

GROWING ISSUE OF PLASTIC MARINE DEBRIS



VANCOUVER ISLAND UNIVERSITY

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Addressing the Growing Issue of Plastic Marine Debris within the Central East Coastline of
Vancouver Island

Victoria Bowns
Christine Jenkins
Nancy Njigha
Vanessa Stratton
Julian Telfer-Wan

Vancouver Island University – CBAIR Program
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Executive Summary

Single-use plastic and marine debris is one of the most universal pollution problems plaguing the world's oceans as it has serious negative impacts on wildlife, sea life and human health. Most studies have focused on improved waste management or more recycling as primary solutions to the problem of marine plastic pollution, however, production of plastic is estimated to increase four-fold by 2050 (Hinojosa & Thiel, 2009). More collection and recycling of plastics is unlikely to keep pace with the massive projected increase in the use of plastics, especially for single-use, disposable applications. This study addressed the gap in both past literature and practice by collecting data aimed towards recommending potential solutions for overall plastic reduction, which could, as a result, impact the levels of ocean debris and ocean pollution in a positive manner. The research documents the contributions and needs of ocean cleanup organizations and ocean-based industries along the Central East Coastline of Vancouver Island. The research also highlights the public's perception of plastic usage and the impact on the marine environment. The research considers the impact of plastic on human health, degradation to marine environment, marine life and Styrofoam within the oceans.

In conducting this research, two methods were employed for data collection. Structured surveys were utilized in gathering data from Vancouver Island community members and semi-structured interviews were conducted to gather the perspectives of stakeholders from various oceanic industries. Overall, the research shows that initiating action to drastically reduce the use of single-use, disposable plastic should be a priority. This can be done by utilizing the research findings when recommending options that could be adopted by the various levels of government, including municipal, provincial and federal. Further recommendations are also targeted towards utilizing the research information to emphasize funding resources available for ocean cleanup organizations, to encourage industries to produce biodegradable materials and to implement educational programs to further encourage better waste management and purchasing behaviours.

Introduction

Plastic marine debris has become a significant problem in the world's oceans. The impact on the environment and human life is so dire that it now requires immediate attention. For this reason, there needs to be pressure on Canadian governments through the various municipal, provincial and federal levels, to pass legislation to help reduce single-use plastics. Action is required not only to save oceanic environments but to help preserve them for future generations. Consumers have become accustomed to buying single-use plastics, as these products are affordable and easily accessible, but often people who buy single-use plastics lack awareness of the consequences associated with the improper disposal of these materials. As a result, large quantities of plastic waste are entering oceanic ecosystems.

The oceans' ecosystems are quickly becoming contaminated from the impact of single-use plastic debris, which significantly harms marine life (Gall & Thompson, 2015). Entanglement and ingestion are the primary negative implications on marine life, which often result in death. Out of "115 marine mammal species, 49 are known to have become entangled in marine debris" (Withgott, Brennan, & Murck, 2013, p.389), which conveys the need for regulation of plastics and the need for more public awareness demonstrating how marine life is impacted by humans.

The aim of this research is to inform the development and implementation of legislation and educational programs that will curb the use of single-use plastics. By conducting the research on the Central East Coastline of Vancouver Island, the researchers gained insight from area residents regarding their perceptions on how single-use plastic waste is dealt with and the potential support or resistance to legislation around single-use plastics. In addition, the researchers interviewed stakeholders from ocean-based industries to determine their level of awareness about the mounting problem of single-use plastic waste and if they are willing, through possible incentives, to counter the problem of plastic marine debris.

Objectives of Research

The purpose of this paper is to provide The Ocean Legacy Foundation with research they can use to: (a) develop recommendations to help guide policy development for the British Columbia provincial government; (b) gain insight into the perspective of community members and organizations regarding single-use plastics and plastic marine debris within local oceans and; (c) raise further awareness about the growing issue of plastic marine debris.

Literature Review

Marine debris has become a global crisis and is negatively impacting the oceanic environment (Phillips, 2017). The introduction of plastics in the 1950s greatly influenced people's consuming needs as these products were time saving and easily accessible; for these reasons they are still mass produced, despite the negative effects on both human health and ocean ecosystems (Sarafraz, Rajabizadeh, & Kamrani, 2016). With increasing levels of plastic waste in the oceans, scientific evidence is being documented and research is continuing to gauge the impact these materials have on human populations, other species and ecosystems (Hardesty, Good, & Wilcox, 2015). Relevant issues that will be discussed in the literature review are: Impacts of Marine Debris on Ocean Life, Health Implications for Humans, Styrofoam Debris within Oceans and Global Policies on Ocean Waste.

Impacts of Marine Debris on Ocean Life

There is a substantial increase in the quantity of litter produced by humans that ends up in the world's oceans, resulting in a vast range of potentially harmful impacts on the environment affecting marine life (Hardesty, Good, & Wilcox, 2015). On a global scale, marine habitats on shorelines, in deep ocean waters and at surface levels are being polluted with man-made debris (Gall & Thompson, 2015). In 2015, Hardesty et al. noted that "more than six million metric tons of plastic is estimated to enter the ocean each year from land-based sources" (p.4). Gall and Thompson (2015) have described that over 600 species have encountered debris in the ocean.

In a similar regard, Hardesty, et al. (2015) argue that considerable marine life, as many as over 700 species have been affected by marine debris, which suggests that an abundance of these toxic substances are in ocean waters. Items that are composed of plastic, wood, metal, glass, rubber, clothing and paper waste appears to be causing significant harmful effects on marine life, because biodiversity is being threatened by fatalities (Gall & Thompson, 2015). Gall and Thompson (2015), as well as Moore (2008), suggest that deaths of birds, turtles, fish and marine mammals are being well documented and are increasing due to the rise of marine debris in oceans: the number of casualties of fish, birds and mammals that are affected by human-associated litter each year is expected to be in the millions (Moore, 2008). Gall and Thompson (2015) emphasize that the mortalities of marine life

through the ingestion and entanglement from marine debris are increasing, similarly Moore (2008) suggests that plastic debris in the ocean are the main culprit of death by “killing marine life through drowning, strangulation, dragging and reduction of feeding efficiency” (p.132). As Gall and Thompson (2015) have pointed out, plastic in the oceans is being scientifically documented and 92% of encounters with marine debris result in finding plastic. Marine habitats are quickly becoming polluted by manufactured or processed materials, which are disposed, discarded or abandoned in ocean ecosystems and thus contaminating them, which significantly harms marine life (Gall & Thompson, 2015).

Health Implications for Humans

Certain plastics found in the oceans are harmful as they contain chemicals that can potentially lead to life-threatening health consequences (Harse, 2011; Schuyler, Hardesty, Wilcox, & Townsend, 2012). Plastic has become a vital entity in everyday lives, making up common everyday items such as fast food and beverage packaging (Graca, Beldowska, Wrzesień & Zgrundo, 2013; Harse, 2011; Jagne, White & Jefferson, 2016; Vom Saal, Nagel, Timms, & Welshons, 2005). The complication is that most people are not aware of the plastic production process and the chemicals utilized to compose such items. The literature lists two significant chemical compounds found in the production of plastic: bisphenol A (BPA) and phthalates (Harse, 2011; Vom Saal et al., 2005; Velis, 2014). These chemical compounds are known to be “endocrine disrupting/modulating chemicals (“EDCs”)” (Harse, 2011, p. 4) that have produced adverse health effects when exposed to lab animals (Harse, 2011; Vom Saal et al., 2005). Focusing specifically on BPA, as it is a common monomer found in polycarbonate plastics (Jagne et al., 2016; Mersha, Patel, Patel, Richardson, & Dhillon, 2015; Pettipas, Bernier & Walker, 2016), studies evaluating the effects of BPA at human exposure levels demonstrate several health implications. Examples of health issues include increased mammary gland growth in rodents and nervous system disorders in humans (Mersha et al., 2015). Jagne et al., (2016) noted hormonal interferences in women leading to increased chances of infertility. Although products using these chemicals have received FDA approval due to the low levels of these chemicals, the literature demonstrates that low doses of said chemicals still impose a significant threat to consumer health (Harse, 2011; Jagne et al., 2016).

Food packaging often contains EDCs, which leads to varying levels of consumer exposure to EDCs. BPA contamination has been found most commonly in food and beverage products such as bottled water and fast food packaging (Graca et al., 2014; Jagne et al., 2016; Wagner, 2009) but also baby products such as teething rings and bottles (Berger, Potouridis, Haeger, Püttmann, & Wagner, 2015). Concerning the reuse of such products, Vom Saal et al., (2005) stated that “...the continued use of polycarbonate food or beverage products after they show evidence of wear can result in very high levels of exposure” (p. 245). Similarly, exposure of polycarbonate packaging to higher temperatures releases a greater concentration of BPA chemicals into food and drink products. (Harse, 2011; Jagne et al., 2015;). Extensive use of such plastic products, intended for daily use, increases one’s exposure to the harmful impacts of BPA chemicals.

Styrofoam Debris Within Oceans

Plastic marine debris is extremely abundant within oceans and can be largely attributed to the presence of high levels of Styrofoam within aquaculture (Lee, Lee, Jang, Hong, Shim, Song, & Hong, 2015; Hinojosa & Thiel, 2009; Heo, Hong, Ha, Hong, Lee, Song, & Shim 2013). Floating marine debris also known as FMD can be found in all oceans (Hinojosa & Thiel, 2009). Research has been conducted to see what plastics are most

dominant and it has been demonstrated that the bulk of FMD are plastics (Hinojosa & Thiel, 2009). This is due to their long lifecycle, which leaves not only a negative impact on wildlife, but also the environment (Hinojosa & Thiel, 2009). Styrofoam that is expanded polystyrene, is the most common plastic within the ocean and 80% of plastic marine debris contains polystyrene (Hinojosa & Thiel, 2009). Sea-based aquaculture, such as mussel and salmon farming, are responsible for most of the Styrofoam plastic pollution (Hinojosa & Thiel, 2009). Styrofoam has many negative effects on the marine environment and is abundant within oceans, which can cause havoc on both marine animals and the oceanic ecosystem (Hinojosa & Thiel, 2009).

Global Policies on Ocean Waste

Globally, there are many nations who have taken the initiative to develop their own policies to prevent further marine waste (Clapp & Swantson, 2009; Xanthos & Walker, 2017). Most policies target single use plastic bags and microbeads found in cosmetic products (Afroz, Rahman, Masud & Akhtar, 2016; Synthia & Kabir, 2015; Xanthos & Walker, 2017). In comparison to rising bans on single use plastic bags in other continents, North America is noted to maintain sparse policies regarding the issue. Currently, only two cities and six municipalities within Canada have imposed levies or bans on plastic bags (Xanthos & Walker, 2017). In countries such as Ireland and Wales, plastic ban and regulation policies have demonstrated significant success in reducing plastic, leading to a substantial decrease of up to 90 percent (Xanthos & Walker, 2017). Internationally, global governance of marine waste has seen the development of initiatives such as the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (International Maritime Organization, 2018). Unlike the responsibility of nations monitoring their waste disposal, there is greater difficulty in monitoring international marine dumping and therefore requires the implementation of individual policies by nation states (Vince & Hardesty, 2017). For global marine policies to be successful, individual nation policies must have support from the public it serves. Therefore, awareness on the issues targeted by such policies is vital (Afroz et al., 2015).

In conclusion, the literature reveals that plastic marine debris is harmful to the oceans and their unique ecosystem but also how plastic negatively impacts human health. However, global policies offer vital solutions as to how to combat the problem of single use plastic debris if countries are willing to raise public awareness and work with their citizens to promote the banning of single-use plastic. The focus areas of the literature review are human health, degradation to marine environment and life, styrofoam within oceans and marine waste policies around the globe. This information will provide a basis of knowledge for the research conducted through this project with regards to how the impacts of plastic marine debris may impact the public's perception on the development of legislation.

Methodology

In this study, both interviews and questionnaires were used to obtain data relevant to the research question. Two methods of data collection were utilized, the first being phone interviews with stakeholders who have a vested interest in the plastic ocean waste issue. The second research method employed public surveys that were done in person, with the researchers facilitating the questions being asked amongst local community members.

Participants

With regards to the interviews, the stakeholder participants included commercial fisheries groups, ocean cleanup organizations and other commercial or community stakeholders. There were eight interviews in total, five being individuals who were involved in ocean cleanup organizations and three being involved in businesses which rely heavily on the ocean. All the interviewees were passionate on the topic providing opinions and insight into how the plastic ocean waste issue has affected them and their organization. Due to ethical consideration, these individuals and the organizations they work and/or volunteer for were kept anonymous. Therefore, no further identifying information will be shared about these participants.

The public surveys consisted of directed interviews, participants were selected via a convenience sample method. There were only three parameters the respondents had to meet: the respondents must have been verbally asked by the researchers to participate in the survey, been over the age of 19 and had verbally consented to have their answers used for this study. Survey locations included the Nanaimo Harbour and Lantzville beach. Every member of the community did not have an equal chance to be selected for participation in the study; therefore, there was no sampling frame from which a sample could be drawn randomly to ensure that all adults in the targeted community had an equal chance of being included in the sample. The sample pool incorporated individuals of diverse age, gender, socioeconomic background and race; however, we did not collect any demographic or identifying information for the survey.

Research Design

All stakeholder interviews were conducted over the phone or using the video chat platform, Skype. Each semi-structured interview consisted of five (5) main questions and engaging a conversation style interview with back and forth discussion with the use of question probes when necessary (See Appendix A). Each question was followed up with a prompt to give the interviewees a chance to elaborate and add depth to their responses and to provide interviewers opportunities for clarification. This also allowed for extra room and freedom for stakeholders to add additional insight and information to the study that was not directly asked of them. This method allowed for detailed questions to be asked and ambiguities to be easily clarified. The duration of interviews ranged from 20 minutes to 90 minutes, with most interviews lasting between 30 and 45 minutes.

A structured interview (See Appendix E) was used to gather information from community members. Each questionnaire consisted of two (2) questions in which the respondent was prompted to pick one (1) answer out of a five-point Likert scale and three (3) open-ended questions in which the respondents were prompted to give an in-depth answer. This survey method was chosen due to its time-efficiency and convenience, while allowing participants to express themselves in their own words. Since the questionnaires were completely anonymous, this allowed participants to respond without fear of identification, thus, giving participants more of an incentive to be truthful in their answers. This, in turn increased the validity and reliability of the survey. However, the survey method, although anonymous, respondents may have wanted to provide answers that they perceived would present them in a favorable manner, despite anonymity.

Stakeholder Interviews

Prior to conducting interviews, stakeholders were contacted via a scripted email (See Appendix B) from Ocean Legacy Foundation with a Letter of Intent (See Appendix C).

Those who chose to participate were sent a consent form (See Appendix D) to sign prior to arranging a time and place for the interview. There were eight (8) interviews in total ranging from 20 minutes to 90 minutes long and they all took place between February 28th and March 19th, 2018. All the interviews were recorded via note-taking and for further clarification purposes, seven (7) of the eight (8) interviews were recorded via an audio recorder. Only one stakeholder did not consent to having their interview recorded. Recording the audio of the interviews gave the researchers a chance to go back and listen to the recordings to ensure accuracy of interviewer notes.

The interviews were all conducted by either one or two researchers, depending on how many were available at the time. If there were two researchers, the first would conduct the interview and the second would take notes. The interviews were semi-structured and treated as discussions, where the interviewees were free to elaborate on their answers and had the freedom to give as much information as they deemed necessary.

Community Surveys

Seventy-five (75) interviews were conducted within the timeline of February 13th to March 19th, 2018. A convenience sampling method was used in obtaining information from community members. Survey locations included the Nanaimo Harbour and Lantzville waterfront. The community members that were present and solicited by the research team, were approached and asked to participate. The solicited and agreeing community member who was in our geographical target area, 19 years or older, and was willing to participate in the survey was asked to verbally consent using a scripted introduction (See Appendix F1). The participants were then presented an information card (See Appendix F2). A notation of consent given was made on the questionnaire form by the researcher at the time of consent. The participants were also given the option to remove their answers from the study up until the end of the survey, however, none of the respondents asked for their responses to be removed.

The surveys lasted between one (1) and five (5) minutes, varying on the response time of the participant. The survey data was recorded on the questionnaires by the researchers. In some cases, some of the participants chose to write down their own answers on the survey. After all the answers were recorded, the participants were given information on how to contact the research team if they were interested in the results of the study once completed.

Data Analysis

With respect to the stakeholder interviews, a thematic analysis was performed with the interview data. The researchers broke up the thematic analysis by question, pulling every theme mentioned from each interview and each separate question and grouping common themes together across all interviews. This allowed the researchers to see commonalities and differences between the interviewees' answers. Since the interviews were semi-structured, this was the most effective way in analyzing the data due to the varying amount of information collected from each interview.

For the public surveys, data from the first two questions on the surveys were analyzed using measures of central tendency and frequency distributions. In addition, cross-tabulation analysis was used to examine whether there was a relationship or an association between these variables (Appendix E). This data was collected to demonstrate the relationship between the level of concern people have with plastic in the ocean and how often people recycle their plastics.

Thematic analysis was used for the other three questions. Researchers therefore performed a thematic analysis of the qualitative data and referred to the quantitative data to reinforce the significance of the qualitative findings.

Ethical Consideration

When assessing stakeholder interviews, the research team discovered that certain interviews presented some level of personal risk, particularly if a participant disclosed information or opinions that could be perceived to be a poor reflection of themselves in the view of their community or organization. The strategies that the research team used to manage these risks included fully anonymizing the data to prevent any potential for research participants to be identified.

Personal identity of stakeholder participants was thus treated as confidential. Information provided by interview participants was coded, with the coding table known only by the principal researchers. When assessing the participation of community members through the community surveys, the ethical consideration was consistent with the stakeholder interviews', confidentiality was of the utmost importance to ensure that the surveyed participants felt comfortable and confident that there would be no repercussions based on their answers and further, that they were able to speak freely and be forthright with their answers. It was disclosed that no personal information about the participants would be recorded, guaranteeing confidentiality.

Limitations

The research was limited in both methods used. The research was further limited by time restrictions. All research team members are students of Vancouver Island University and as a result, based on timing of semesters and the format of the CBAIR program, Research Ethical Board approval and timing, researchers had four months to collect data, analyze data and present the findings.

The research was limited such that researchers conducted the community surveys only along certain areas within the Central East Coastline of Vancouver Island including beaches, parks and Harbour fronts in Nanaimo and Lantzville. Research was conducted on both weekdays and weekends, throughout various times of the day, which may have influenced the presence of people in these particular areas.

Sample size was also limited due to budget restrictions and time. There was also a level of difficulty reaching stakeholders as they have other work and time commitments. When surveys were conducted, there were limiting constraints such as interview bias for the park interviewers. However, stakeholder interviews were held over the phone and via Skype, which did allow the research team to facilitate the interviews that were conducted.

While the research team did not achieve the broad geographical coverage hoped for, the results provide a basis into understanding some of the perspectives in this region. Based on the fact that the research tools measured what was aimed to be measured, the results are valid through means of face validity.

Results

Stakeholder Interviews

In the words of a stakeholder "plastic pollution is growing more and more that individual cleaning will not solve it." Stakeholders consider the ocean as an entire entity and

not in terms of coasts and as such used the West Coast and East Coastline of Vancouver Island interchangeably. They believe that the Central East Coastline of Vancouver Island was a natural aggregate for any debris that goes into the Pacific Ocean in the Northern hemisphere based on ocean currents and weather patterns that move from West to East and from South to North. As a result, waste from Japan and other countries ends up on the shores of British Columbia and the province faces having to clean up the waste that goes into the North Pacific Ocean. One stakeholder mentioned that “the West Coast is unbelievably bad.” He emphasized how the West Coast is completely permeated with debris, stating that every inch of shoreline from the entire continent is cluttered with plastic marine debris, making for a very serious issue in that it is also visibly apparent. The stakeholder continued to explain that the waste within his coastal community was at times waist deep and went on for kilometers, ranging from about 40 to 50 meters wide.

Stakeholders further recognized the growing nature of plastic pollution. They believed that the use of plastics continues to grow, with global production expected to rise markedly over the next few decades in order to meet demand. Stakeholders believed that plastics are by far the biggest debris in the ocean as it is used in so many different materials. In the words of one stakeholder, “what we see on the shorelines is predominantly plastic based, a lot of Styrofoam, because of the nature of plastics which allows it to float.” They also stated that on the shorelines other leaden materials such as metals, hard plastics, rubber and tires are hardly observed on the shorelines. The most common debris identified by stakeholders are coffee cups, straws, Styrofoam, plastic bags, micro plastics, buoys, plastic bottles, fishing gear and ropes.

Stakeholders also emphasized the fact that marine debris is affecting businesses, most especially businesses in the commercial fishing, shipping and tourism industries. “Animal welfare is in jeopardy; and 10%-30% of global fish stock have been destroyed by ghost gear,” as explained by a stakeholder. He further explained that fish aggregating devices (FADs) used to catch fishes and draw them out of their natural habitats are made of plastics; which break down eventually and release micro plastics into the ocean. Multiple stakeholders also referred to the 2009 joint report produced by the UN Food and Agriculture Organization (FAO) and the UN Environment Programme (UNEP) in 2009 which reported that abandoned, lost or discarded fishing gear in the oceans made up around 10 percent (640,000 tones) of all marine litter (Richardson, Gunn, Wilcox, & Hardesty, 2018). Stakeholders believed that fish within these areas starve to death because they eat tiny pieces of micro plastics which they cannot break down.

One stakeholder explained how marine debris affects tourism and fish farming. The shorelines are littered with giant piles of plastic and Styrofoam. Microplastics have destroyed crops of fish and resulted in farms having to move.

Stakeholders also emphasized how plastic debris is a tremendous threat to our ecosystem and food chains. One stakeholder explained how the micro plastics and synthetic materials permeating the food chain threatens all humans considering how much seafood individuals eat. Another stakeholder mentioned that “plastic debris is a tremendous threat to our ecosystems and our food chains and we the members of coastal communities rely on [that] food chain and the food sources that we can get from our local areas for a tremendous amount of our diet.” This stakeholder believed that plastic debris creates a cyclical effect in that the ingestion of natural food sources such as those retrieved from the ocean are becoming more and more toxic. As a result, individuals are deterred from this source thus encouraging greater dependence on mass produced food imposing negative implications on both the environment and the individual.

Interestingly, the research team found that while industries blamed the consumers, clean-up organizations blamed industries for the plastics issue. Clean-up organizations

believed that the messages from industry are about shifting the responsibility for waste onto the public rather than themselves. They perceived that the choice made by industries in packaging and lack of accountability in taking back the plastics is what causes the over-accumulation of waste within oceans. On the other hand, industries believed that consumers were to blame and should be held accountable for recycling their used plastics.

Stakeholders interviewed were noted to be involved in different practices targeted towards reducing plastic marine debris. These practices include the following:

1. Ocean/beach clean-ups

Stakeholders reduced the impact of plastic waste through ocean and beach clean-ups on the grassroots level. By organizing ocean clean-ups, these businesses assembled groups to gather plastic pollutions in the oceans and on shorelines. To facilitate ocean clean-ups, other organizations and volunteer groups are heavily depended on. Stakeholders therefore coordinate funding and partner up with external groups who focus on cleanups to assist in some funding for these groups.

2. Raise public awareness/education

Stakeholders stated that they are currently trying to reduce the impact of plastic waste through public awareness programs by designing initiatives and organizing events, such as conferences to raise awareness and mobile individuals to take necessary action.

3. Work with government on policy and legislation

Some stakeholders specified that they were currently working on supporting policies and legislation targeted towards the production and use of single-use plastics. These include bans in the production of plastics, defining best practices for management of fishing gear and designing other preventative measures.

4. Collaborating with other organizations

Stakeholders are also working with industries to reduce the impact of plastic waste. According to one stakeholder, "I'm trying to work with industries because in coastal communities around the world you need economy." These businesses are working with industries such as horticulture, commercial fishing, shipping and tourism industries who rely on the marine environment to develop strategic plans and partnerships targeted towards reducing reliance on synthetic materials and developing more sustainability. The stakeholder mentioned that many organizations are going about it the wrong way by trying to alienate coastal industries because they do not live in coastal communities. They insisted that, "If you grow up in coastal communities, you will understand that you need industries of some sort, you cannot just have a bunch of people picking up plastics off the beaches; it is not sustainable." These organizations are therefore working hand-in-hand with industries to create a more sustainable symbiotic relationships between industries and the ecosystem that they operate.

Stakeholders agreed that to reduce the impact of waste in the ocean, it is important to reduce, reuse and recycle plastics in addition to educating the public and developing policies directed towards the production and use of plastics. They emphasized the importance of reducing the amount of disposable plastic used by individuals, reusing disposable plastics when possible and recycling anything that can be recycled, so it stays out of landfills, where they can be blown away and end up in the oceans. In the words of a stakeholder, "we need to be practical and realistic and hold ourselves accountable in every aspect of our lives and leave the earth better than we found it."

Some stakeholders further expressed their desire to see the municipal government get involved in addressing the problems of plastic production and use. One of the stakeholders stated that there has been some community involvement at the municipal level. In their words, "the municipal level has shown far more success in the last couple of years than the provincial and federal levels at creating effective and lasting change in terms of reducing the

prevalence of synthetic materials in our communities.” There was a level of questioning if government will receive positive support from the people if it came up with legislative policies that forced industries to meet more stringent requirements in terms of the amount of reliance they will have in the future on these synthetic materials. According to the stakeholders, significant change could be created on the legislative level, but a radical shift can be created through the power of private industries and the contributions that they make to political entities.

Other stakeholders expressed their desire to see their perceived responsible industries such as fish farmers, get involved. They voiced their desire to see industries creating and utilizing alternative materials in local areas to reduce their reliance on plastic materials and more importantly contribute to rehabilitation efforts that will deal with damage already caused, along with working to ensure that damages are mitigated moving forward. In the words of a stakeholder, “with certain legislation, you could hold the top seven conglomerates responsible to take back all their packaging and that is where we need to go. If we do not go there, we will never get to zero waste.” Stakeholders believed that industries shift the responsibility for waste management and control on to the public rather than themselves; and this lack of responsibility is the major cause of waste. They further expressed that consumers are not at fault because they must buy the plastics in their finished and packaged forms and are therefore not to be blamed. In a stakeholder’s words, “it isn’t fair to blame consumers, super unfair and unjust.”

Some other stakeholders expressed their desire to see the federal government get involved in addressing the problems of plastic production and use. They believed that even though people have the skills, most of them are volunteers on ocean preservation projects and cannot solely dedicate their time to the cause. In the words of a stakeholder, “with legislation, lack of education regarding the issue does not entirely hinder the progress as it would be law.” Another stakeholder expressed the need for the federal government to focus more on marine debris and less on preventing oil spills which should not be in existence in the first place. He voiced that “Bill 151 - Waste-Free Ontario Act” introduced by the Government of Ontario in November 2016, targeting waste reduction and resource recovery is a good step towards handling the issue of plastic pollution.

Community Member Survey

The research team’s survey of community members revealed that 88% (Figure 1) of participants stated that they limit their use of single-use plastics. Those who limit their use of such plastics make use of reusable items instead (58%). A slim majority of respondents (51%) always recycled their plastics; 29% recycled most of the time, 16% recycled occasionally and only 4% never recycled their plastics. Interestingly, community members who failed to recycle their plastics believed it was no concern of theirs and was not convenient.

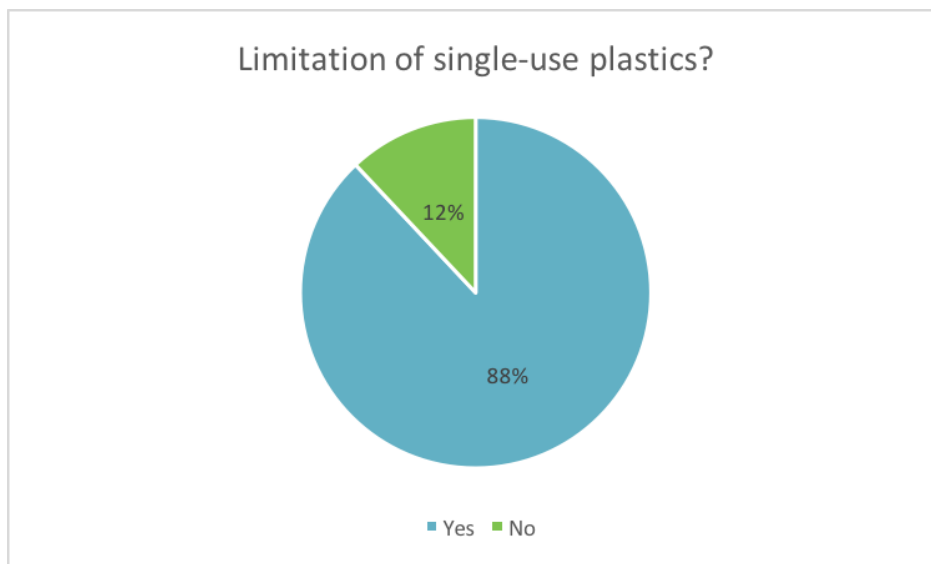


Figure 1

Community members believed that they would be encouraged to reduce their use of single-use plastics through a ban on the production and use of plastics, provision of cheaper alternatives and education that is targeted around environmental protection. Seventy-seven percent (77%) of community members signaled support for legislation on plastic use, four percent (4%) were against legislation and nineteen percent (19%) were not sure about their feelings towards legislation (Figure 2). Those in support of legislation showed concern for the current and next generation and believed that it was necessary to protect the environment and marine lives, reduce pollution by holding individuals accountable and ensure sustainability. However, community members who were against legislation emphasized their displeasure towards high government control and the extra cost of upholding those policies. Those who were unsure of legislation believed that upholding those policies would not be easy, others expressed that they could agree if they had more information concerning the policies, while others emphasized their hatred towards limitations.

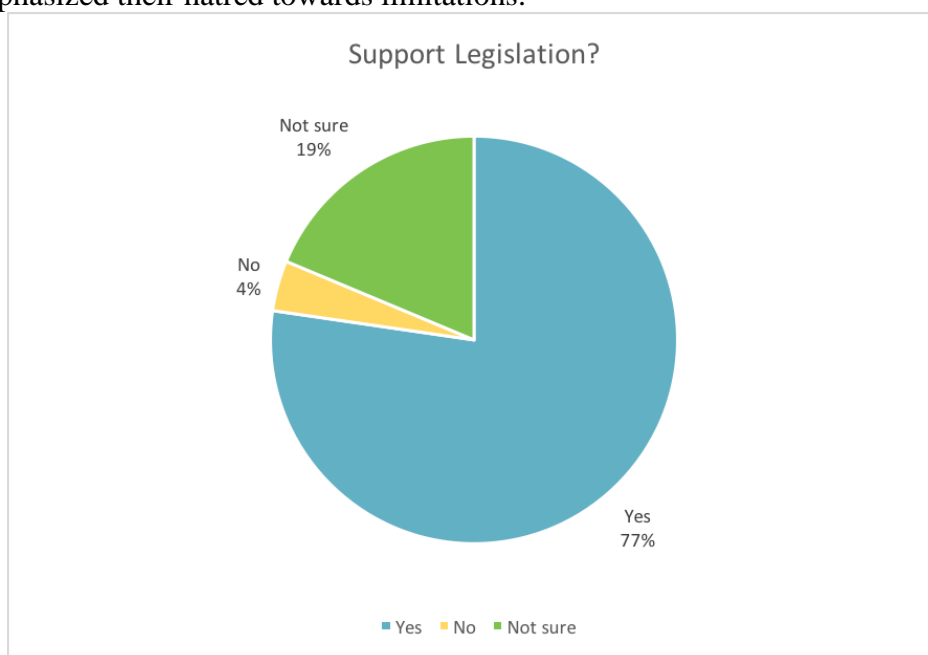


Figure 2

The results of the interviews with stakeholders and the community surveys, indicate that the majority of the sample are putting a certain level of effort in reducing their use of single-use plastics. The research further outlines that with additional public education and awareness initiatives, other members of the population will gain the resources needed to increase the awareness of the negative effects of plastic debris. This encourages conscious efforts to reduce, reuse and recycle their plastics. Moreover, most the sample are willing to support legislation that targets single-use plastics, with preferred assistance from municipal governments.

Discussion

Information from the survey conducted with community members displays the public's willingness to support movements that work against single-use plastics. In wanting to implement legislation, public support is an important aspect to ensure that legislation will have more of a chance to be successful. In a similar regard, information collected from the stakeholder interviews also demonstrates the need for government participation as the plastic issue is not solely the fault of consumerist habits. Furthermore, from the conversations with stakeholders who are extremely knowledgeable, the researchers have determined that the Ocean Legacy Foundation could collaborate with such stakeholders to inform the public about possible methods to help reduce single use plastics. In considering the data obtained, the researchers found that government involvement, public education and the need for plastic alternatives to be the most prominent themes amongst stakeholders and survey participants.

Government Involvement

From the stakeholder interviews, there was a clear demand for involvement from the municipal government. The researchers had not considered the municipal government to be an option, but rather were expecting responses calling for the involvement from the provincial or federal government. One stakeholder had stated that there has been some community involvement at the municipal level. Reasons provided for this response were due to previous municipal government action and contribution to ocean cleanup organization events and funding. As stated by one of the participants, "the municipal level has shown far more success in the last couple of years than the provincial and federal levels at creating effective and lasting change in terms of reducing the prevalence of synthetic materials in our communities." Considering the local level in which municipal governments operate, knowledge and familiarity of an area may contribute to more efficient means of tackling the plastics issue. Thus, the development of legislation should consider the impacts of plastic marine debris on coastal communities. By considering the area's most vulnerable to the issue, the focus of legislation would embody the needs of these communities, making for more effective means of solving and preventing the problem.

Within the surveys conducted with community members, a large portion of the individuals surveyed stated that they would support legislation that would target the use of single-use plastics. Despite the significant level of agreement, community members who stated they were unsure of supporting legislation believed that upholding those policies would not be easy, others expressed that they could agree if they had more information concerning the policies, while others emphasized their dislike towards limitations imposed by the government. With regards to the literature studied, it is noted that for policies to be successful, support from the public is a must (Afroz, Rahman, Masud, & Akhtar, 2017). The lack of certainty amongst the stakeholders is noteworthy in that to gain legislative support, the potential policies being implemented will need to cater to the interest and needs of those

unsure and not impede on their daily lives too drastically. With increased awareness about the harms of plastics and the policies being proposed, there is potential for increased public support and compliance.

Public Education

Among the answers received regarding contributions from the public, a significant portion of stakeholders stated that the public need to get educated on the issue. Four stakeholders stated that they were making efforts to reduce the impact of plastic waste through public awareness programs by designing initiatives and organizing events, such as conferences for raising awareness and mobilizing individuals to take necessary action. Educating the public about single-use plastics is important in that engaging the public and making them aware of the problem will bring greater acknowledgement of their purchasing, disposal and recycling habits. In becoming more conscious with one's actions, limited use of single-use plastics may result. Educating the public may also bring more advocacy for the cause in challenging legislators and government to create policy calling for more limitations on the production of single-use plastic materials and products.

Regarding education, stakeholders had also noted the importance of the further public engagement in plastic reduce, reuse and recycle behaviours. In developing more education programs and events regarding the impact of single-use plastics and plastic marine debris, these programs should include information and demonstrations that show the public how to further participate in these methods. With the development of these programs comes associated costs and the need for informing the public of the availability of such programs. Therefore, recommendations for the client should consist of the need to push for more funding and implementation of programs in either schools and/or within communities.

In the surveys conducted with community members, one of the questions asked was regarding the level of concern community members had for the plastics issue. Noted within the research results, there were 34 percent of individuals who shared far less concern for the plastic marine debris issue. Such responses indicate a lack of knowledge and awareness of the severity of the issue. From the literature reviewed and information gathered from stakeholder interviews, plastic marine debris is a vast growing issue, therefore public knowledge of this information is important to tackle the overall problem. Considering the area surveyed being a coastal community and our sample size being relatively small, it was assumed that there would be greater concern for the potential impacts that may result within the area. These surveys thus demonstrate the need for greater public awareness and education programs and resources. Considering the level of knowledge held by the stakeholders regarding the issue of plastic marine debris, there is potential collaboration with stakeholders in further educating the public on the need for the reduction and appropriate disposal of single-use plastics.

Need for Alternatives

In the community member surveys, the majority of the participants indicated that they limit their use of single-use plastic products through the means of reusing certain items and using reusable containers and grocery bags and avoiding the purchase of heavily plastic based products. Many community members also claimed that they would be more inclined to use plastic alternatives if they were cheaper. In a similar regard, certain stakeholders interviewed had noted the lack of non-plastic alternatives made available to shoppers, leaving shoppers quite limited in exercising more eco-friendly purchasing decisions. If consumers are left without alternatives to purchase, there is no means of reducing consumer dependence on plastic products.

Also, noted in the interviews, some stakeholders felt that consumers were unfairly blamed for the plastics issue when in fact it is the industry that produces such products. Therefore, in terms of legislation development, there needs to be less focus on limiting the purchase of plastic items and increasing recycling habits. This includes a focus on limiting or banning plastic products produced by industries, with an aim to increase incentives to produce items made of - or packaged in - biodegradable material.

Recommendations

The research team is providing recommendations for The Ocean Legacy Foundation that fall under two areas; (i) the research data can be used to support further initiatives and undertakings by The Ocean Legacy Foundation and, (ii) the information from this research can be used for The Ocean Legacy Foundation to directly implement the given recommendations.

Research Data – Usage to Support Further Initiatives

Legislation – Regulation and/or the ban of single use plastics.

The results from the survey conducted conveyed that implementing legislation had a positive response rate as 77% of individuals surveyed stated that they would support legislation against single-use plastics. Putting forward legislation was a significant focus in the survey as many individuals support the use of legislation. It is believed it could help save not only the environment, but also assist marine life if there is a reduction of pollution within the ocean environment. Developing legislation could hold not only producers responsible but also consumers, which would help reduce pollution to help save and protect the environment. When assessing the results, one thing to consider is that there is the idea that consumers could voluntarily reduce their usage of single-use plastics. However, this would likely need strategic involvement from businesses and respective industries to facilitate the awareness campaigns and strategic marketing. As another alternative, there are different types of regulations that can occur, including requirements for recycling and/or for manufactures to engage in the acceptance of returning to recycle. Those areas do not come without additional costs, however, there is also an opportunity for government and legislation to be proposed that could provide subsidies to these types of initiatives to happen.

Funding – Structure and funding option.

Based on the feedback from the stakeholder interviews, the funding structure varies from organization to organization and is based around either government funding where applicable or through grants and initiatives, external sponsorship or fundraising that the organizations operate and facilitate of their own accord. The research team recommends that The Ocean Legacy Foundation use the data collected to promote more structure in terms of financial resources and assets for other ocean cleanup organizations via awareness and sustainability resources. Resources would include documentation, promotion of grants and/or available financial awards through their website and social media platforms, promotional materials and community engagement events for other industries to utilize.

Research Data – Usage to Directly Implement Initiatives

Public awareness and public knowledge.

Based on the data collected through both the stakeholder interviews and the public community surveys, the research team has assessed a need for increasing the public's awareness and knowledge about what is currently occurring in the oceans along the Central East Coastline of Vancouver Island. By raising public awareness, stakeholders agreed that education could help reduce the impact of plastic waste. This could be done by mobilizing individuals to act, such as reducing plastic consumption, recycling their used materials and participating in beach clean ups. Furthermore, from the research conducted through community surveys, only 63% of individuals stated they were extremely concerned about ocean pollution. Subsequently, a possible solution to counteract the harms of plastic would be to expand public awareness to demonstrate how the oceans are being negatively impacted by plastic. The need for education was also apparent in the responses and highlighted that more education and information could help reduce the use of single-use plastics. Through providing more awareness specifically about plastic debris and collaboration with other ocean clean-up organizations to educate the public, such methods may help individuals become more conscientious about their plastic consumption and about pollution in local waters. It is important to note that any public awareness campaign needs to provide feasible alternatives and solutions for community members, otherwise it is a waste of resources and time. There is also the opportunity to assess what a formalized curriculum or program would look like. The idea would be documentation that could be distributed to ensure broad exposure and awareness of information regarding the impacts of plastic marine debris and methods to reduce one's usage.

Promote the availability of compostable plastics.

Many industries tend to blame consumers for the growing issue of plastics. Through the interviews conducted, some stakeholders stated that they felt the consumer should not be the only one held accountable. Consumers often experience limitations in the products they purchase and how they are packaged. If more compostable packaging for products was available and utilized in place of plastic packaging, it could promote global change. If these types of practices are implemented, it may start to shift the mindset of the industries and companies that utilize plastic packaging.

The recommendation to The Ocean Legacy Foundation is to use research analysis to directly approach companies to assist in reducing the negative effects that plastic has on both human health and the environment. Based on these negative effects, the researchers urge companies to look for alternatives to their packaging processes. This can be done through awareness campaigns, relationship building with community businesses and expanding the information available in this area and the accessibility of the information to the public and private sectors, businesses and industries.

Conclusion

It has been noted that plastic marine debris has developed into a significant issue in the world's oceans. In partnership with The Ocean Legacy Foundation, this research provides data and supportive evidence for future legislation aimed towards the reduction of single-use plastics in British Columbia. The Central East Coastline of Vancouver Island was the targeted area for research and by accumulating public knowledge and awareness on plastic marine waste through surveys, researchers found that 88% of our surveyed population believe they

limit their plastic use and 77% support the development of legislation to reduce single use plastic items. The specific interviews with the industry stakeholders highlight how single-use plastics contribute to the pollution and degradation of the oceans.

Plastic marine debris is one of the most universal pollution problems plaguing the world's oceans as it has severe negative impacts on wildlife, sea life and human health. The research results are intended to provide The Ocean Legacy Foundation with the appropriate data to assist in their pursuance of municipal, provincial and federal level government legislation. Action is required to save the oceanic environments and help preserve them for future generations.

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Appendix

Appendix A: Interview Questions for Stakeholders (45 minutes to 1 hour)

Questions will be 45 minutes to 1 hour. Questions will be asked on a selective basis depending on the background of the stakeholder.

1. Give us some insight on your understanding of the level of marine debris in the waters off the East Coastline of Vancouver Island?

Follow Up

Does this level of debris cause problems in the operation and/or profitability of your business?

Our study is directed particularly to plastic waste in the oceans, how big a problem do you think this is?

2. Do you know the kinds of debris present in the oceans?

Follow up

What kind of marine debris do you think is out there?

3. Is your organization currently doing anything to reduce the impact of plastic waste in the ocean?

Follow up

If yes what are you currently doing?

If no, is there a reason why?

How long have you been doing this?

Why did you put actions in place?

4. From the public's perspective, what do you think can be done to reduce the impact of plastic waste in the oceans? Meaning, what can the general public do to help?

Follow up

Do you think the provincial government should be involved? (Find out the point of resistance)

Do you think the federal government should be involved?

Who else do you think should be involved?

5. What have you observed regarding plastic marine debris in the ocean? (Alternatively - Do you have any experiences regarding plastic marine debris in the ocean?)

If the interview has been conducted for an hour and you still want to proceed, informed consent will be necessary at this point.

“Wow! We are learning a lot from you, are you okay if we keep this discussion ongoing?”

Appendix B: Scripted Email

Email would be sent from Ocean Legacy on behalf of our CBAIR group

Hello Everyone,

As many of you know, we at Ocean Legacy Foundation have devoted our organization to reducing the amount of plastic in the waste stream, improving solid waste management, and increasing the capture and reuse of plastic marine waste.

We have recently partnered with the Community Based Applied Interdisciplinary Research group at Vancouver Island University and they are conducting research with the purpose to investigate the policies, directions, and initiatives that would be appropriate for the provincial government in British Columbia to use in order reduce the social and economic impacts of plastic ocean waste. Our research partners are Vanessa, Christine, Julian, Victoria, and Nancy.

What we are looking for is your help and participation in gathering the appropriate information through one-on-one interviews conducted by our new partners. The interview process would take 45-60 minutes of your time and can be done in person, over the phone or Skype/FaceTime.

Please reach out to the VIU group at oceans6ixresearch@gmail.com to schedule a time with them. They are more than happy to answer any questions you may have about the process and information they are looking to collect.

Let's work together to create long-term changes to ensure current waste plastics are processed on land and diverted from shoreline and ocean water ecosystems.

Kind Regards,



Chloé Dubois
The Ocean Legacy Foundation
www.oceanlegacy.ca

Appendix C: Letter of Intent

(stakeholder name)

(title)

(organization)

(date)

Dear (Stakeholders)

We are a group of five Vancouver Island University students involved in a program called CBAIR, which stands for Community-Based Applied Interdisciplinary Research. As you know, we have partnered with Ocean Legacy Foundation to conduct research into the impacts of plastic marine debris on the central east coastline of Vancouver Island. We would appreciate it if your organization would assist us in our research efforts: we believe you could provide us with valuable information.

Our research team's goal is potential policies, directions, and initiatives that would be appropriate for the provincial government in British Columbia to consider or enact in order to reduce the social and economic impacts of plastic ocean waste.

We are working with The Ocean Legacy Foundation: an organization devoted to reducing the amount of plastic in the waste stream, improving solid waste management, and increasing the capture and reuse of plastic marine waste. Our goal is to gather information that will allow us to further research methods to reduce the ongoing problem of plastic in our oceans as a province.

Our main focuses are:

- The impacts of marine debris on ocean life
- Health implications on humans from marine debris
- Looking at Styrofoam pollution in oceans
- Analysing other countries policies on ocean debris/plastic waste (India, others)

As we move forward with our research, we would appreciate the opportunity to contact you and set up an interview to discuss these prevalent issues. Our contact information is via email at oceans6ixresearch@gmail.com

Thank you for your time and consideration, and we look forward to hearing from you.

Sincerely,

Victoria Bowns
Christine Jenkins
Nancy Njigha
Vanessa Stratton
Julian Telfer-Wan

Ocean 6ix - CBAIR Research Course
Vancouver Island University

Appendix D: Stakeholder Interview Consent Form

Addressing the growing issue of plastic marine debris along the Central East Coastline of Nanaimo

To the participants of this study,

The purpose of this research study is to determine the impacts of plastic marine debris on the Nanaimo community in order to develop a set of recommended policies towards the monitoring of plastic disposal within the province of British Columbia. The data collected will be used in support of a final report for an interdisciplinary research course intended for further use by The Ocean Legacy Foundation.

Study Procedures

Once the consent form has been received by the research team, an interview will be scheduled, either face-to-face or over-the-phone, depending on your preference and location. The interview will require 45 minutes to an hour and will consist of questions prepared by the research team supplemented with anything else that you might choose to share. As the interview proceeds, we may ask questions for clarification or further understanding, but our part will be mainly to listen to views, opinions, experiences, or knowledge on the matter at hand. Each interview will be recorded via handwritten notes and an electronic audio recording device. However, you may opt out of the electronic audio recording.

Confidentiality & Anonymity

The information obtained in the interview will be kept in strict confidence and stored in a password protected file, only accessible to the research team. Participants will not be identified in any future presentations or publications. All raw data (i.e. notes and recorded audio) will be destroyed within one year after the completion of the study anticipated for May 30, 2019.

Benefits

There will be no direct benefit to you if you participate in this interview. However, the possible benefits of your participation to society include the potential development of legislation or regulations to reduce the amount of plastic in our waste stream. This will improve the health and well-being of marine life and reduce the amount of toxins in the food chain, therefore benefiting human health. Other benefits include a possible reduction of the amount of visual plastic waste along our coastline. You will not receive any compensation for participating in the interview.

Risks

We will keep your personal information completely anonymous and your participation confidential. All participants will be assigned numbers and referred to as “Interviewee #_”. If we learn anything during the research that may affect your willingness to continue being involved in the study, we will notify you immediately.

Voluntary Participation

You are under no obligation to participate in this interview. Your participation is strictly voluntary. You may at any time refuse to answer a question or withdraw from the interview process. In order to withdraw from the study, the individual may email the principal investigators or their supervisor through the contact information listed below. Should you withdraw from this study, any recorded written or typed information gathered to that point will be shredded and any recorded audio information will be deleted. At no time will value judgments be placed on your responses, nor will any evaluation be made of your effectiveness as a participant. Finally, you are free to ask any questions about the research and your involvement with it and may request a summary of the findings of the study.

Contact Information**Research Team**

Ocean's 6ix: Victoria Bowns, Christine Jenkins, Nancy Njigha, Vanessa Stratton, Julian Telfer-Wan
Vancouver Island University
900 Fifth Street, Nanaimo, BC, V9R 5S5
oceans6ixresearch@gmail.com

Supervisor

Robert Willis
Vancouver Island University
900 Fifth Street, Nanaimo, BC, V9R 5S5
Robert.Willis@viu.ca

Consent Statement

By signing this form, I consent to participate in the interview and share my information on behalf of my business or organization with the Ocean 6ix research team. I have thoroughly read the consent form and the research study has been explained to me. I understand that my participation is entirely voluntary and have been made aware that I have the option to discontinue my participation at anytime. If I have any additional questions or inquiries, I have been provided with the contact information of the research team. I will also receive a copy of this consent form after I submit it.

I consent to have my interview audio-recorded.

Participant's Name (printed)	Signature	Date
Name of Person Obtaining Consent (printed)	Signature	Date

Appendix E: Survey Questions for Community Members

1. At home, how often do you recycle your plastics?

1 - Never

2 - Once in awhile

3 - Most of the time

4 - Always

2. How concerned are you about pollution in our local ocean waters?

1- Not concerned

2- Slightly concerned

3- Moderately concerned

4- Very concerned

3. What do you think would encourage you to reduce your use of single use plastics?

4. Would you support the legislation that requires you to reduce your overall use of single-use plastic items?

If yes, why?

If no, why not?

Not sure?

5. Do you limit the use of disposable or single use plastics in your everyday life?

If yes, how?

If no, why?

Appendix F1: Verbal Script for Survey

Q1: Excuse me? Do you have five minutes to answer a few questions about plastic marine waste?

A1a: Yes

Great! My name is ---- and I'm a member of Ocean Six, a student research team at Vancouver Island University. We are conducting a study on behalf of Ocean Legacy, a foundation devoted to reducing the amount of plastic in our waste stream, with a focus on the capture of plastic from our oceans. We are hoping to gain some insight into the views of the Nanaimo community.

A1b: No

That's alright! Have a great day!

After the interview:

Thank you so much for your participation, here is some more information on our project and how your information will be used. If you have any questions, concerns, or comments, our contact information is available on this sheet. Have a great day!

Appendix F2: Survey Information & Consent Card

Ocean 6ix is a student research team from Vancouver Island University conducting a study on behalf of Ocean Legacy Foundation. Ocean Legacy is a foundation devoted to reducing the amount of plastic in our waste stream, with a focus on the capture of plastic from our oceans. The aim of this project is to develop a set of recommended policies for British Columbia concerning the monitoring of plastic disposal.

If at anytime during the survey that you feel you would like to no longer participate, you may withdraw consent and your survey will be discarded. It should be noted that due to the anonymity of all surveys, surveys cannot be withdrawn once the survey process has been completed.

The information you have provided will be used to gain further insight into the views on plastic use in the Nanaimo community. The information recorded is kept anonymous as we are not collecting any personal identification information from volunteer participants. If you have any questions, concerns, or comments regarding our study please feel free to contact us at: ocean6ixresearch@gmail.com or robert.willis@viu.ca

If you have any concerns about your treatment as a research participant in this study, please contact the VIU Research Ethics Board by telephone at (250) 740-6631 or by email at reb@viu.ca.

Do you consent to the data you provide being used in this study?

Yes / No