



Distribution of Marine Debris in Biawak Island, West Java, Indonesia

Noir P. Purba^{1,*}, Mega L. Syamsuddin¹, Rona Sandro²,
Isnan F. Pangestu², M. Reza Prasetyo²

¹Department of Marine Science, Faculty of Fisheries and Marine Science, Padjadjaran University,
Jatinangor 45363, West Java, Indonesia

²KOMITMEN Research Group, Padjadjaran University, Jatinangor 45363, West Java, Indonesia

*E-mail address: noir.purba@unpad.ac.id

ABSTRACT

Marine debris becomes a challenge to the ocean view especially in Indonesia as a maritime country. This study investigates the distribution of marine debris in the Biawak Island, Indramayu district, Indonesia. This study was conducted in November 2013 and 2014 by completing the standard form of the global International Coastal Cleanup (ICC) Network. By doing this, we aim to establish the condition and distribution of debris in the ecosystem area. The data collected from 7 stations along the coast of the Biawak island. The results showed that the total weight of marine debris ranged from 3-26 kg in each station with the highest density located at the eastern part of Biawak Island. The total weight of marine debris was 68 kg of 655 meters from total length 4.93 km of coastal line. Marine debris that found in the region predominantly composed of waste rope, styrofoam, and plastics. Debris from fishing activities also suggesting as a prevalent debris item found in the region. The result indicates that sources of debris transported from other regions by the ocean currents.

Keywords: Biawak Island, plastics, fishing gear, tracking, mangrove ecosystem

1. INTRODUCTION

Marine debris as a global issue for this century [1]. This issue blow up by UNEP Report in 2011, Rio +20 Conference in 2012, and World Economic Forum in 2016. The report

concluded that almost marine debris affected biodiversity of ocean. Especially in Indonesia, marine debris becomes a serious problem for coastal areas and small islands, because this area as habitat for marine life and ecosystems. Most of this waste comes from human activities which transported by ocean currents to all areas depending on the oceanographic system. Since Indonesia as the world's largest archipelago (comprising 14.466 islands), the spread of marine debris becomes more complex due to transported by the current system which is locally and shifting [2]. The study about marine debris has been done in some coastal and island area. Founded that marine debris from various continents was drifted by ocean currents in Amami Island, Japan [3]. Marine debris distributed in the beach when the high tide ends occurred [4]. The study on the island of Santa Catarina, Brazil, found that abundances of litter ranging from 12.8 to 498 items/100 m² [5].

There are many different types of debris enter the ocean. A study estimated that millions of tons of plastics enter the ocean each year [6]. Furthermore, Ocean Conservancy stated that the distribution of the top ten global garbage in coastal includes cigarettes, caps, plastic, beverage bottles, plastic bags, food wrappers, cups/plates, glass, straws, beverage cans, and paper bags [7]. Types of debris in the form of cigarettes and exhaust cutlery were the most frequent debris encountered in the entire coast of the world, accounted for 32 % and 9 % of the total debris, respectively. In some commercial beach in Indonesia, approximately 65 % of the waste that located in the coast sourced from tourists [8]. A similar study showed the portion of waste from land and sea is about 3:1 [9].

One of the isle that exist in the northern of West Java province is Biawak Island, which is categorized as Marine Conservation Areas (MCA). This isle consists of three islands named Biawak, Gosong, and Candikia. These islands are located in the Java Sea with characteristics that resemble the "*big river*" with alternating currents system. Biawak Island has a long coastline and located at 4.88 miles off the coast of Java Sea, ±40 km north coast of Indramayu spanning between 05°56'002" S and 108°22'015" E, located 26 miles (50 km) north of fishing base in Indramayu. The island is characterized by flat topography with some parts of the island covered by mangrove inundated by sea water, especially at high tide. Biawak Island is about ±120 Ha wide, consisting of 1 ±80 hectares of mangroves and coastal forests ± 40 ha/land [10]. Mangroves are scattered along the beach to be a perfect trap for the garbage that comes from the sea due to the roots. Some survey of environmental conditions has been conducted in the Biawak Island, namely the BIEXRE I & II (2012-2013), T-RAX (2013), and MYSEA Project (2014). The survey results showed that the status of the ecosystem 80% was in a good condition. The population of the island is only 1-2 people in charge to maintain the lighthouse.

The importance of this study is because the marine debris, which almost inorganic matters, can damage the ecosystem [11]. Marine debris impacts on environmental conditions are less publicized than ingestion and involvement include the smothering of the ocean floor sinks when marine litter [12]. In this study, a preliminary study was conducted to determine the type and distribution pattern of debris in the Biawak island.

2. MATERIALS AND METHODS

A wide range of measurement methods have been applied to aquatic litter studies and a selection is described below [4,8,13]. The method used in this study was follow the standards

of the International Union Conservancy of Nature (IUCN) with the supplied standard data tables containing pollutants that found in the location of activities. The coastal cleaning type was a shore cleanup [7] started from the area of the highest tides to a near dunes area that is not affected by the tide. The filling forms consist of 39 items question with focus on weight and distance sampling point.

2. 1. Preliminary Data

In 2012, the preliminary observations focus on the mangrove ecosystem area and oceanographic have already done in the Biawak Island. Meanwhile, in this project, the observations were conducted in November 2013 and 2014. The total stations were 4 stations in 2013 and 3 stations in 2014 (Table 1).

Table 1. Characteristics of sampling station area in Biawak Island conducted during 2013 and 2014 with the average characteristics of the stations is mangrove.

Year	Station	Latitude	Longitude	Characteristics	Length of Transect (m)
2013	1	5.9328 S	108.3758 E	Mangrove, sand	100
	2	5.9319 S	108.3872 E	Mangrove, rubble, silt	99
	3	5.9253 S	108.3792 E	Coastal, coastal forests	81
	4	5.9357 S	108.3823 E	Mangrove, rubble, silt	100
2014	5	5.9285 S	108.3867 E	Mangrove, rubble, silt	85
	6	5.9269 S	108.3721 E	Mangrove, mud, sloping	90
	7	5.9305 S	108.3738 E	Mangrove, mud, sloping	100
				Total Length (m)	655 m

Based on table 1, the sampling location of this study is mangrove ecosystem. The length of the transect is varied from station 1 to 7 with average transect is 93.57 meters. Mangrove ecosystem on the Biawak Island are in the intertidal zone and partly in areas with muddy sand substrate. Early preparation was performed by explaining the technical implementation of the coastal cleaning, including to inform the types of pollutants that have to be removed and the mechanisms of data collection to the volunteers.

2. 2. Measurement Description

Additionally, before the project started, the questionnaire sheet was given to each volunteer as a pre-test and divided them into small groups (3-4 people). Every small group will perform three locations area as far as 50-100 m. Each group brought five large trash bag, standard log sheet, and gloves. Each group noted contaminants that appropriate those found in

the standard log sheet. When all procedures are completed, each group collects the debris in the plastic bags that containing pollutant at each point of a predetermined area. Then, debris quantities was measured for knowing its weight. Methods involving volunteer fairly effective because it provides knowledge about the debris in the ecosystem and the beach [14];[15]. The site selection is based on the amount of debris and it represents the characteristics of the island. Additionally, interviews and determining the location of the fishing station also carried out to provide an overview related to the source and type of debris in the waters.

3. RESULTS AND DISCUSSION

The sites of data collection located along the coast of the Biawak Island. Sampling sites are mostly located in the region of mangrove ecosystems and on the sandy beach. Garbage collection performed at different stations for each year. This section will show the type and amount of waste and the dominance of species that exist in each of the station.

3. 1. Distribution of Debris

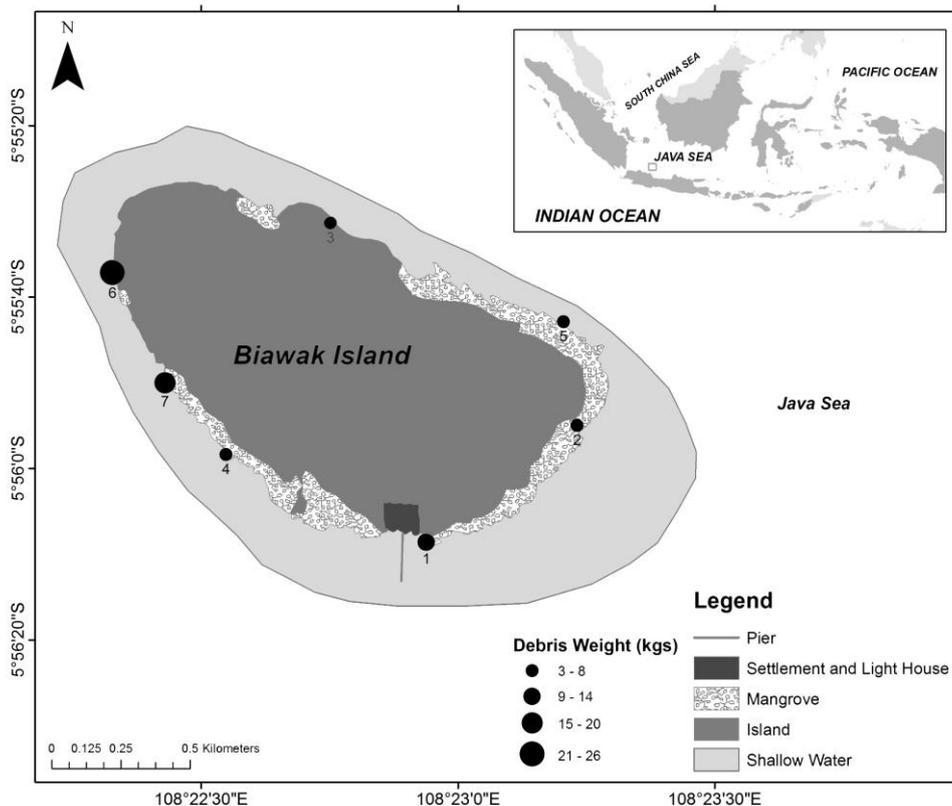


Figure 1. The station locations and the study area in the Biawak island (black dots shows station number) overlaid with water depth (grey line contours). The inset map shows the wider area of the Indonesian seas, with the box representing the study area. The grey box shows the lighthouse. Shallow water ranges from 0-1 meter.

The location of debris found mostly in the mangrove ecosystem and only one site located on the sandy beach (station 3) in north of the island. In the mangrove area, debris found among the roots, while at the sandy beaches, in the line of highest tides. Litter weight ranged from 3 to 26 kg, with stations 6 (east) is the location with the heaviest litter quantity (21 to 26 kg), while the least weight is in around the pier (stations 1 and 4). East region (stations 6 and 7) and south (station 4) have the greatest concentration of debris (Figure 1). In these areas, mangrove *Avicennia* dominate the beach and its roots submerged at high tide and low tide. At other stations, mangrove roots submerged only at the highest tide. Marine debris commonly found at high tide [16]. This indicates that the mangrove roots have strong influence as a trap of marine debris. Furthermore, based on the shores characteristics (Table 1), the marine debris were located in shore by wave breaking.

Preliminary analysis indicates that the debris in all the beach is not an endemic debris but brought by ocean currents. It is indicated that all the debris have been transported far away from the settlement. The results of interviews with people who lived in this island, showed that the debris sourced from fishing vessels and also from other regions. Additionally, residents in this island have its own landfill.

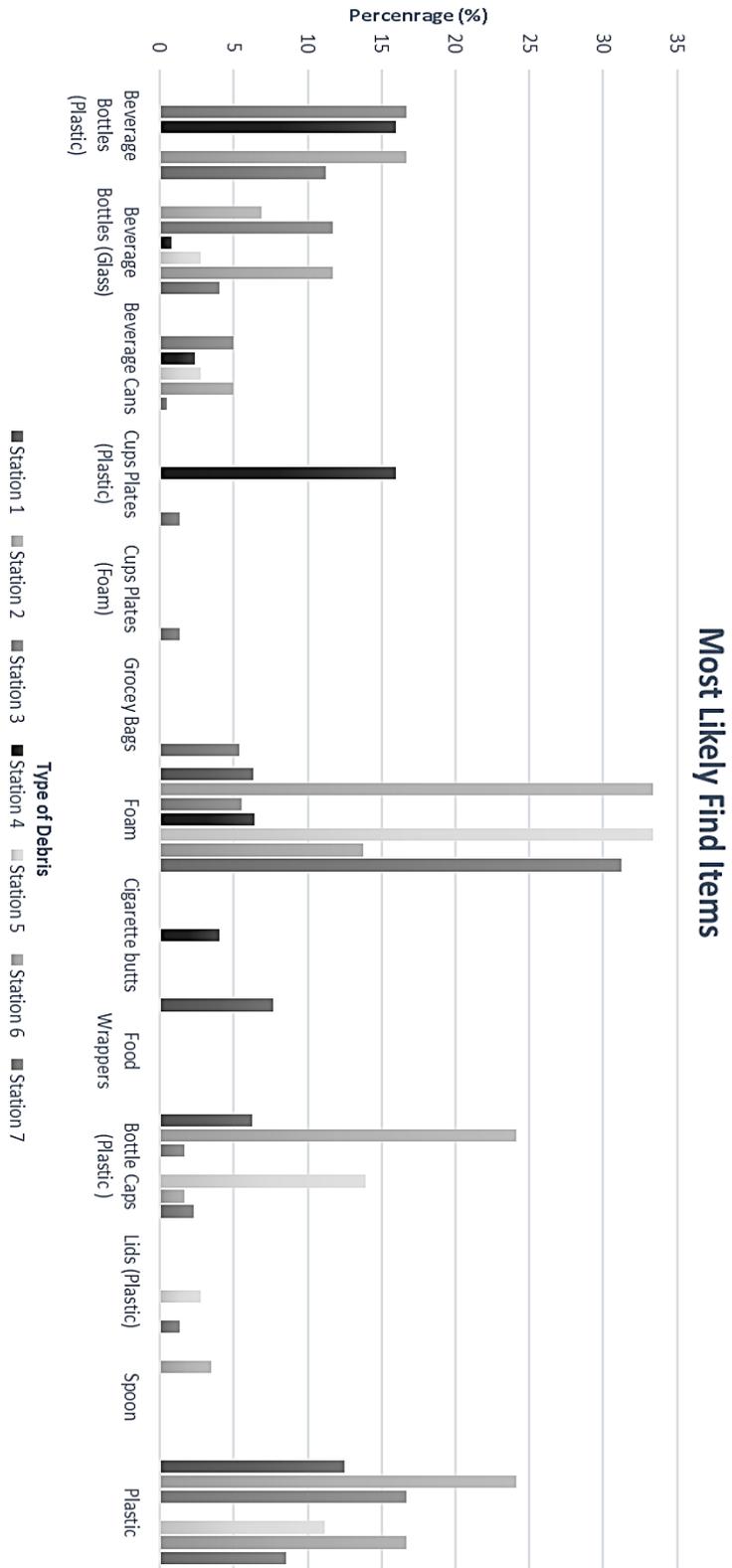
Based on the results of data collection and field survey, the marine debris was very hard to take, especially plastic and rope that trapped in the mangrove roots. This garbage has been trapped approximately one year (annual), because in the second year of monitoring conducted in different places. Then, the cause of this condition probably occurs due to alternating current system in the mangrove roots.

3. 2. Types of Debris

Other results showed that the most frequent type of debris found are nets, and ropes around the mangrove ecosystem (Figure 2). Rope most widely found at almost every station. The fishing net are not found in station 1 because the location quite close to human activities, so that they may have been cleaned. From the 18 types of "Most Likely to Find Items" there were 14 types of debris found along the coast with the foam concentration of about 33% at stations 3 and 6. As for the type of "Fishing gear", there were 3 types of 4 obtained in the form of the ICC Network found most widely in Biawak Island about 50% of rope is the highest percentage found. Items of "Personal Hygiene" and "Other Trash" were not found in every station and also has a small quantity <5%. Types of waste that not found in this region include: fishing line, condoms, diapers, syringes, tampons, tires, etc. Biawak island with a length of 655 meters produces 68 kg of waste.

From the trash that found in this island, indicate that the debris come from the ship, which mean debris is not came from the island. Debris from the ocean float by current through the sea to Biawak Islan. Java seas is one of the main transportation from east to west vice versa.

The results of Ocean Conservancy report for Indonesia showed that the length of 1.6 km has a weight of 653 kg [7]. From 7 stations obtained, there were 4 types of debris collected in every station consist of foam, rope, beverage bottles (glass), and bottle caps (Figure 3). The rope has weight average of the most numerous and it was derived from fishing activities. The characteristics of fishermen in this area are always bringing fast food. When they are repair a fishing nets in the sea, residual nets are dumped with food debris



a

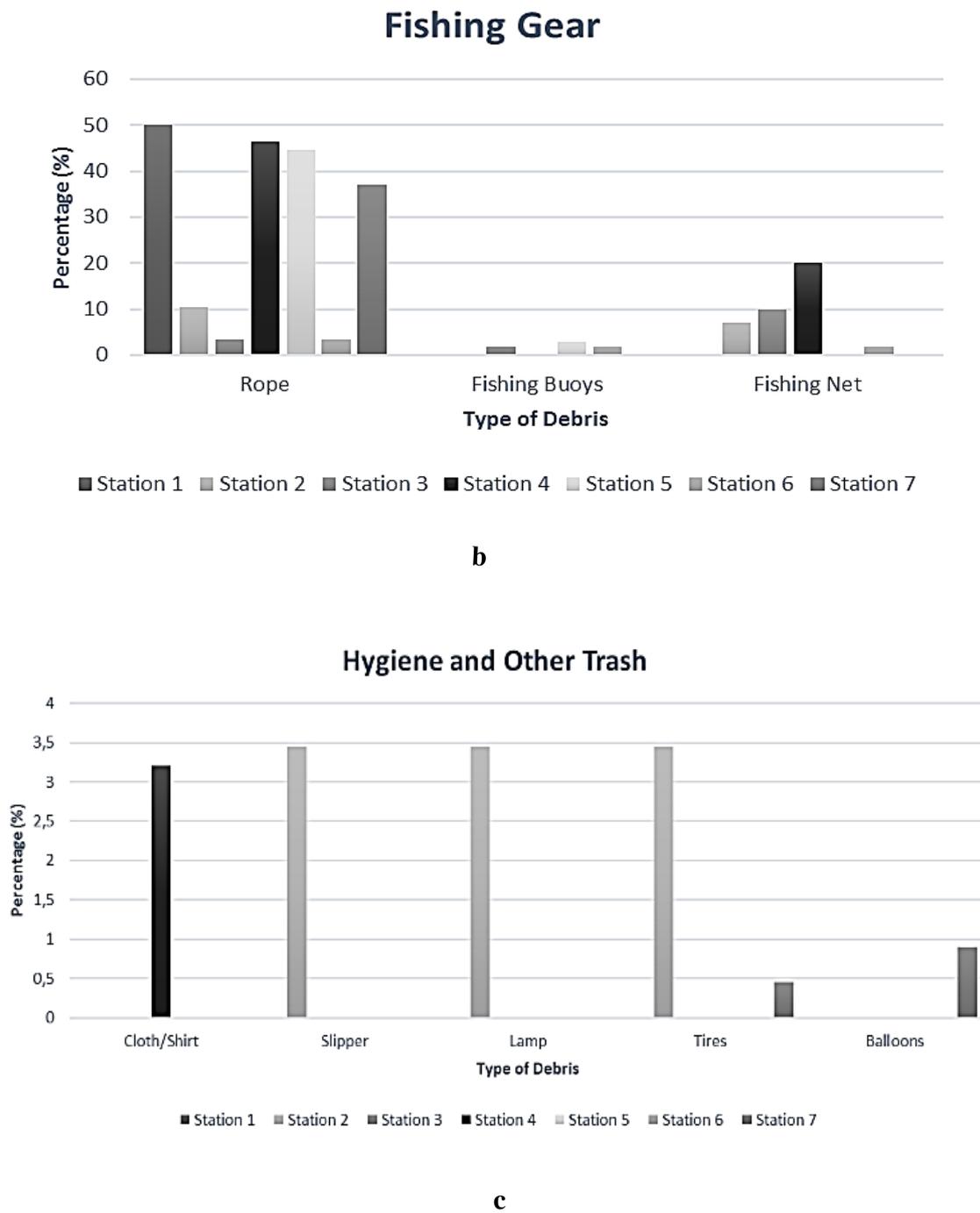


Figure 2. a) Debris which is often found in the whole station is foam and the second highest is plastic; b) There is debris which is found in the form of fishing gear throughout the station, rope, the presentation is about 50%; c) There is found Personal Hygiene in the form of two types, namely, cloth /shirt by 3.2% and slipper by 3.4% which was in station 2 and 4. There are three types of other trash which is found at the site, Lamp Tires and Balloons, which are found at station 2 and 7 with the largest percentage obtained from tires and lights by 3.4%.

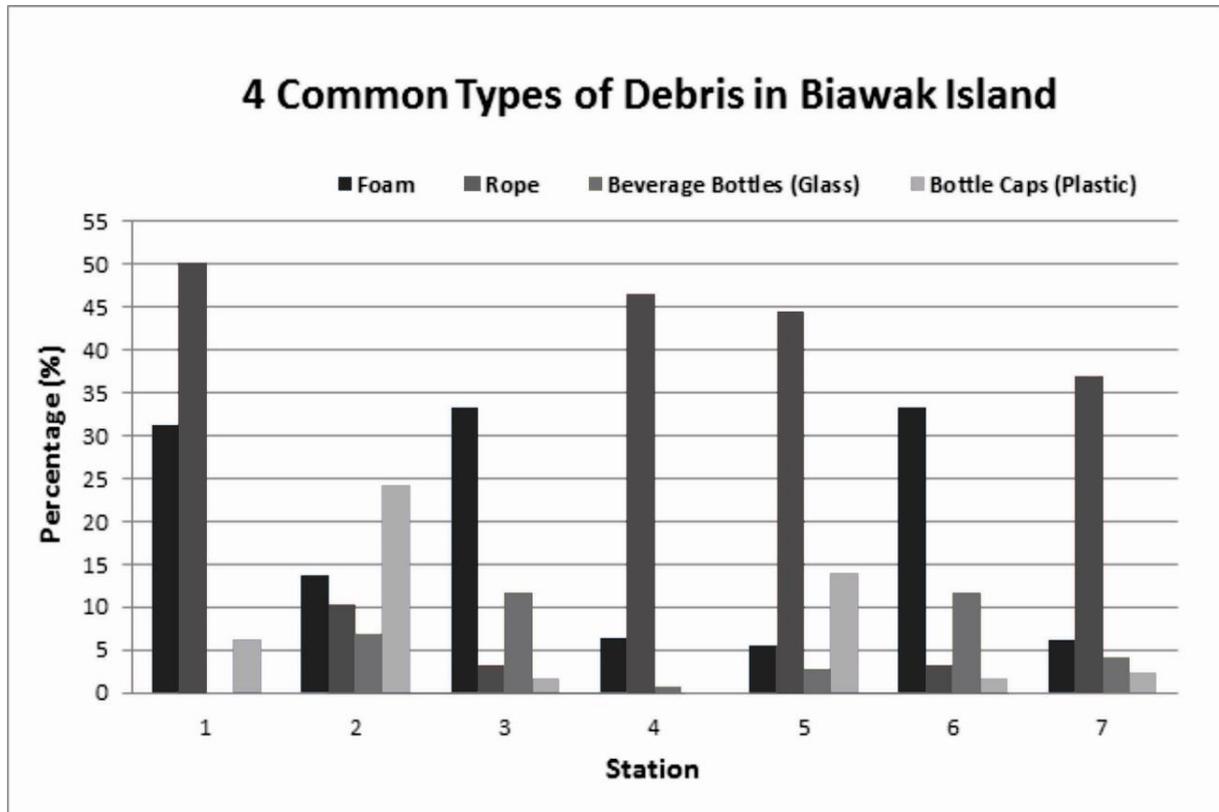


Figure 3. From the entire station 4 Common types of debris is found in Biawak Island, there are ropes with the greatest presentation, namely 50% at station 1, the smallest presentation obtained glass bottle, 1% at station 4 and almost found throughout the station are foam and plastic.

Based on Figure 3 that showed the four types of debris found at every station, the most common debris type was ropes. Rope was also most commonly found in station 1. The second highest concentration is foam, followed by bottles caps, and beverage bottles. The fourth type is also the most commonly found on other beaches around the world (Figure 4). Number of styrofoam and plastic that found in Biawak Island could be caused by the debris that floating in the ocean, a small density that can be carried by winds and currents may explain this conditions. A similar study in other areas also found that styrofoam has a very high level at the beach [17], as well as the plastic about 50% were found in the Maltese Island [16,18] in New South Wales about 72-86% and a major litter on beaches [19]. However, the fishing activities seem to cause this waste.

Styrofoam hard to drown and moved towards the mainland. This debris probably came from the Java or Borneo islands. Styrofoam mainly used by the fishermen as a freezer or cooler as well as food containers during fishing activities. All bins are obtained along the coast and so easy to find. This means that the radius of the beach is not more than 20 meters and 50 meters farthest can be found debris. Debris causes the environment dirty and further will give negative impacts on Biawak island as a tourism site. Almost all of the waste that is not sourced from this region. Based on the identification of debris in this region, almost all

debris were difficult to unravel. Globally, there were different results when we compared with the results of the ICC, they found that cigarettes as the first rank, while in the island Biawak dominated by rope, styrofoam, and plastic. But overall, this types of debris still include of the 10 ten types of trash found in the world.

Based on the type and distribution patterns of garbage derived from outside the Biawak island and mostly fishing's debris, then further analysis is needed to see the flows pattern and consider the fishing position in the region. Biawak island is an area with a high intensity of fishing and fishermen from Indramayu and from outside the region (Figure 4). The first approximation of debris on the Biawak island is caused by several factors, that is the currents, wind, bottom topography, and waves [20]. The flow pattern in this region is associated with the tides and wind. Current dominance occurs always leads to the coast. As a result of the dominance of tidal currents, wind direction different from the flow surface current 0,272 m/s in the direction of the daily fluctuation [21]. The wind blows from north to south, while the current is moving from east and west. Biawak region located between the islands of Borneo and Java, which, seen as a largest "watershed". In Kuta beach, Bali, mostly debris found during the west season [22,23].



Figure 4. **a)** There was found a large trash such as pieces of plane or boat that was tucked away in the mangrove forest area; **b)** Plastic bottle was found in one of the stations which tucked in the mangrove roots; **c)** There was a rope which was found on the sidelines of mangrove roots on the Biawak island; **d)** Some types of fishing gear such as ropes and nets found lodged in the mangrove roots on the Biawak island which can disrupt growth of mangrove

It was difficult to determine the flow pattern of specifically brand or types of marine debris. This is due to the observation conducted in 2014 did not find the same trash on the location of the previous survey in 2013. Further investigation through the use of long period observation on distribution patterns of debris are needed in this region.

4. CONCLUSIONS

Marine debris were found on all coastal area of Biawak island and trapped by the ocean currents. The weight of debris ranged from 3-26 kg with the total of 68 kg of 655 meters from total length of 4.93 km. The majority of debris found in the mangroves area and mostly consisted of fishing's debris (ropes). Based on the stations sampling, there were 4 types of debris collected in every station consisted of foam, rope, beverage bottles, and bottle caps. A greater understanding of marine debris in island in Indonesia needs to be obtained by further studies to know the source.

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