Identifying Recyclable and Non-Recyclable Plastic Polymers on Southern Vancouver Island Beaches

Save Our Shores - Plastic Pollution

Oak Bay High School

Canada

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Abstract

Why should we care about plastic pollution? Plastics have so many appalling effects on the environment. When small particles of plastic are eaten by marine animals, they are passed up through the trophic levels of ocean food webs. The effects of plastic pollution are becoming better known, and now it should be time to start thinking about where and what we can do to stop the flow of plastics into our oceans. To begin our look at what we can do to address plastic pollution, we first need to learn what kinds of plastics are washing up on our beaches. For our plastic pollution study, we have two research questions: (1) What types of plastics from #1-7 are washing up and are the types they recyclable or non-recyclable? (2) What types are most abundant on our beaches? To answer our research questions, we will sample and collect plastic debris at local beaches through the use of a transect line to determine our sample area and sieve screens to collect the plastic debris. With the collected plastic, we will use relative densities of specific liquids to identify the standard plastic classification types and determine the relative % of plastic polymers which are recyclable in the Greater Victoria area.

Keywords

Plastic, pollution, recyclable, polymer, shoreline

1 Introduction

To throw away a piece of plastic is a mindless task, but thinking about where plastics end up after they are thrown away is a crucial step in understanding the impacts of plastic pollution. Little pieces of plastic debris that may seem insignificant are accumulating in the world's oceans. They lead to detrimental ramifications for marine ecosystems, migratory seabirds, and humans alike. Both micro and macro plastics have significant effects on the environment, but micro plastic pollution has become a specific concern because of the serious implications of bioaccumulation of these plastics in marine life. These implications include diminishing numbers of many species. These micro plastics are categorized by their chemical structure into groups called polymers.

Plastic polymers are different varieties of plastics, made up of various chemical combinations. Some examples of polymers are #1-PETE, #2-HDPE, and #3-V-flexible. On most consumer plastics, one of these codes is molded on to the bottom for ease of identification. This identification system was established by the Society of Plastics Industry to help the general population a way to identify plastic polymers. Plastic polymers are made into products such as plastic bottles, straws, and utensils. The majority of the products we use on a daily basis are made from plastic polymers. This can pose a problem; if a consumer product becomes more popular, will we see it more commonly as a pollutant on our shores? A significant number of consumer products use plastic packaging. The making of plastics became a large industry in the 1940s, and ever since then, the production has increased drastically, and with it, the amount of plastics making their way into our environment.

Many plastic polymers can be frequently found on local beaches on the southern Vancouver Island. The project objectives are to identify the plastic polymer types comprising the beach plastic pollution and to determine which of the plastics found are recyclable in the Capital Regional District (CRD), composed of the City of Victoria and twelve other municipalities. To prevent further plastic pollution from entering our marine ecosystems, determining the source of the plastics, whether it be from consumers or industry, would be an important first step. The goal of this project is to identify plastic polymer types comprising the plastic pollution found on local beaches and to determine whether or not these plastic polymers are recyclable in the CRD.

2 Methodology

2.1 Beach Sampling

Plastic samples were collected from September 27th to 30th at three beaches around Victoria, B.C. : Willows Beach, Cadboro Bay Beach, and French Beach. Willows Beach and Cadboro Bay Beach are eastern facing and less exposed to the wave action. The beach substrate is composed of coarse sand on both beaches. French Beach is westward facing and faces the open ocean. As such, this beach exposed to a significantly larger amount of wave energy. The substrate on French Beach is composed of cobbles, pebbles and sand.

Plastics were accumulated with a 20 meter section of rope, shovels, and sifters in sizes 0.5 cm, 1 cm, and 2.5 cm. Samples were taken along the 20 m of the rope, with a distance of 0.5 m from both sides of the rope The screens were used to sift the top 10 cm of the beach, separating the sand or wood and removing the plastic for collection. The samples were then bagged, labelled, and dated according to when and where they were sampled.

Each bagged sample was run through a specific sequence of liquids of different densities, thus separating each plastic type by density (see Appendix A). Approximately 400 mL of each liquid was placed in a 1000 mL beaker in order to accommodate the larger pieces of plastic. Between tests of relative densities in their different test liquids, the plastics were cleaned with paper towels then rinsed in water. Large pieces of plastic too large to fit in test containers were cut apart in order to allow for determination of plastic polymer types without using the entire sample. Because the general density of solids objects is constant throughout the object, the small pieces of plastic have the same density as the larger piece. These samples helped to determine the amount of overall plastic on the shores and also gave a frame of reference regarding the density of specific types of plastic on certain sections of beach. All plastics, from #1 PETE, to #7 ABS, were categorized and documented in 1g/20m as per mass over the length of the transect line.

2.2 Grocery Store Survey

In order to help determine a potential source of the plastics found on the beach, a survey was conducted at a local grocery store, Save-On-Foods. Students surveyed the hard plastic container packaging used for food, beverage and other consumer products contained in the grocery store. For each container observed, the product type and the plastic polymer number were recorded.

3 Results

3.1 Plastic Polymers Collected

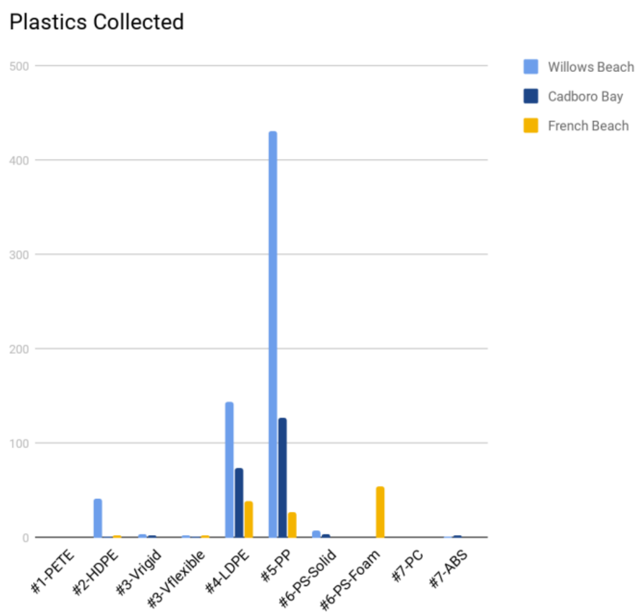

Figure 1: Amount of Plastic Polymer Types Collected at Willows Beach, Cadboro Bay Beach, and French Beach.

The results were gathered from three beach locations; Willows Beach, Cadboro Bay Beach, and French Beach. At the first location sampled, Willows Beach, 41.1g of #2-HDPE plastic, 4.0g of #3-Vrigid plastic, 2.1g of #3-VFlexible plastic, 144.0g of # 4-LDPE plastic, 431.1g of #5-PP plastic, 8.0g of #6-PS-Solid plastic, and 5.0g of #7-ABS plastic was found. In comparison to the two Cadboro Bay Beach and French Beach where plastic pollution was also sampled from, Willows Beach ended up having the largest amount of plastic by mass.

At the second sampling location, Cadboro Bay Beach, there was 1.5g of #2-HDPE plastic, 2.0g of #3-Vrigid plastic, 1.4g of #3-VFlexible plastic, 74.1g of #4-LDPE plastic, 127.1g of #5-PP plastic, 3.6g of #6-PS-Solid plastic, and 2.9g of #7-ABS plastic found.

The final sampling location for plastic pollution collection was French Beach. At this location there were 2.3g of #2-HDPE plastic, 2.2g of #3-VFlexible plastic, 38.6g of #4-LDPE plastic, 27.5g of #5-PP plastic, 0.2g of #6-PS-Solid, and 54.8g of #6-PS-Foam found.

There was no amount of #1-PETE or #7-PC plastic at the three locations, as well as no #6-PS-Foam found at Willows Beach or Cadboro Bay Beach. There was no #3-Vrigid or #7-ABS found at French Beach.

Plastic	Density (g/mL)
#1-PETE	1.31
#2-HDPE	0.96
#3-VFlexible	1.15
#4-LDPE	0.93
#5-PP	0.89
#6-PS	1.05
#7-ABS	1.25
#7-PC	1.40

Table 1 – Density of Recyclable Plastic Polymers

3.2 Grocery Store Survey

The local grocery store, Save-On-Foods, was surveyed to compare the type of plastics used in product packaging in a typical Canadian grocery stores to provide a basis for comparison to the plastic found on the beaches. #1-PETE (Polyethylene Terephthalate) was found in 35 of the products tested from the grocery store, yet there was no #1-PETE found at the beaches. This could indicate that consumers in the CRD are recycling #1-PETE as it is recyclable by provincial recycling programs.

#2-HDPE (High Density Polyethylene) was found in 33 of products tested, and 41.1g of #2-HDPE was found at Willows Beach, 1.5 g at Cadboro Bay Beach, and 2.3 g at French Beach, although #2-HDPE is recyclable by most recycling programs.

#1-PETE	Sport Drink, Ice Tea, Pop Bottle, Coffee, Juice, Popcorn, Peanuts, Sprinkles, Seasoning, Mayonnaise, Salad Dressing, Oil, Mustard, Ketchup, BBQ Sauce, Tartar Sauce, Honey, Applesauce, Desi Ghee, Parmesan, Rice, Cheese Cake, Cake, Shampoo, Makeup Remover, Mouthwash, Face Wash, Soap, Conditioner, Baby Oil, Dish Soap, Cleaners, Window Spray, Bathroom Cleaner, Solo Cups
#2-HDPE	Protein Drink, Coffee, Water Jug, Milk to Go, Milk Jug, Chips container, Baking Powder, Chocolate Syrup, Coffee Mate, Vinegar, Maple Syrup, Wine Conditioner, Soy Sauce, Smarties Container, Shampoo, Face Wash Agent Cream, Goat Lotion, Sunscreen, Axe, Vitamins, Stomach Antacid, Body Wash, Conditioner, Baby Oil, Baby Lotion, Protein Powder, Kitty Litter Sand, Cleaners, Wipes, Bleach, Bathroom Cleaner, Fabric Cleaner
#3-VRigid/VFlexible	Liquid Sugar
#4-LDPE	Honey, Shampoo
#5-PP	Spiderman Drink, Juice Bottle, Pitcher, Food Container, Soup, Chicken Stock, BBQ Sauce, Tic-Tacs, Honey, Frozen Strawberries, Pancake Syrup, Sundae Syrup, Cool Whip, Wonton Soup, Yogurt, Margarine, Cottage Cheese, Sour Cream, Salsa, Frozen Eclairs, Pudding, Tums, Baby Cups, Dog Treats, Solo Cups, Playdough, Ny Quil
#6-PS	Instant Noodles, Solo Cups, Fake Log Candle Container
#7-ABS/#7-PC	Juice Concentrate, Sundae Syrup, Applesauce, Oatmeal, Fruit Cup, Pudding, Soy Sauce, Caramel Sauce

Table 2 – Plastic Polymer Grocery Store Products

#3-VRigid and #3-VFlexible plastic was found in one of the products. 4.0g of #3-VRigid and 2.1g of #3-VFlexible was found at Willows Beach, 2.0g of #3-VRigid and 1.4g of #3-VFlexible was found at Cadboro Bay Beach, and 2.2g of #3-VFlexible at French Beach. This disproportionate amount could be due to the fact that #3-VFlexible and #3-VRigid are not recyclable by most recycling programs.

#4-LDPE (Low Density Polyethylene) was found in two of the products tested, and there was 144g of # 4-LDPE found on Willows Beach, 74.1g at Cadboro Bay Beach, and 38.6g at French Beach. This could be due to the fact that #4-LDPE is not recyclable by most recycling programs.

#5 - PP (Polypropylene) was found in 27 of the products tested. There was 431.1g of #5-PP at Willows Beach, 127.1g at Cadboro Bay Beach, and 27.5g at French Beach. #5-PP is recyclable in some recycling programs in the province.

#6-PS (Polystyrene) was found in three products. There was 8g of #6-PS-Solid at Willows Beach, 3.6g of #6-PS-Solid at Cadboro Bay Beach, and 0.2g of #6-PS-Solid and 54.8g of #6-PS-Foam at French Beach. #6-PS is not recyclable in most recycling programs.

#7 was found in eight of the products tested. There was 5 g of #7-ABS at Willows Beach, and 2.9 g of #7-ABS at Cadboro Bay Beach. #7-ABS and #7-PC are not recyclable by most recycling programs.

4 Discussion

4.1 Discussion and Results

Density, the degree of compactness of a substance, revealed information such as why only certain kinds of plastics were washing up on beaches and why others were not. Willows and Cadboro Bay beaches were composed of rough sand and relatively sheltered, which have contributed towards the preservation of large plastic samples. French beach is a rocky cobble beach also exposed to open ocean wave action. With waves containing plastic crashing onto shores of cobble beaches, it is possible that a significant amount of the plastic pollution was broken up into micro plastics and lodged between rocks or thrown into the trap zone above the water line. The result is plastic polymers found during beach sampling bias towards those polymers with a density less than water, as the wave energy deposits them further up shore into the beach debris trap area.

#4 LDPE & #5 PP were most prominent with respective densities of >0.906 g/mL (#4 LDPE) and <0.906 g/mL (#5 PP). A reason these plastics were the most prominent could be due to their density being less than saltwater. The most commercially produced consumer plastics (one-use drink cups, fast food packaging, water bottles, etc) are made from #4 and #5 type plastic polymers as they are easy, fast, and relatively cheap to manufacture. #4 and #5 also float in water, potentially allowing them to wash up onto shores or create patches of floating plastic where currents converge.

Along with the collection and classification of plastic debris on local shores, the team conducted a survey of a local grocery store to discover in what abundance plastic products are sold in the area. This survey sparked some interesting debate amongst the members of the Water Is Life team at Oak Bay, as it was noted that many of the plastic debris found on local beaches is, in fact, recyclable with local recycling programs in the CRD.

4.2 Potential Sources of Error

The methods used to determine the density of the plastic debris and to then classify each sample as a certain plastic polymer was demonstrated to the Oak Bay Water is Life group by staff members and undergraduate students from the University of Victoria. The procedure was practiced under supervision with plastic debris found from a plastic pollution survey conducted in the previous year. Confidence in executing the process was gained and after 3 collection periods at Willows Beach, Cadboro Bay Beach, and at French Beach, the polymers were identified in a few lab sessions at the campsite at French Beach, and in the classroom at Oak Bay High School. Once the results were reviewed and understood, suggestions for refining the identification process appeared from students in the group, as well as from teachers and staff at the University. Collectively, it was decided that for the ease of the next group who is eager to classify plastic polymers using classroom supplies, a more sophisticated labelling and storing system should be used to ensure the precise, consistent classification of all debris collected.

4.3 Next Steps

From the results collected in this study, further investigation is required in order to understand the reasons why certain plastic polymers are found in such abundance on particular beaches. It was noted during the sampling procedure that sampling locations at Willows Beach and Cadboro Bay Beach did not contain a uniform spread of plastic pollution material along the beach shoreline. Interestingly, the sampling locations with the highest amount of plastic collected were in relatively close proximity to storm water outfalls. Further investigation is warranted to determine if this observation is scientifically valid. It may also be possible to conduct a study with the local regional governing body (CRD), to collect and analyze material entering our marine ecosystems from the storm drain network. In conduction with a beach survey around storm drain outfalls, the amount and types of plastics could be analyzed to determine if the storm drains are a source of plastic pollution on our local beach shorelines.

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7 Appendices

Appendix A – Use of Density to Determine Plastic Polymer Composition

PART A (broad identification)
Add plastic debris to water, stir, and let set

- Floats, #6-PS-Foam, #5-PP, #4-LDPE, #2-HDPE

Collect Debris and set aside in labeled container

- Sinks, #7-PC, #7-ABS, #6-PS-Solid, #3-V-Rigid, #3-V-Flexible, #1-PETE

Collect Debris and set aside in labeled container

PART B (castor oil)
Add plastics debris to castor oil,stir, and let set

- Floats, #5-PP, #4-LDPE

Wipe off Castor oil and place in Canola oil

- Sinks, #2-HDPE

Collect Debris and set aside in labeled container

PART B (canola oil)
Add plastic debris to canola oil, stir, let set

- Floats, #5-PP

Put in labeled container

- Sinks, #4-LDPE

Put in labeled container

PART C (dark maple syrup)
Add plastic debris to syrup, stir, let set

- Floats, #7-PC

Put in labeled container

- Sinks, #1-PETE, #3-V-Rigid, #3-V-Flexible, #6-PS-Solid, #7-ABS

PART C (light corn syrup)
Add plastic debris to syrup, stir, let set

- Floats, #3-V-Rigid, #3-V-Flexible, #6-PS-Solid, #7-ABS

Put in labeled container

- Sinks, #1-PETE

Put in Labeled container

PART C (glycerin)
Add plastic to glycerin, stir, let set

- Floats, #3-V-Flexible, #6-PS, #7-ABS

Put in labeled container

- Sinks, #3-V-Rigid

PART C (dish soap)
Add plastic to soap, stir, let set

- Floats, #6-PS

Put in labeled container

- Sinks, #3-V-Flexible, #7-ABS

Put in labeled container

PART D (weighing)
Weigh plastic debris that float in water versus the plastic debris that sinks in water
Separately weigh polymers and record
By mass, what percentage of polymers does each # represent of collected plastics?

Prepared by danielbm@uvic.ca (with feedback from Dr.Tom Fyles, UVic Chemistry)