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Barriers to the Elimination of Plastic in Single Use Beverage Containers in Byron Bay, NSW

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Barriers to the Elimination of Plastic in Single Use Beverage Containers in Byron Bay, NSW

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Environmental Science

Australia, New South Wales, Byron Bay

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a program of World Learning



ISP Ethics Review

(Note: Each AD must complete, sign, and submit this form for every student's ISP.)

The ISP paper by _____ Katherine Senechal _____ (student) does conform to the Human Subjects Review approval from the Local Review Board, the ethical standards of the local community, and the ethical and academic standards outlined in the SIT student and faculty handbooks.

Completed by: Peter Brennan

Academic Director: Peter Brennan

Signature:

Program: Australia: Sustainability and Environmental Action

Date: 17/5/2018

Abstract

Plastic debris is a global threat to the natural environment. The accumulation of plastic debris has resulted in the destruction of marine habitat as well as a threat to marine wildlife. Single use plastics, including plastics associated with single use food and beverage containers are contributing to a considerable amount of debris and other litter in the world's oceans. As awareness of this issue spreads, both large corporations and small businesses are beginning to transition to plastic alternatives for their single use beverage containers. In Byron Bay, Australia, an area of increasing environmental awareness, businesses are beginning to reduce single use plastics. The purpose of this study is to investigate barriers to the elimination of plastic in single use beverage containers, to formulate a better understanding of the current issues around this transition and to further aid businesses in their elimination of single use plastics.

To identify these barriers, I first inventoried the materials for single use beverage containers currently in use among Byron Bay businesses. I then interviewed businesses and relevant organizations in Byron Bay to understand their business practices and discern any potential barriers to the elimination of plastic in their single use beverage containers. Additionally, I examined the environmental impact of bioplastics commonly used as plastic alternatives among Byron Bay businesses.

After speaking with businesses and relevant organizations, three main barriers to businesses were identified: increased price of plastic alternatives, customer demand, and working with a wholesale distributor/ business hesitancy. Additionally, after a review of the environmental impact of bioplastics I determined that while the production of bioplastics may contribute less to the effects of climate change than traditional petroleum based plastics, there are still significant impacts created upon the disposal of bioplastics due to a lack of proper infrastructure.

These results suggest that bioplastic implementation may not be the best plastic alternative given the current infrastructure for bioplastic disposal. Instead it may be more beneficial for businesses to continue trying to reduce single use beverage containers all together to reduce the amount of inputs to litter and debris in the natural environment.

Keywords: Take away containers, single use plastics, bioplastics, marine debris, Byron Bay

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Abbreviations:

Polylactic acid (PLA)

Polyethylene terephthalate (PET)

1.0 Introduction

1.1 Environmental impacts of plastic debris in the marine environment

Today, increasing inputs of plastics and other trash are accumulating in large circular oceanic currents creating many square miles of floating debris (Cózar, Echevarría, González-Gordilo, Irigoien, Úbeda, Herández-Leon, Palma, Navarro, Garía-de-Lomas, Ruiz, Fernández-de-Puelles, and Duarte 2013, p. 10240). There are currently not enough resources to estimate the magnitude of plastics waste that has polluted the world's oceans, but science suggests that floating plastic debris is just a portion of the total amount of plastic pollution in the marine environment (Baztan, Carrasco, Omer, Murieal, Gabaldon, Thierry, Lionel, Jorgenson, Miguez, Paillard, and Vanderlinden, 2014, p.303). Plastics debris has found its way into some of the world's most pristine and remote areas, including the arctic poles, shorelines of tropical nations, and nationally protected marine areas (Baztan et al., 2014, p.303). Man-made marine debris can be defined as "any persistent manufactured or processed material discarded, disposed of, or abandoned in the marine environment." (Barnes, Galgani, Thompson, and Barlaz, 2009, p. 170). Man-made debris poses a series of threats to the marine ecosystem as a whole. Large plastic debris have obstructed waterways, entangled marine wildlife, and disrupted the natural functions of ecosystems (Thompson and Gall, 2015, pp. 175-177). However, plastics in the ocean also have the ability to break apart into microplastics. The term micro plastics, coined by Thompson et al. in 2004, refers to traces of plastic less than 5 mm in diameter found in the ocean as a result of physical breakdown (Thompson, Olsen, Mitchell, Davis, Rowland, John, McGonigle, and Russell, 2004, p. 838). The United Nations Clean Sea campaign has estimated that there were 51 trillion micro plastic particles in the ocean today. While there are various campaigns to extract the debris from the oceans, micro plastics are virtually impossible to collect, severely limiting organizational efforts to clean plastic litter from the marine environment (Auta, Emenike, and Fauziah, 2017, p. 173).

Micro plastics are also a direct threat to marine wildlife. Micro plastics can be ingested by sea animals as well as sea faring birds. A study conducted in 2015, found that 693 different species have been known to have encountered some form of man-made marine debris. Many of these animals become entangled in marine debris that severely limited them from natural movements (Thompson and Gall, 2015, p. 172). Additionally, this study found that animals including, but not limited to, birds, fish, and turtles are accumulating large

amounts of microplastics in their intestines, ultimately leading to their ill health and potential death (Thompson and Gall, 2015, p. 172).

Micro plastics also have the ability to leach chemicals into the ocean. Many plastics and mixed materials are made from additives that are toxic to marine and human health. Over time additives can leach from their plastic matrices and pollute the areas around them, including the oceans (Rani, Shim, Han, Jang, Al-Odaini, Song, and Hong, 2015, p. 352). Many of these additives are persistent organic pollutants (POPs), which are highly persistent toxic chemicals that are carried through waterways and can be aerosolized by oceanic evaporation and wind action to spread across large distances (Koelmans, Besseling, and Foekema 2014, p. 52).

1.2 Environmental impacts of single use beverage containers

In an international study conducted on marine debris, plastic beverage bottles were the second most collected rubbish item at 1,578,834 items collected. The first being cigarette butts (Belhouari, Farnum, Jenkins, Kieser, López de omán, McCauley, Rochman, Schreiber, Schwatz, Taylor, and Trott, 2017, p. 13). Single use plastics are intended to be disposed of immediately. These items are primarily used as packaging, and in many cases packaging of food and beverage containers such as coffee/tea cups, straws, and plastic water bottles (Jambeck, Geyer, Wilcox, Siegler, Perryman, Andrady, Narayan, and Law, 2015, p. 768). Polyethylene terephthalate (PET) is a petroleum based plastic commonly used to make water bottles. However, PET is also used to line hot beverage containers and construct clear cold drink containers made for smoothies and other cold drinks (Eerhart, Faaij, and Patel, 2012, p. 6414). In the process of manufacturing PET there are substantial inputs of non-renewable energy such as fossil fuels that upon combustion to make PET produce significant amount of greenhouse gas emissions (Eerhart et al., 2012, p. 6417). PET plastics are also considered to be highly persistent in the environment. While much of the single use plastic is found along the coastline Southeast Asian nations (e.g. China; see Table 1, Jambeck et al., 2015), the accumulation of man-made plastic debris into the marine environment is not uniform around the globe due to natural wind and oceanic currents (Welden and Lusher, 2017, pp. 486). In recent years awareness of the accumulation and environmental effects of single use food and beverage containers has increased due to documentation by tourists and divers of plastic pollution in Southeast Asian. Images and videos of plastic pollution on the coast of Bali have gone viral and received global media attention (Janzen and Kilvert, 2018, para 20).

Due to the rising awareness of the impacts of plastics in the natural environment, many businesses have begun exploring new materials for their single use food and beverage containers. For example, big corporations such as Coca Cola and Pepsico have set deadlines to transitioning their bottles to either completely or majority recycled content within the next 10-15 years (Meyer, 2018, para. 16). Additionally, Starbucks Coffee has just launched a campaign to create a compostable coffee cup that can replace the nearly 6 billion non-compostable cups that the company produces annually (Meyer, 2018, para. 2). Other efforts to reduce the impacts of long lasting plastics has resulted in the production of biodegradable plastics. For example, paper cups and biodegradable plastics (referred to as bioplastics) have become increasingly popular as environmentally friendly alternatives to traditional plastics (Nampoothiri, Nair, and Pappy, 2010, p.8494).

1.3 Implementation of bioplastics as a single use plastic alternative

As defined by the European Committee for Standardization, a bio based product is a “product wholly or partially derived from biomass.” (2018, para. 1) It is important to note that bioplastics are not primarily derived from fossil fuels like traditional plastics. Instead, bioplastics are a type of a biological based product that are made through renewable agricultural products, forestry, or waste stream products such as byproducts of food processing (European Commission, 2017, p. 2). Due to their formation from biomass products, bioplastics have the ability to relatively biodegrade depending on their structure and the mixture materials they are comprised of (Razza and Innocenti, 2012, pp. 303-304). Biodegradable plastics are thought to have a reduced environmental impact compared to traditional plastics due to their relative biodegradability making them less persistent in the natural environment and energy savings in the form of GHG emissions (Piemonte, 2011, pp. 992-993).

Innovation and technological advances have progressed the development of bioplastics for global use. Some countries are beginning to restructure manufacturing away from the production of plastics made from petroleum bases and towards bioplastics. The European Union is encouraging the restructuring of their petroleum based economy to that of a bio based economy. The European Commission projects that by 2021 Europe will be producing a quarter of the worlds bioplastics (European Commission, 2017, p. 2). Additionally, in an assessment conducted on the economic benefits of bio based industry in the United States, it was found that bio based industry was valued at 393 billion dollars in 2014. This study recommended that the United States Congress support the further

development of bio based products including that of the bioplastic industry (Golden, Handfield, Daystar, McConnell, and Morrison, 2016, p. 104-107).

However, it is important to note that the actual environmental impact of bioplastics is still in review. Bioplastics need specific conditions to degrade that involve the presence of microorganisms that breakdown the material (Razza and Innocenti, 2012, pp. 303-304) and it is not fully known how bioplastics interact with in the environment when these conditions are not met. While bioplastics are comprised of biological material, they are not strictly 100% biomass product (European Commission, 2018, para 1.). One study observed the biodegradability of bioplastics and found that under varying conditions, some bioplastics actually gained mass (Harding, Gounden and Pretorious, 2017, p. 108). It is therefore important to evaluate the relative sustainability of the bioplastics used in comparison to traditional plastics to determine if the implementation of bioplastics as alternatives to traditional single use plastics is results in the reduction of the environmental impact of single use food and beverage containers.

1.4 Plastic litter in Northern New South Wales

The Clean4Shore campaign is a community based initiative aimed at removing litter and other waste from natural estuaries and shorelines along the coast of NSW, Australia. In 2016, 20 trips were taken to waters surrounding Brisbane. During this time, Clean4Shore found 108,559 items of litter, a decrease from 2015 where the campaign found 160, 943 items. A breakdown of the litter collected found that plastic drink bottles made up 20% of the total rubbish collected (Johnston, 2017, p. 22). This report highlighted the difficulty surrounding plastic litter as it is very mobile and easily accumulates on shorelines and deep into natural vegetation (Johnston, 2017, pp. 7, 20).

Byron Bay, Australia is a well-known tourist destination on the north coast of New South Wales (NSW), and just two hours south of Brisbane. In Byron Bay, a local organization named Positive Change for Marine Life, works to spread awareness about litter and waste contamination on the shores in marine environment. Positive Change for Marine Life organizes beach clean-ups on Main Beach in Byron Bay and also at Seven Mile beach just south of Byron Bay. The setting of these two beach clean-ups is important, as Main beach, a heavily touristed beach, allows Positive Change to analyze the trends of commonly littered items. Whereas Seven Mile beach, a much more secluded beach, allows the organization to analyze what types of marine debris are being washed in from the ocean. In an interview with organization coordinator Simon Fitzpatrick, cigarette butts on Main beach

and microplastics along Seven Miles Beach appeared to be the most prevalent types of litter found (Fitzpatrick, 2018, pers. comm.)

Recent data from Positive Change for Marine Life's beach cleanups have totaled 5636 items of plastic debris on Main Beach in 2017. This means that plastic debris comprised of 63% of all litter collected in 2017 on Main Beach. On Seven Mile beach there were 3279 items of plastic were collected comprising of 80% of all litter collected in Positive Change for Marine Life's cleanups in 2017. So far in 2018, Positive Change for Marine Life collected 3483 items of plastic debris on Main Beach, and 1301 items of plastic debris on Seven Mile beach. This means that in 2018 plastic debris has accounted for 58% of all litter collected on Main beach and 94% of all litter collected on Seven Miles beach (White, 2018, pers. comm.).

Environmental sustainability emphasizes the use of natural resources at a rate that protects them from depletion for generations to come, including the protection the environment and natural systems (Cumings 2018). The information given above highlights the ways in which single use plastics and single use beverage containers can jeopardize the resources such as fossil fuels, as well as the natural environment in the years to come. It is therefore important to investigate the ways in which we as a society can reduce the impacts of single use beverage containers through either the elimination of plastics or the overall reduced use of single use beverage containers.

1.5 Purpose of Study

Few studies have been conducted on single use containers that focus on the business' point of view. As businesses play a pivotal role in the consumption habits of consumers, it is important to recognize the strategies and obstacles they may encounter in phasing out plastics from their single use beverage containers. The purpose of this study is to identify potential barriers for business that have or are attempting to transition away from plastics in single use beverage containers. This research will be conducted by undergoing a comprehensive analysis of business practices from the point of view of establishments and partnering plastic free organizations. There are a variety of different factors that can influence the behavioral practices of any given business. Understanding business practices in relation to single use plastic beverage containers gives a unique insight to both the facilitation and the demand of plastic consumption. Additionally, assessing barriers to businesses who are in transition or already using plastic alternatives or various other strategies to eliminate and reduce plastics in their single use beverage containers is useful in how best outside organizations can facilitate businesses. Therefore, to implement meaningful change in the consumption of single use

plastics, it is necessary to examine barriers to businesses, as instrumental players in the demand chain of single use plastic products.

This research will examine the types of materials used for single use beverage containers in Byron Bay area. Additionally, this research will investigate the motivations behind businesses in the use of these materials as well as their relative environmental impact of any plastic alternatives used. The results of this research will provide an evaluation of potential barriers businesses may encounter if they have already, or are willing to, transition away from single use plastics beverage containers. Understanding current strategies and the barriers to the elimination of plastic in single use beverages containers, is a useful tool for businesses outside of Byron Bay to help phase plastics out of their establishments. Additionally, identifying the barriers to eliminating single use plastics could be beneficial for councils, and plastic free organizations alike to work to aid businesses in overcoming the obstacles in the elimination of single use plastics.

2.0 Methods & Ethics

2.1 Location of study

In Byron Bay, heavy tourism has resulted in a substantial amount of single use food and beverage container consumption. Byron Bay encompasses five major beaches and experiences marine debris litter on the beaches as well as in the marine environment. The Byron Shire is known for its environmentally sustainable practices, where campaigns such as Plastic Free July and Ban the Bag have been driven from grassroots community organization (Mainsbridge, 2018, pers. comm.). Many local businesses in Byron Bay have already started transitioning away from plastic. Responsible Cafes, a national organization that catalogs businesses who give discounts for customers that bring their own reusable beverage containers, has recorded 12 businesses and the numbers are growing (See Live Map, Responsible Cafes, 2018). Conducting this research in a town attuned to environmental efforts and in plastic elimination transition, allows for a better understanding of what we can learn from businesses that have or are currently transitioning away from single use plastic use. Due to the current environmental push in Byron Bay, the coastal location, and heavy single use beverage consumption, it is an ideal location to conduct a study on the barriers for local business on plastic elimination in single use beverage containers.

2.2 Constructing an inventory of single use beverage containers

In order to examine barriers to the elimination of plastic in single use beverage containers, I first had to identify what types of containers were currently in use in Byron Bay. This information was important in understanding at what stage businesses were in transitioning away from plastic use in their takeaway beverage containers. In my analysis of single use beverage containers, I decided to include both hot and cold beverage containers. Hot containers used for coffees and teas pose a unique packaging challenge as hot drinks are both wet and need insulation. In many cases, paper is used to insulate the cup and a plastic lining is used to keep the liquids from soaking through the paper material. In turn, cold drinks, such as smoothies or iced coffees, require no insulation and plastic is commonly used to construct these containers. Additionally, I made the decision to include the lids of beverage containers. Lids are an important component to single use waste and are commonly made from plastics. Positive Change for Marine Life recorded 274 counts of plastic lids and beverage tops in 2017 alone and already 187 counts of these items from beach clean ups in 2018 (White, 2018, pers. comm.). Lids are used as insulators for hot beverages and are commonly used in conjunction with cups used for hot and cold drinks.

To catalog beverage containers and their associated items, I walked from store to store in Downtown Byron Bay and The Arts and Industrial State and inventoried the type of cup (hot beverage cup and cold beverage cup) as well as the type of lid and plastic straw used in each establishment. Figure 1 shows the downtown area and the Byron Arts and Industry Estate from which I inventoried businesses on their single use beverage containers. It is important to note that I did not survey every business in Byron Bay. Rather, I chose these two sites based on the high density of businesses that sold take away food and beverage options.

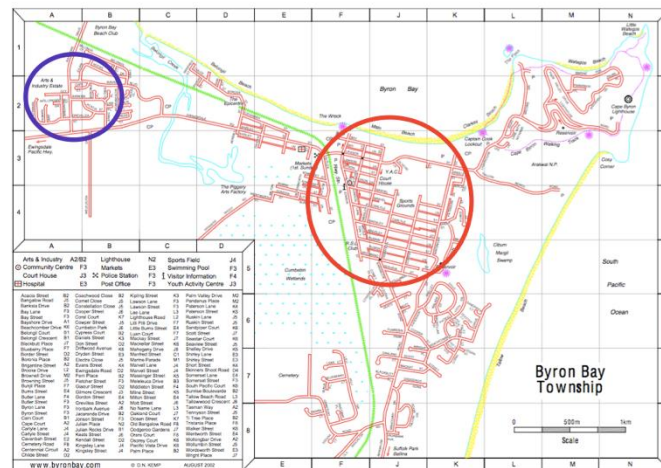


Figure 1. A map of Byron Bay with the downtown area (circled in red) and the Arts and Industry Estate (circled in blue). (image created and retrieved from ByronBay.com website)

With the information gathered from businesses in both the Downtown area and The Arts and Industrial Estate I created a list of the materials used for each single use beverage container and lid. In the event that I could not discern what materials were used to construct their single use beverage containers, I took down the name of the company that manufacturers the cup or lid and conducted online research to analyze if there were any plastic materials in the final production of these products. I then took these findings and separated businesses into two categories, those who used plastics in their single use beverage containers, and those who did not. Businesses who did not use plastics in their single use beverage containers could use a variety of plastic alternatives such as bioplastic, paper, bamboo etc., which I distinguished and recorded.

In addition to permanent businesses residences, I also included the Byron Farmers' Market and the Byron Spirit Festival in my research. To understand the various barriers in eliminating plastic in single use beverage containers, I found it important to survey all types of businesses. Farmers' markets and festivals produce large amounts of waste. In recent years, many festivals and markets in the Byron Shire have begun to implement waste standards that stallholders must follow if they wish to sell goods at certain festivals. An

example of this is The Byron Spirit Festival, where in 2017 stallholders were encouraged to bring reusable plates and use a provided wash station instead of producing waste as single use food and beverage containers (Mainsbridge, 2018, pers. comm.). It was therefore necessary to include these venues in my research in addition to permanent residence businesses to gain a greater understanding of the variety of potential barriers that could arise.

2.3 Interviews with businesses and relevant organizations

To gain an understanding of the perceived barriers from a business' perspective, it was necessary to approach businesses and relevant organizations and conduct short interviews. These interviews were with managers, owners, or other employees that were knowledgeable about the practices of the business in reference to their single use beverage containers. Before starting this research I obtained approval of ethics from the Local Review Board. The biggest ethical risk for subjects that I interviewed was embarrassment and or discomfort in answering questions and having those questions published in a written report. Before using any information given to me, I ascertained verbal consent from the individuals I spoke to given the possible risks and uses of this research (see appendix A). To help alleviate any potential embarrassment or discomfort I offered to keep both names of individuals and any affiliated establishments or organizations to be kept anonymous in this final report. There are individuals from businesses and organizations that wanted to keep their name and or affiliated establishment anonymous in this report. I will refer to these people in this report generally, as individuals from businesses or organizations in Byron Bay. In total I interviewed 27 individuals, comprising of 21 businesses and 5 organizations (two interviews were conducted from individuals from the same organization). Names and affiliations of all interviews are available in Appendix B.

When talking to businesses, interviews were guided by a series of questions (see Appendix C). However, the majority of these interviews were informal. All of my interviews with managers, owners or employees of businesses took place in their establishment during regular business hours. In many instances, business owners had limited time to talk and therefore did not answer all of my research questions. Other times, owners did not have time to speak in person and gave me information over email correspondence, resulting in varying levels of detail and response to my questions. In these cases I recorded as much information as I could and recorded "unknown" for information not given.

Interviews were primarily guided by answers provided by business owners and their motivations for using certain types of single use beverage containers. I chose to include

business' motivations as an important aspect of the interview process as a way to understand the reasoning behind business behavior. Analysing business motivations will help to answer why certain businesses have chosen to use non plastic single use beverage containers even given the potential barriers. When talking to businesses I took notes in person, then rewrote my notes in depth after leaving the business. This process allowed me to immediately go over the material I had just gained from the interview and document all of the information. I repeated this process for the Byron Farmers' Market and The Spirit Festival.

There were several companies and organizations that I interviewed on the environmental impact of, and business' relationship with single use beverage containers. I chose these organizations based on their work revolving around single use plastics. These companies included wholesale distributors GreenPak and another local distribution company which sell single use food and beverage containers directly to Byron businesses. Additionally, I conducted interviews with non-profit organizations Mullum Cares and Positive Change for Marine Life, that, among other things, work with businesses to reduce single use plastic waste. The purpose of these interviews was to gain a broad understanding of all the possible barriers to businesses eliminating single use plastic that businesses may not tell me directly due to some of the limitations to my data (see section 2.6). These interviews were more formal and followed a structured model of interview questions (see Appendix D and E).

2.4 Evaluation of the environmental impact of bioplastics

To investigate the environmental impacts of bioplastics I conducted an extensive online review of current literature. Since bioplastics were found to be the most used plastic alternative among Byron Bay businesses (see Figure 2 and 3), it was important to analyze the relative sustainability of these products as alternatives to traditional petroleum based plastics. All of the studies that I reviewed were conducted outside of Australia and are not specific to Australian waste systems. To gain further insight of the impacts of bioplastics in Australia and Byron Bay, I included information gathered from interviews from distributors and materials recovery facilities in the Byron Bay area. To assess the environmental impacts of bioplastics to that of traditional petroleum made plastics, many studies have conducted life cycle assessments comparing PLA and traditional plastics. A life cycle assessment (LCA) is an in-depth evaluation of a given product and the impacts it has on the environment from pre-production to final disposal (Piemonte, 2011, p. 989). LCAs are important tools for analyzing plastics because the LCA process includes the environmental impacts of the final disposals of

plastics including waste management (Gentil, Damgaard, Hauschild, Finnveden, Eriksson, Thorneloe, Kaplan, Barlaz, Muller, Matsui, Ii & Christensen 2010, p. 2636).

2.5 Analyzing the data

To analyze my results, I first created a table of the establishment name, and if plastic was a source material in the single use beverage containers and lids they offered. For the interviews, I organized the data collected into a question and response format in a separate document. This format allowed me to organize interview answers into different sections of my analysis and count relative frequencies to identify emerging themes.

The results of this research are separated into two main categories. The first category is identified barriers to the elimination of plastic in single use beverage containers. This category focuses on analyzing data collected from interviews with businesses as well as interviews with organizations focused on reducing plastic and other stakeholders including wholesale distributors, the Byron Shire Council, and the Lismore Materials Recycling Facility. It was important to include information from outside organizations and other stakeholders as a way to draw a holistic understanding of business' perceived barriers as there were many outside influences that contributed to the behaviors of businesses. Within this category I include examples of ways in which businesses worked to reduce these barriers as possible strategies to the elimination of plastic in single use beverage containers given the identified barrier. The second category is focused on motivations of businesses in using plastic alternatives in their single use beverage containers. I found it important to analyze business motivations even given identified barriers as a potential incite in creating successful plastic elimination in other businesses outside of Byron Bay. These two main categories will be sub-headed by themes that I identified based on prevalence in interviews with businesses, organizations, and other stakeholders (identified above).

2.6 Limitations to data

There are several limitations to the methods of data collection outlined above. First, my data collection was limited by the number of people who had time and were willing to talk to me. There were several businesses that may have used plastic single use beverage containers, but I did not have the opportunity to talk to them, nor the ability to discern what types of beverage containers they used on my own. This severely limited my data surrounding businesses that currently used plastics for their beverage containers. Second, when talking to business managers, owners, or employees in their given establishments there

were several occasions where customers in the establishment could hear our conversation. In these instances, there was a possibility that the businesses people I was interviewing may have altered their answers based on what they thought customers that could hear our conversation wanted to hear. Additionally, these business people could have altered their answers based on what they thought I may have wanted to hear based on my introduction as an Environmental Science major. Tailoring their answers to customers or myself could have resulted in biased reports where businesses either under reported on barriers they were experiencing or over reported their motivations to eliminate plastic in their single use beverage containers. These limitations should be taken into consideration when analyzing results found in this research.

3.0 Results and Discussion

3.1 Plastic use in single use beverage containers among businesses

I collected data on plastics in single use beverage containers from 30 businesses in Byron Bay. As seen in Figure 1, one business uses a plastic lining for hot beverage cups, 28 businesses use bioplastics as a substitution to traditional plastics, and one business does not offer single use beverage cups at all. To see the full list of businesses and their single use beverage container plastic use, see appendix F. There were six businesses that use plastic lids, 22 businesses that use bioplastic lids, one business that uses paper and corn starch lids, and one business that does not offer single use lids at all (Figure 3). In total, there were six out of the 30 businesses that use plastic in either their cups or lids.

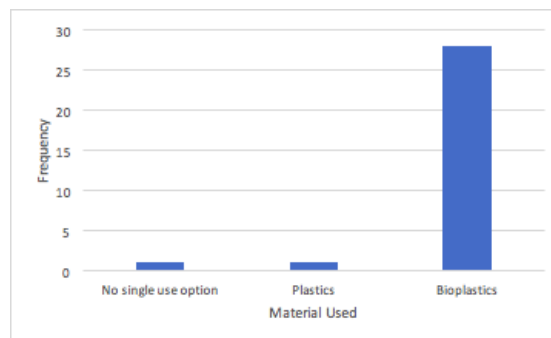


Figure 2. Frequency of plastics or plastic alternatives used by businesses in single use beverage cups in Byron Bay, NSW (n=30).

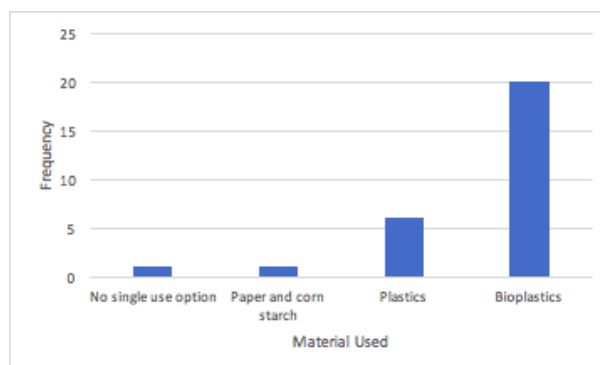


Figure 3. Frequency of plastics or plastic alternatives used by businesses for single use lids in Byron Bay, NSW (n=30).

These data show that businesses in Byron Bay choose to use bioplastics more frequently than traditional petroleum based plastics for both their single use beverage containers and lids. These findings also suggest that it is more likely for businesses to use

plastic lids than plastic cups. However, it is still most likely that businesses will choose to buy single use cups and lids made from bioplastics over that of any other material.

These results suggest that Byron Bay is well into a transition away from plastic in single use beverage containers, and that the preferred plastic alternative is bioplastics. These results can be used to clarify my further findings, as it is important to note that due to the limited number of businesses that use plastic in their single use beverage containers, the results of this study will be biased to the responses of businesses that are not currently using plastics in their single use beverage containers. More specifically, these results will be biased towards businesses that use bioplastics as a single use plastic alternative. This distinction does not mean that my results could not apply to businesses that use plastic single use beverage containers, but that the barriers I identify will be primarily subject to businesses that already have transitioned to bioplastics as a plastic alternative in their single use beverage containers.

3.2 Barriers to the elimination of plastic in single use beverage containers

I conducted interviews with 21 different businesses in Byron Bay. This is less than the 30 businesses that I inventoried due to the fact that some business owners did not have the time to speak to me about their choices for their single use beverage containers. Out of these 21 businesses, only 4 businesses used plastic in either their single use cups or lids. It is important to note that the following results come from a majority of businesses that do not use plastics in their single use beverage containers. The barriers identified below are not prohibiting most of the reported businesses in eliminating plastic in their single beverage containers. However, understanding the barriers that businesses encounter, especially businesses that do not use traditional petroleum based plastics, are important to understanding the current issues among plastic elimination in single use beverage containers that persist even after the elimination of plastics.

There were three main barriers experienced by businesses in the elimination of plastic in single use beverage containers. The most prevalent barrier among businesses was the increased price of plastic alternatives specifically bioplastics, followed by the demand of plastic items by customers, and working with a wholesale distributor (see Figure 4). There were four businesses that felt no barriers to eliminating plastics in their single use beverage containers. It is important to note that there are several factors that could have contributed to these four businesses stating that they did not experience any barriers in the elimination of plastic in their single use beverage containers. These factors are outlined in section 2.6. Do to

these factors, these results cannot support the claim that these businesses do not experience the perceived barriers that other businesses have identified.

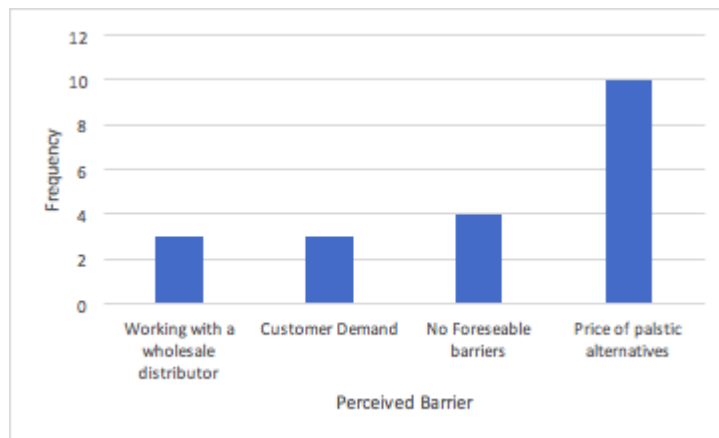


Figure 4. Perceived barriers to the elimination of plastic in single use beverage containers as experienced by businesses in Byron Bay.

3.21 Price

There were ten businesses that identified price as a barrier to the elimination of plastic in their single use beverage containers. Out of these ten businesses, all ten use cups made from bioplastics and seven use lids made from bioplastics, with the remaining 3 businesses using lids made from traditional petroleum based plastics. When talking to businesses about this barrier, many businesses stated that they usually absorbed the additional cost of bioplastics. To examine this barrier further I spoke with two local wholesale distributors that sell single use beverage containers to Byron Bay businesses. Stefanie, a manager at GreenPak Wholesale, said that the price of bioplastics is apparent when working with businesses in choosing products. For example, it is 79 dollars per 1000 pieces for CPLA bioplastic lids and only 42 dollars per 1000 pieces for traditional plastic lids (2018, pers. comm.). A member of a different local wholesale distributor agreed that the price of bioplastics was significantly higher. He noted that an increased price for bioplastics was true for most plastic alternatives, giving the example that a business can buy one plastic straw for 0.5 cents and one paper straw for 6 cents (2018, pers. comm.). While this price difference may seem small, when buying products in bulk, small individual unit price differences can add to significant differences.

These results show that an increase in price for plastic alternatives is a clear barrier to the elimination of plastics in single use beverage containers. Higher prices between plastic alternatives and traditional plastics is a burden that businesses must absorb if they choose not to use plastic single use beverage containers. If businesses do not have the monetary stability

to absorb such prices this barrier may limit businesses to using traditional petroleum based plastics in their single use beverage containers, even if they wish to transition to plastic alternatives. This barrier was addressed by 3 out of the 4 businesses that used plastic lids. Paul, co-owner of Novella cafe, uses bioplastic cups and PET plastic lids. Even though his business uses PET plastic lids Paul encourages his workers not to automatically put a lid on a take away coffee cup and wait for customers to ask for lids if they feel that they need them (2018, pers. comm.). I identified this behavior in another cafe in Byron Bay where the owner would place plastic lids and straws under the counter out of sight of customers. She claims that her customers were less likely to ask for a plastic lid or straw when they were out of site and therefore she did not need to purchase and sell as many single use plastic items (2018, pers. comm.).

I highlight these examples as useful strategies to working around the price barrier while still reducing the amount of plastic in single use beverage containers. While neither of these businesses have eliminated plastic lids, they are still avidly trying to limit the impact their plastic single use items have on the environment by not automatically offering them to customers. Through this behavior, these businesses are reducing both business and customer consumption of single use plastic lids. This strategy may even be more influential in reducing environmental impact than using bioplastic lids as it encourages consumers to use less single use items.

3.22 Customer demand

The second major barrier that businesses identified in the elimination of plastic in single use beverage containers was customer demand. While the strategies above may appear useful when price becomes a barrier to reducing and eventually eliminating the use of plastic in single use beverage containers, a customer's insistence on using plastic lids becomes a barrier as well. Three out of the four businesses that I interviewed that used single use plastic lids cited that some customers insisted on using plastic lids even given the businesses efforts to avoid offering lids to customers (see Figure 4). The owner of Curly Kale stated that she tries to avoid using lids for her coffee cups as much as she can, however since coffee is usually drunk hot, some of her customers consistently request lids when ordering their coffees despite her attempts to provide take away coffee without plastic lids.

I did not find any businesses that used bioplastic lids to have cited customer behavior as a barrier to their use of plastic alternatives. This could be due to the performance of bioplastic single use beverage cups and lids being reportedly good, showing no significant

difference from traditional plastic lined cups, with 19 out of 21 businesses in Byron Bay reporting no discernible difference. This distinction suggests that customer demand is a barrier specific to businesses that use plastic lids. However, if a business does not have the monetary means to purchase plastic alternatives, such as bioplastics, and therefore uses plastic lids, customer demand is a potential significant barrier if they wish to reduce their distribution of single use plastic.

3.33 Working with a wholesale distributor and businesses hesitancy

There were three businesses that cited working with a wholesale distributor as a barrier to eliminating plastic in single use beverage containers. Sparrow Coffee pointed out a branding issue with their wholesale distributor that resulted in the use of plastic cups for water. Even though the business uses bioplastic lined coffee cups and bioplastic lids, there were plastic cups available near a water cooler. The product distributor that services Sparrow Coffee had no comment on this issue. One other cafe in Byron cited continuing issues when working her wholesale distributors. When ordering from her wholesale distributors the owner felt a hesitancy to commit to large quantity of plastic alternatives that she was not familiar with. She suggested that smaller amounts of product and lower prices from the wholesale distributor would allow her to commit to a more sustainable plastic alternative for her coffee lids (Cafe owner, 2018, pers. comm.).

Sasha Mainsbridge of Mullum Cares believes that at the center of this issue is a hesitancy to commit to something unfamiliar. Mainsbridge explained that businesses want to provide the best products for their customers and businesses that have been operating for long periods of time using certain products are less likely to change. Mainsbridge stated, “They (businesses) don’t want to offend their customers. It comes down a lot to business confidence.” (Mainsbridge, 2018, pers. comm.) Mainsbridge proposed that a potential solution to business hesitancy of committing to large quantities of unfamiliar products are plastic free campaigns. Campaigns tailored to businesses to reduce and eliminate their single use plastic products for short periods of time allow businesses to trial products without committing to large quantities through wholesale distributors. This tactic, Mainsbridge explained, also allows businesses to put the “blame” on someone else if things go wrong and an establishment receives negative customer feedback (Mainsbridge, 2018, pers. comm.).

While no businesses stated that negative customer feedback was a barrier to eliminating plastics in their single use beverage containers, Mainsbridge proposal of plastic free campaigns has held success in plastic elimination before. In 2016 the IGA grocery store

in Mullumbimby participated in Plastic Free July, a campaign aimed at businesses in the Byron Shire to reduce their distribution of single use plastics. The grocery store participated by stopping to offer single use plastic bags for the month of July. After Plastic Free July, the grocery store decided to eliminate all plastic bags in their Mullumbimby location.

Mainsbridge believes that this campaign not only gave the grocery store the ability to try eliminating single use plastics, but also the confidence to transition given the success of the campaign (Mainsbridge, 2018, pers. comm.).

Additionally, plastic eliminating proposals at festivals and markets allow for vendors to trial certain products and become familiar with reducing single use waste. At the Byron Spirit Festival in 2017, vendors were asked to bring reusable service ware that would be washed at a provided washing station in an attempt to significantly reduce single use food and beverage containers. In 2018, the Byron Spirit Festival did not provide a washing station and instead encouraged vendors to reduce their single use plastic as much as possible on their own (Mainsbridge, 2018, pers. comm.). When asked in April of 2018 which method stallholders preferred, many stallholders were eager to have the festival implement a washing station again to avoid having to purchase single use food and beverage containers (2018, pers. comm.).

While these results show that working with wholesale distributors to eliminate single use plastics in beverage containers can be complicating, there is a deeper barrier for businesses to overcome hesitancy to try something new. Opportunities to trial plastic free single use products or reduce single use food and beverage containers by implementing reusable options has the potential to instill business confidence in transitioning away from single use plastics. Plastic free campaigns and standards imposed by festivals help to increase business confidence, through the facilitation of trialling products and practices that reduce single use plastics. In this way, campaigns and enforceable standards can be useful tools in aiding the elimination of plastic in single use beverage containers even given initial hesitancy from business.

3.24 Barriers to the reduction of single use beverage containers

It is important to note that some businesses choose to reduce or eliminate plastic in their single use beverage containers through the complete reduction or elimination of single use beverage containers all together. An example of this is Santos Organics, where coffee is sold in ceramic cups and patrons are not offered single use coffee cups. To a lesser extent, other businesses I interviewed reduced their use of single use beverage containers by

encouraging customers to dine in and use washable ceramic cups. This strategy can be implemented by businesses that do use plastic single use beverage containers as a way to reduce the impact of the material they are purchasing.

While this strategy may be beneficial to some businesses, it can only be applied to businesses that offer dine in services. Businesses that are considered “take away” cannot offer ceramic cups or other washable serveware due to lack of adequate washing facilities (Mainsbridge, 2018, pers. comm.). Allpress Cafe and another cafe in Byron stated that they would prefer to offer reusable items for customers to use, but that their designation of a “take away” business does not allow them to do this (2018, pers. comm.). These results show that there is an additional barrier for take away businesses. These types of businesses are restricted by the distinction of “take away” in providing reusable cups to customers to use on site for their beverage needs.

Another strategy to reducing the use of plastic in single use beverage containers was encouraging customers to bring reusable containers through the implementation of a discount reward. Responsible Cafes, a nation wide Australian organization, encourages businesses to register as a Responsible Cafe if they offer discounts to customers for bringing a reusable beverage container. For registration onto the website, businesses are placed into a database that helps consumers locate their business for its sustainable practices such as offering discounts for reusable containers. Responsible Cafes either partner with councils to encourage businesses to offer a discount for keep cups, or businesses that already offer discounts reach out to Responsible Cafes to be identified on the organization’s website and interactive map (Draper, 2018, pers. comm).

In Byron Bay, there are currently 12 businesses registered as Responsible Cafes that offer varying discounts to customers that bring a reusable cup. When talking to Rachel Draper, an operations manager at Responsible Cafes, she identified providing these discounts as a viable way for businesses to reduce the use of all single use beverage containers including those that contain plastics (Draper, 2018, pers. comm). However, when asked if there were any potential barriers to businesses using this strategy, she stated that some businesses were not monetarily able to provide a discount to customers for their reusable containers. She said that a price barrier in offering a discount was most apparent in smaller cafes (Draper, 2018, pers. comm.). Out of the 19 businesses that I interviewed, none specifically stated that they were not able to offer a discount for reusable cups based on the added monetary expense. However, this is another potential example of how prices and monetary costs can prohibit businesses from reducing and eliminating plastics single use

beverage containers. The only difference from the price barrier explained above, is that these businesses have chosen to reduce single use containers all together instead of purchasing plastic alternatives.

3.3 Motivations behind the use of plastic alternatives in businesses

Out of the 21 businesses that I interviewed, 19 businesses responded to questions about the motivation behind the use of specific materials for their single use beverage containers. All 19 of these businesses used plastic alternatives, either bioplastic or paper and corn starch, single use cups or lids. The most frequently mentioned motivation among businesses that use plastic alternatives was having environmental sustainability as a key part of their business model, followed by influence from customers, and the physical location of their establishment (see Figure 5). Some businesses cited more than one primary motivation for their choice of bioplastics over traditional petroleum based plastics, this accounts for the greater total number of responses over that of the number of businesses interviewed ($n_{\text{interviewed}} = 19$, $n_{\text{responses}} = 26$).

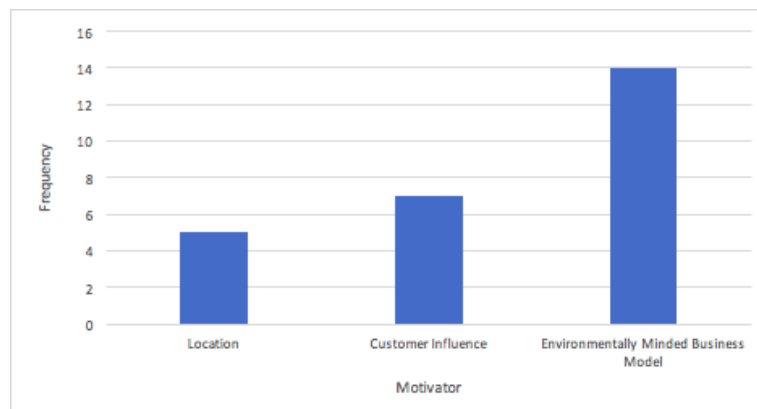


Figure 5. The frequency of different motivations used by businesses in the purchasing of plastic alternatives for single use beverage containers ($n=26$).

There were 14 businesses that reported having environmental sustainability a key aspect of their business model as a primary motivation for their use of plastic alternatives for single use beverage containers. Out of these 14 businesses 13 used bioplastics for their lids and cups and one business used bioplastic to line their single use coffee cups and paper and corn starch resin lids (see Appendix F). Many business owners mentioned having strong beliefs towards reducing the amount of plastics that animals encounter in the ocean. Naomi Peled, owner of the Golden Donut, refuses to sell any single use plastics at all, as she would not feel comfortable putting single use plastics out into the environment knowing the effects

they have on animals (Naomi Peled, 2018, pers. comm.). When talking to Allpress Cafe, reducing the establishment's environmental impact is built into their business plan as both a cafe and a wholesale distributor of single use beverage containers (2018, pers. com.).

There were seven businesses that cited customer influence as a primary motivation to using plastic alternatives in their single use beverage containers. Many businesses said that their customers would not frequent their establishment as much if they did not use a bioplastic lining for their coffee cups instead of traditional petroleum based plastic. Anna the owner of Authentic South Indian Food thinks strongly that her customers appreciate the fact that she uses bioplastics. She feels that her business profits from the choice to use plastic alternatives in their single use beverage containers because customers are more likely to buy food from her business (2018, pers. comm.). One business owner in Byron Bay mentioned that her choice of using bioplastics was motivated by customers as well. The owner, believes customers would show negative reactions to her, including ridiculing her, if she used traditional plastics (2018, pers. comm.).

The final major motivation among businesses was the physical location of Byron Bay. There were five businesses that specifically cited the physical location of Byron Bay as a primary motivation behind using plastic alternatives in their single use beverage containers. Byron Bay is surrounded by some of the most beautiful beaches in the world, making it an area of extreme natural beauty. Paul from Novella pointed to the ocean, a backdrop to his beachfront cafe, and mentioned that he could see the direct impacts of everything he sells out his front door (Paul, 2018, pers. com). Simon Fitzpatrick of Positive Change for Marine Life echoed these sentiments saying that NSW was a relatively environmentally conscious place, where businesses and consumers are more receptive to the damage that plastics cause on the environment. He believes this increased awareness is due to because the direct link between what they "dish out" onto the street and the littered debris they encounter in the ocean (Fitzpatrick, 2018, pers. comm.).

These data show that having environmental sustainability as a key aspect of a business model, customer influence, and the physical location of an establishment can all be significant motivators to the elimination of plastic in single use beverage containers even with the aforementioned barriers. These motivations can be used to understand under what conditions businesses are more likely to absorb or work through barriers to reduce and eliminate plastic in single use beverage containers. Given the high levels of use of bioplastics, these findings also suggest that businesses in Byron Bay regard bioplastics as a suitable environmentally sustainable alternative to traditional plastics. This is a significant

finding given the current scientific debates regarding the environmental impact of bioplastics both in a comparison to traditional plastics and as a stand-alone commodity in today's economy.

3.4 Environmental impact assessment of PLA bioplastics

One of the most commonly used bioplastics is polylactic acid (PLA). The popularity of PLA comes from its availability, relative strength, and compatibility, and biodegradability (Garlotta, 2001, p.64). PLA can be used for a single use food packaging and was designed as an environmentally friendly substitute for traditional petroleum based plastics such polystyrene (PS) and polyethylene terephthalate (PET) (Jamshidian, Tehrani, Imran, Jacquot, & Desobry, 2010, pp. 561-562). PLA is most commonly made from a base feedstock of corn starch or potato starch, but can be made from simple sugars from cane or beets and cheese whey (Garlotta, 2001, p.64). PLA is used for a variety of things including construction, electronics and appliances, medical and hygiene products, and food packaging and serviceware (Bopp, 2012, p. 24-33). PLA is additionally used to line the inside of paper coffee cups, create clear cups and lids, for cutlery, and increasingly as the base material for bioplastic straws. NatureWorks LLC, started in 2002, is one of largest producers of PLA and a leader in innovating new technologies for lactic polymer development. Their trademark product Ingeo is used as a commercial application of PLA (Bopp, 2012, p. 24). For the purpose of this paper, I will be focusing on the single use beverage container applications of PLA as this was the primary bioplastic used among single use cups that I identified among businesses in Byron Bay including the lining of coffee cups and the formation of clear cups, and lids.

3.41 Performance of bioplastics for single use beverage containers

It is important to take the performance of PLA bioplastics into account in this research as PLA must perform to a certain standard to become desirable for businesses to use. A worker at Allpress cafe said that as a cafe they were focused on the end product for their customers, but that they were always looking for better more sustainable materials to provide the same quality of product which includes both the coffee and the container (2018, pers. comm.). There were 28 businesses that used bioplastics in their single use beverage containers (see Figure 2). When asked if they encountered any trouble with the performance of containers made from bioplastics as opposed to traditional plastics 19 out of 21 businesses reported that there were no discernable performance issues.

3.42 Energy and GHG emissions

PLA is most commonly produced from either corn or potato starch. NatureWorks, one of the major producers of PLA for commercial application, utilizes corn, cassava, sugar cane, or beets to produce its PLA product, Ingeo (Bopp, 2012, p.22). Traditional petrochemical based plastics or PETs are derived from petroleum. In a comparison of GHG emissions and energy demand of production, it was shown that PLA bioplastic has a significantly lower environmental impact throughout its lifecycle than PETs (Piemonte, 2011, p. 991). Similarly, in a study conducted on energy use per hectare of land, PLA showed to consistently use less nonrenewable energy upon production than its fossil fuel based counterparts (Bos, Meesters, Conijn, Corré, and Patel, 2012, p. 153-154).

3.43 Land use change

While PLA may be made from renewable resources instead of fossil fuels, it is not necessarily a sustainable alternative in respect to land use. Numerous studies have shown that changing the land from a natural environment to a large agricultural farm to feedstock bio based products has possible negative environmental effects (Piemonte and Gironi, 2011, Weiss, Haufe, Carus, Brandao, Bringezu, Hermann, and Patel, 2012 and Bos et al., 2011). Firstly, land use change must be taken into account when calculating the reduction of GHG emissions between PLA and PET. Much of the appeal of bioplastics comes from the reduction of GHG emissions upon production of bioplastics over traditional petroleum based plastics (Piemonte, 2011, p.991). Secondly, changing land from natural environments to large scale agriculture has been shown to reduce the potential of carbon sequestration resulting in significantly lower GHG savings than previously expected (Piemonte and Gironi, 2011, p. 687). Lastly, soil degradation and eutrophication from agricultural practices due to the production of bioplastics such as PLA can increase with the growing demand of bioplastics (Weiss et al., 2012, p. 173).

While the materials may be coming from renewable sources such as corn and cassava, PLA is used in millions of single use items creating a huge demand on and for land in the production of PLA. It is therefore important to acknowledge the significant environmental impact of the production of such bioplastics to better evaluate the sustainability of these products as petroleum plastic alternatives.

3.44 Composting of PLA bioplastics

One of the most significant assessments for the environmental impact of PLA and other bioplastics has been on the impacts of PLA in the waste stream. PLA is a biodegradable product (Garlotta, 2001, p.64). However, the biodegradability of PLA does not eliminate the environmental impact that PLA products have upon entering the waste stream. Several studies have shown that the disposal of PLA products is complicated by a variety of factors both in the design of PLA and upon entering current commercial waste facilities (Piemonte 2011, Razza and Innocenti, 2012 Piemonte, Sabatini, and Gironi, 2013 and Potting and Harst, 2015).

First, the ability of PLA to biodegrade is one of the key factors in the global appeal for bioplastics over traditional petroleum based plastics. PLA takes on average 6 months to 2 years to degrade in the environment. Whereas petroleum based plastics take between 500 to 1000 years to degrade in the natural environment (Garlotta, 2001, p.64). However, PLA does not efficiently degrade in most natural settings. A review of studies conducted on PLA in 2010 reviewed the biodegradability of PLA in various disposal scenarios. This review also found that in composting facilities, PLA degrades well under set conditions of high heat around 60 degrees celsius (Jamshidian et al., 2010, p. 567). Additionally, this review also found that PLA is degraded by naturally occurring microorganisms. However, PLA has shown resistance to microorganisms in soil and sewage in natural conditions and is therefore not compostable in traditional backyard composts and must be composted in facilities (Jamshidian et al., 2010, pp. 566-567). It is therefore necessary for PLA products to be disposed of properly by composting facilities or recycling if the aim is to alleviate the current litter crisis in the natural environment.

Composting PLA products is an appealing solution to waste management as it creates a valuable product that can be put back into the earth for the production of other things such as food. However, the composting of PLA bioplastics is often energy intensive and not the most beneficial option for PLA waste treatment. A study conducted in 2016, compared the environmental impacts of composting to mechanical and chemical recycling of PLA. It was found that composting had significantly higher environmental impacts than either mechanical or chemical recycling in all three major categories of climate change, human toxicity, and fossil fuel depletion (Cosate de Andrade, Souza, Cavalett, and Morales, 2016, p. 379). A different study conducted in 2011 found similar results when comparing PLA composting to recycling and incineration. In this study composting had the highest environmental impact on human health and natural resources (Piemonte, 2011, p. 993). The increased environmental

impact of composting PLA can be attributed to the GHG emissions associated with biomass production, where recycling practices retain viable PLA to be reused where composting does not (Andrade et al., 2016, p. 379 and Piemonte, 2011, p. 992).

Even with the associated environmental impacts of composting PLA over recycling, composting bioplastics is still a viable improvement to reducing the environmental impacts of petroleum based plastics (Piemonte, 2011, p.991 Soroudi and Jakubowicz, 2013, p. 2852). However, PLA coffee cups and lids are not regularly composted as intended. In a study conducted in Europe, it was found that major commercial composting facilities are often not able to distinguish between clear plastic cups and PLA compostable cups. More importantly, the turnaround time for many of these commercial composting facilities is less than the required time for the complete composting of PLA, leaving large traces of bioplastics in the final compost product (Potting and Harst, 2015, 1152). The Lismore Material Recovery Facility (MRF) is the local waste facility for the Byron Shire. At this facility all inputs to the commercial composting must seek Australian Certification to be composted at this facility. Currently, Bio Pak, a major manufacturer of PLA bioplastic single use service ware for many of the wholesale distributors in the Byron Bay area, is seeking certification (Potter, 2018, pers. comm.). Kim Potter, the business project coordinator, at Waste Wise Smart Business, is excited for the certification of Bio Pak and other positive change businesses to help facilitate better disposal of biodegradable material (2018, pers. comm.). However, this means that currently, Bio Pak compostable serviceware, commonly used in the area, can not be composted at the local commercial composting facility.

Given that PLA bioplastics may be certified, I decided to test the feasibility of properly disposing of a biodegradable PLA cup. I found no public composting bins in the Arts and Industrial Estate and one in the Downtown area. The lack of public composting bins in these high-density business areas suggest that there is a higher likelihood that PLA biodegradable single use beverage containers are put in either the public recycling or landfill bins. Customer behavior is an important factor in the disposal of bioplastic single use goods. Rachel Draper of Responsible Cafes spoke to this issue, “cafes are buying these (bioplastic single use beverage containers) with the best intentions but are not actually helping the problem.” (Draper, 2018 pers. comm.) This quote is in reference to the lack of structure regarding the proper disposal of biodegradable and compostable materials for single use items. Draper highlights the issue that even though businesses may be trying to reduce their environmental impact by purchasing bioplastic single use beverage containers, improper disposal can undermine the sustainability of these products. These results suggest that the

biodegradability of PLA bioplastics in composting facilities is not a significant environmental advantage to traditional petroleum based plastics in areas where proper disposal infrastructure is not available.

3.45 Recycling of PLA bioplastics

Mechanical recycling has been shown to have the lowest environmental impacts for waste disposal of PLA (Soroudi and Jakubowicz 2013, p. 2581 Piemonte et al., 2013, p. 646 and Andrade et al., 2016, pp. 379-383). However mechanical recycling of PLA has underperformed in current recycling facilities. PLA recycling has the ability to contaminate petroleum based recycling streams because the polymers in PLA and PET are not totally compatible (Soroudi and Jakubowicz, 2013, p. 2851). Additionally, the complex mixed materials used in biodegradable coffee cups makes commercially recycling PLA difficult (Sherwood. Clark, Farmer, Herrero-Davila, and Moity, 2016, p. 12) Incompatibility of plastics along with complex mixed materials and similar visual appearances complicates current commercial recycling facilities requiring PLA to have its own recycling stream (Soroudi and Jakubowicz, 2013, p. 2851 and Sherwood et al. 2016, p. 12).

Recycling of plastics including PLA bioplastics in Australia has been restricted due to China's recent ban of importing mixed recyclable material. Australia exports nearly 30% of its recyclable materials to China (Lasker and Goloubeva, 2018, para. 4). China's decision to refuse mixed recycling has put pressure on Australian recycling facilities to think of new ways to manage the waste. Facility managers are calling on governments to take action to support recycling facilities in the transition (Lasker and Goloubeva, 2018, para. 45). China's recycling ban also emphasizes the continued issue with single use products. The complexity and instability surrounding international waste agreements has the potential to significantly reduce the benefits of investing in single use PLA and other bioplastics as a long-term solution to waste management.

These results suggest that PLA bioplastics do have a reduced environmental impact when compared to traditional petroleum based plastics. However, PLA bioplastics do not curb overconsumption and wasteful practices that many studies suggest are the heart of the greater issue of man-made debris in the environment (Ogunola, Onada, and Falaye 2018, p. 9302). While PLA is a viable alternative to traditional petroleum based plastics for single use beverage containers, it is important to acknowledge that PLA bioplastics are not free of significant environmental impact. Since many businesses in Byron Bay utilize PLA in their single use beverage containers based on the environmental benefits (see Results and

Discussion section 3.3), it is necessary that further development of bioplastics continue to improve the sustainability of the products used.

4.0 Conclusions

This research intended to examine barriers to the elimination of plastics in single use beverage containers in Byron Bay, Australia. Through interviews with local businesses and relevant organizations three main barriers were identified. The most frequent barrier among businesses was an elevated price of plastic alternatives, mainly bioplastics, in replacement of single use plastic beverage containers. Evidence of this barrier was supported by local wholesale distributors. The second barrier examined was that of customer demand. Some businesses tried reduced the use of plastic lids by not automatically offering these items. However, due to the insulation lids provide for hot drinks, commonly sold with single use beverage containers, some customers demanded the use of plastic lids. The third barrier was that of working with a wholesale distributor and resulting issues of business confidence. Business confidence was discussed as a barrier to businesses committing to new products or behaviors that can reduce or eliminate plastics in single use beverage containers.

These barriers led to an analysis of current strategies that businesses and organizations employ to navigate reducing plastic in single use beverage containers. Various businesses reduce their plastic use by offering reusable cups, discounts for customers that bring their own cups, or avoid using added material on single use beverages such as lids and straws. Other solutions discussed were in the success of plastic free campaigns and waste standards set at festivals. These two strategies allow businesses to trial products made from plastic alternatives or reduce single use plastics without committing to large quantities of products long term plans. These strategies help to increase business confidence in transitioning away from plastic in single use beverage containers. Three key motivations for businesses to transition away from plastic in single use beverage containers were identified to form a greater understanding of the conditions under which businesses will work through the identified barriers. These motivations were, environmental sustainability as key part of a greater business model, customer influence, and location of establishment.

Additionally, an analysis of PLA bioplastic was conducted as a commonly used plastic alternative among businesses in Byron Bay. In a review of current literature, PLA bioplastic production was found to have an overall reduced environmental impact when compared to the production of traditional petroleum plastics. However, PLA bioplastics show an increased environmental impact upon disposal due to the variations of bioplastics to traditional petroleum based plastics and the current lack of local infrastructure in commercial composting and recycling of bioplastic materials.

These results suggest that bioplastic implementation may not be the best plastic alternative given the current infrastructure for bioplastic disposal. Instead it may be more beneficial for businesses to continue trying to reduce single use beverage containers all together to reduce the amount of inputs to litter and debris in the natural environment.

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Appendices

Appendix A: Written Consent Form

INTRODUCTION

My name is Katie Senechal. I am an American student studying abroad in Australia and conducting research during the month of April 2018. This research is part of a SIT Study Abroad program. This research project is focused on sustainability and waste in Byron Bay, NSW. Before you agree to participate in this study, you should know enough about it to make an informed decision. If you have any questions, ask me.

INFORMATION

Participation in this study will involve the participation of an interview either face to face, over the phone, or through written email correspondence. Interview questions will be focused on the sustainability and use of single-use material in the participant's affiliated establishment. The information gained from this interview will be incorporated into a written report that will be submitted for an undergraduate class and will be included in the program library and may possibly be published on the internet. It will also form part of a short oral presentation that I will make to my class. Additionally, this data has the potential to be used as part of a senior thesis at my home institution (Colby College) in the United States of America.

RISKS

The potential risks of agreeing to provide information via an interview can be embarrassment or discomfort in answering questions face to face and the potential risk of a breach in confidentiality. To minimize these risks, the participant has the ability to decline to answer any question and end the interview at any point. The participant also has the ability to choose the way they wish to be identified, if at all, in any final products of this research.

BENEFITS

Participation in this study may not benefit you directly. However, this research aims to provide a deeper understanding of the plastic litter crisis. Results of this research will aim to provide specific ways in which businesses can work to reduce the amount of single-use plastics that are being introduced into consumption.

CONFIDENTIALITY

You have the option to either remain anonymous or of having your contribution to the study acknowledged. Your anonymity can include the name of your affiliated establishment. If you choose to remain anonymous, the information in the study records will be kept strictly confidential and will be available only to myself. No reference will be made in oral or written reports which could link you to the study.

PARTICIPATION

Your participation in this study is voluntary; you may decline to participate. If you decide to participate, you may withdraw from the study at any time. You may also decline to answer any specific question. If you withdraw from the study at any time the information already obtained from you will be destroyed.

Sign below if you agree to participate in this research study.

Subject's signature _____ Date _____

Researcher's signature _____

Date _____

Legally authorized representative's signature _____

Date _____

Appendix E: Table of interviews with subject names, dates and places

Name	Date	Affiliation
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Simon Fitzpatrick	4 April 2018	Positive Change for Marine Life
Business owner	4 April 2018	Business in Byron Bay
Paul	4 April 2018	Novella
Owner of a Byron Bay cafe	4 April 2018	Byron Bay cafe
Naomi Peled	4 April 2018	The Golden Donut
Anthony	5 April 2018	Combi
Owner of Coffee Stand	5 April 2018	Farmers' Market Coffee Stand
Steve	6 April 2018	Sparrow Coffee
Alice	6 April 2018	Coffee Box
Employee	6 April 2018	Twisted Sista
Alison Campbell	6 April 2018	Love Byron
Sasha Mainsbridge	7 April 2018	Mullum Cares
Stefanie	10 April 2018	GreenPak Wholesale
Man from Distribution Company	11 April 2018	Local Wholesale Distribution Company
Woman from Allpress	12 April 2018	Allpress Cafe and Wholesale Distributor
Man from 100 Mile Table	12 April 2018	100 Mile Table
Employee from Jing Shack	12 April 2018	Jing Shack
Woman from McTavish	12 April 2018	McTavish
Owners of Curly Kale	12 April 2018	Curly Kale
Natasha	20 April 2018	Home Comfort Soul Food
Anna	20 April 2018	Authentic South Indian Food
Joanna	20 April 2018	Sacred Seed
Tanya	20 April 2018	The Cart Cafe

Ginny	20 April 2018	The Art of Culture
Vendor at Spirit Festival	20 April 2018	Vendor at Spirit Festival
Zoe White	30 April 2018	Ocean Survey Officer at Positive Change for Marine Life
Rachel Draper	29 April 2018	Operations Manager at Responsible Cafe

Appendix C: Interview questions for businesses

1. What types of materials are used to make your single-use coffee cups?
2. What motivated you and your business to purchase these types of cups?
3. Would you consider using any other material for your single-use coffee cups?
4. How have customers reacted to the use of this material?
5. Have you experienced any barriers in eliminating plastic in your single use beverage containers?
6. Is sustainability important to you and your business model? Do you feel that sustainability is important to your customers?

Appendix D: Formal interview questions for wholesale distributors

1. What are the materials used in your cups, lids, straws? Where are they sourced from?
2. What is the quantities of cups sold to Byron Shire?
3. Who sets the price for your products?
4. What is the minimum quantity that one business can get at a time (trialability)?
5. What is the science behind the eco friendliness of your materials?
6. What happens if these materials are not properly disposed of?
7. Where is the bioplastic technology moving?
8. Is sustainability important to your business model?

Appendix E: Formal interview questions for single use plastic focused organizations

1. What type of single-use food or beverage container do you think is the most detrimental to the environment?
2. How has your organization worked with businesses to transition away from single use plastics?
3. Are there any major obstacles that you have identified as barriers for businesses in transitioning away from plastic in their single-use food and beverage containers?
4. Do you think that changing business models away from single-use plastics will create significant positive change in the marine environment?
5. Do you think that business changes will change consumer habits away from plastic packaging in general?

Appendix F: Table of use of plastic or plastic alternative per establishment in Byron Bay.

Establishment Name	Single Use Beverage Container	Lid
Goodies Juice Bar	Bioplastic	Bioplastic
The Bookroom Cafe	Paper and Bioplastic	Plastic
Cafe in Byron Bay	Paper and Bioplastic	Plastic

Novella	Paper and Bioplastic	Plastic
The Golden Donut	Paper and Bioplastic	Bioplastic
Combi	Paper and Bioplastic	Bioplastic
Farmers' Market Coffee Stand	Paper and Bioplastic	Bioplastic
Get Toasted	Paper and Bioplastic	Plastic
Sparrow Coffee on the Fly	Paper and Bioplastic	Bioplastic
Warung Bagus	Paper and Bioplastic	Bioplastic
Coffee Box	Paper and Bioplastic	Bioplastic
Love Byron Bay	Paper and Bioplastic	Plastic
Twisted Sista	Paper and Bioplastic	Bioplastic
Allpress Espresso	Paper and Bioplastic	Bioplastic
Jing Shack	Paper and Bioplastic	Bioplastic
100 Mile Table	Paper and Bioplastic	Bioplastic
McTavish Cafe	Paper and Bioplastic	Paper corn starch
Curly Kale	Plastic	Plastic
Hideout	Paper and Bioplastic	Bioplastic
YoFlo	Bioplastic	Bioplastic
SPAR Express	Paper and Bioplastic	Bioplastic
Byron Corner Store	Paper and Bioplastic	Bioplastic
Sweet Byron Frozen yogurt and Juice Bar	Bioplastic	Bioplastic
Authentic South Indian Food	Paper and Bioplastic	Bioplastic
Comfort Home Soul Food	Paper and Bioplastic	Bioplastic
The Cart Cafe	Paper and Bioplastic	Bioplastic
The Art of Culture	Bioplastic	Bioplastic
The Vendor at Spirit Festival	Paper and Bioplastic	Bioplastic
Magic Mixers Elixirs	Paper and Bioplastic	Bioplastic
Santos Organics	No take away option	No take away option