountered on the beaches, which is consistent with studies on touristic beaches around the world [33, 34].

5. CONCLUSIONS

It is clear that abundance of beach debris in PB addressing the problems associated with local activities. The accumulation zone of debris near the MPA. Therefore, educational and advertising campaigns focus to tourists and merchant, fisherman, and local people.

Furthermore, local government should be more active to encourage people especially tourism. Moreover, the limitation of this research, however, the origin and movement are still need development but very important to give more detail information about spreading of debris [35].

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