

CHAPTER 1

INTRODUCTION

Marine debris is defined as solid trash or any human-made object discarded, disposed of and abandoned, eventually thrown away and lost in the ocean. The debris can be considered as any object foreign to the marine ecosystem but usually reserved for human-created trash ranging from plastic bags, polystyrene, plastic bottles to aluminium drinking cans, glass, garments pieces, tyres, fishing lines and nets. These debris can be found on the beach, on the bottom of the sea or floating in coastal waters (Allsopp *et al.*, 2006). Poorly solid waste management from land and sea are the main sources of marine debris.

Many studies have enumerated and measured marine debris on beaches in terms of the number of items, while others have weighed the debris, as well as, floating marine debris surveyed from ships (Morishige *et al.*, 2007; Yamashita and Tanimura, 2006; Abu-Hilal and Al-Najjar, 2004; Thiel *et al.*, 2002; Moore *et al.*, 2001a; Whiting, 1998; Frost and Cullen, 1997; Matsumura and Nasu, 1997; Corbin and Singh, 1993; Lucas, 1992; Wakata and Sugimori, 1990; Horsman, 1982). Only a few studies have examined the distribution of submerged benthic marine debris (Spengler and Costa, 2008; Nagelkerken *et al.*, 2001; Moore and Allen, 2000; Golik, 1997). Even though various studies have been conducted to quantify marine debris found along the beaches but little information has been compiled appropriately which only produced semi-quantitative estimates of debris. However, many organizations including Center for Marine Conservation (CMC) are now vigorously putting the effort to collect and analyze data

on worldview's beach debris to inform the public of this growing problem (Ribic *et al.*, 1997).

1.1 PLASTIC DEBRIS

As listed by CMC in 1991, the 12 most frequently collected marine debris items on beach are cigarette butts, plastic pieces, foam plastic pieces, plastic food bags and wrappers, plastic beverage bottles, plastic straws, foamed plastic cups, plastic caps and lids, paper pieces, glass pieces, metal beverage cans and glass beverage bottles. Not surprisingly, plastics are one of the most frequently collected types of marine debris because they are low in density which can easily enter the marine environment and be washed off onto the beaches.

Plastics are materials that have a wide range of usage in our modern society. Thus, their occurrence as marine debris is overwhelming. As stated by Garrison (2006), 132 million tonnes of plastics waste was generated averaging to about 500 kilograms per person per year in the United States of America (USA) alone. Plastics waste accounts for more than 12% of all solid waste stream in 2010 (Garrison, 2006). Furthermore, plastics will remain in the environment for a long period after they entered the marine realm because of their strength, buoyancy and durability. There are many innovative projects carried out globally to study and remove plastics from the sea. One of those was Project Kaisei, conducted by a team of marine environmentalist between June and August 2009, which estimated that there were four million tonnes of floating plastic waste in a mass on the northeast of Hawaii which is also an area of the Pacific Ocean (Morton, 2009).

The sea is always treated as the ultimate dump and some of this plastic debris will end

up and litter the beaches. Presently, plastics debris make up more than one-half of all anthropogenic debris found at sea and along the coastlines (Derraik, 2002). In 1997, more than 75% out of 209 tonnes of marine debris recovered was plastic (paper and glass accounted for another 15%) during the clean-up activity along the New Jersey – New York coastline (Garrison, 2005). Similarly, Malaysian beaches are also facing identical phenomenon. According to Chan *et al.* (1996), plastics was the most abundant form of debris collected which accounting for about 40-45%, followed by styrofoam, glass and rubber-based debris. These items were found polluting the Chagar Hutang beach, Redang Island and Mengabang Telipot [part of the northern mainland beach in Terengganu], with debris originating from fishing activity, coastal villages and from Malaysian and neighbouring countries' off-shore ship industry (Chan *et al.*, 1996).

In the last few decades, plastic debris is identified as an indicator of other forms of pollution that pose risks to marine organisms. As most concerned, the threat of plastics to the marine environment has been mistreated for long periods of time, not until recently (Derraik, 2002; Stefatos *et al.*, 1999). Marine animals are known to ingest everything from large pieces of plastic sheeting to tiny plastic resin pellets and this ingestion can have adverse effects. The plastic constricts movements of the marine animals through starvation, exhaustion, internal injury and intestinal blockage (Derraik, 2002; Redford *et al.*, 1997). The animals may starve to death if the plastic clogged their intestines which prevent them from obtaining vital nutrients.

On the other hand, non-biodegradable small plastic particles may accumulate in plankton-consuming animals and could be passed up through the food chain (McDermid and McMullen, 2004). Based on the study conducted by Moore *et al.* (2001b) in the North Pacific central gyre, small plastics such as plastic fragments, styrofoam pieces,

pellets and thin films collected in trawls had a ratio of 6:1 plastic to zooplankton mass. These small pieces of plastic likewise are mistakenly ingested by marine organisms such as seabirds, sea turtles, fish and various planktivores (Blight and Burger, 1997; Laist, 1997; Bjorndal *et al.*, 1994; Carr, 1987; Carpenter *et al.*, 1972).

For centuries, various types of debris especially plastic items entered the world's ocean each year causing primary impact to marine pollution and aesthetic displeasing. Plastics debris that was washed ashore can reduce the recreational and aesthetic value of the beach and can be hazardous to beachgoers and coastal wildlife. Corbin and Singh (1993) stated that trash on shoreline was a serious problem for Caribbean islands where it threatens the health and safety of beach users. This was detrimental to the tourism industry, a major revenue earner in many of these islands. Malaysia also is well-known of its exotic and unique coastal area and beaches especially along the coastline of East Malaysia. If necessary actions are not taken in regards to the abundance of debris on Malaysian beaches, similar situation as in the Caribbean islands will affect Malaysia economically and environmentally.

The threat and impacts of plastic debris have long been ignored. Perhaps lack of visibility of plastic debris and lack of information has allowed society to dismiss the problem as a serious threat. Many researches demonstrate that quantities and impacts of plastic debris are significant (Derraik, 2002; Goldberg, 1995; UNESCO, 1994; Gregory, 1991; Pruter, 1987; Wilber, 1987; Horsman, 1982). It sees an increasing trend where beaches and coastal oceans are becoming the virtual garbage bin for developed and developing world which consequently threaten wildlife, human and marine ecosystem. Thus, sufficient studies and monitored data are needed in order to view a better understanding on the plastic debris pollution.

1.2 OBJECTIVE OF THE RESEARCH

The main objectives of this research were:

- 1) To initiate the study of plastic debris on Malaysian beaches started with the quantification of plastic buried in sand at beaches in Malaysia namely Port Dickson, Kuala Terengganu and Kota Kinabalu.
- 2) To determine the abundance of buried plastic debris according to size range.
- 3) To determine the classification of buried plastic debris at these beaches, and to correlate it to the activities.
- 4) To determine the abundance of buried plastic debris according to tidal zone and berm location.

1.3 IMPORTANCE OF THE RESEARCH

Litter or solid waste which present in marine environment is known as debris. Marine environment including beaches around the world are littered with numerous type of solid waste especially plastics. Plastic debris in environment is usually associated with human activities, and is increasingly being recognized as an international pollution problem.

The level of location, type of beach usage and influence from human activity are the most important factors controlling levels of beach debris (Corbin and Singh, 1993). However, levels are a function not only of the quantity of debris in adjacent waters and the direct input from visitors to the beach, but also indirectly from natural beach physiographic or attributes of the beach profile, slope, exposure and environmental factors (prevailing winds and ocean currents) influencing the transport of the debris

items (Thornton and Jackson, 1998; Frost and Cullen, 1997). Studies by Golik and Gertner (1992) and Vauk and Schrey (1987) have shown that fragmentation and deposition of debris items increased with storms and rain events. Furthermore, once on the beach, plastic debris may bury resulting in underestimation of the total amount of plastic litter reaching the shore (Williams and Tudor, 2001). Therefore, quantitative analysis of plastic debris buried in sand on selected Malaysian beaches in this study is important to determine the deposited debris fragment in sediment. Besides, abundance of the buried plastic debris in this study can also be determined as it is often neglected during the clean – up activities due to its small size and invisibility.

In addition, there is less attention on the abundance and mass of plastic debris based on different attributes such as foreshore (low tide and high tide zone or known as tidal zone) and backshore (berm) location within a shoreline. Thus, this study also would provide the quantities of plastic debris found according to the profile of the Malaysian beach. Besides, quantification of plastic debris fraction in the sediment can display the state of the health of the Malaysian beaches and serve as a parameter for beach quality assessment.

Finally, evaluation of small buried-plastic debris from this study presented scientific data of plastic debris occurrence on Malaysian beaches which can enhance success of cleanup activities and develop efficient prevention effort. Also, it will be useful for future researchers working on plastic waste management in coastal area or other related monitoring in Malaysia specifically, and other countries in general.